University of Glasgow Collage of Science & Engineering

# The Struggle between Nature and Development: Linking Local Knowledge with Sustainable Natural Resources Management in AL-Jabal Al-Akhdar Region, Oman

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**Abstract**.

Increasing awareness about the necessity for natural resources protection represents worldwide recognition of its importance as an important tool in mainstream development. This growing recognition is accompanied by a growing awareness about the importance of activating natural resource management systems to achieve greater sustainability. At present, experiences and studies in this field show the need for the participation of all stakeholders in the processes of decision making in natural resource management. There is also a need to initiate natural resource governance that ensures effective management to benefit sustainable development, the later representing a key foundation for environmental and natural resources management. Moreover, investigations of the prospects of applying traditional knowledge systems and their integration with Western scientific knowledge produces numerous calls to revisit this knowledge where it has proven useful in environmental and natural resources management, both in theory and practice.

In this spirit, this thesis investigates the effectiveness of the natural resources management system in Oman using Al-Jabal Al-Akhdar Region (AAR) as a case study, and linking this management system with the local people's practices, which rely on their traditional environmental knowledge. Based on theories and concepts of natural resource management and sustainability, multiple research methods were used to explore the strengths and weaknesses in the system of natural resources management in the region, to analyze the advantages of traditional practices and knowledge systems, and thus, to deepen the understanding of the continuous struggle between nature and development. Results indicated that although Oman is rich in environmental policies, represented by laws and legislation that theoretically govern protection of the environment, the transformation of these policies into

practice is troubled by practical obstacles. On the natural side, there are volatile climatic conditions, and on the human side, there is inefficiency of planning and a lack of means and tools to implement sustainable natural resources management programmes. Both obstacles expose environmental sustainability to uncertainty. However, as this research points out, traditional environmental knowledge and management practices systems used by local people in the AAR are characterized by useful interpretations of environmental dynamics to guide the direction of resource utilisation and management, and to address any uncertainty on the course toward sustainability.

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## List of abbreviations/acronyms

| Abbreviation | Full name |
|---|---|
| AAR | Al-Jabal Al-Akhdar Region |
| CBD | The Convention on Biological Diversity |
| CBNRM | Community Bases Natural Resources Management |
| CCDD | United Nations Convention to Combat Desertification and Droughts |
| CA | Conservation Agriculture |
| CBNRM | Community-based natural resource management |
| DRC | Diwan of Royal Court |
| EU | European Union |
| ICARDA | International Center for Agricultural Research in the Dry Areas |
| IFAD | International Fund for Agricultural Development |
| ILO | International Labour Organization |
| IK | Indigenous Knowledge |
| IPCC | Inter-governmental Panel on Climate Change |
| IUCN | International Union for Conservation of Nature |
| MA | Millennium Ecosystems Assessment |
| MEA | Multilateral Environmental Agreements |
| MRMWR | Ministry of Regional Municipalities and Water Resources |
| MAF | Ministry of Agriculture and Fisheries |
| MECA | Ministry of Environment and Climate Affairs |
| MOT | Ministry of Tourism |
| MOH | Ministry of Housing |
| MP | The Mountain Partnership |
| NBSAP | Oman's National Biodiversity Strategy and Action Plan |
| NR | Natural resources |
| NRM | Natural Resources Management |
| OVD | Overseas Development Institute |
| PES | Payments for Ecosystem (or Environmental) Services |
| SADC | Southern African Development Community |
| SD | Sustainable Development |
| SEK | Scientific Environmental Knowledge |

| | |
|---|---|
| SNRM | Sustainable Natural Resources Management |
| SQU | Sultan Qaboos University. |
| TEK | Traditional environmental knowledge |
| UN | United Nations |
| UNFCCC | United Nations Framework Convention on Climate Change |
| UNDP | United Nations Development Programme |
| UNIP | United National Independent Party |
| UNEP | United Nations Environment Programme |
| WAC | World Agro-forestry Centre |
| WCPA | World Commission on Protected Areas |
| WIPO | World Intellectual Property Organization |
| WRI | World Resources Institute |
| WCED | World Commission on Environment and Development |
| WWF | World Wide Fund for Nature |

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## DECLARATION

I declare that the thesis, except where acknowledged to others, is the result of my own work and does not include work forming part of a thesis presented successfully for another degree at the University of Glasgow or any other institution.

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**Mohammed Al-Busaidi**

**Glasgow, September 2012**

# Chapter One

# Introduction

## 1.1 The research context: sustainable natural resources management, traditional knowledge and sustainable development

The struggle between nature and human development is inevitable. On the one hand, nature is the theatre for all human activities that aspire to achieve the continuity of human life and prosperity. On the other hand, nature in its various forms and phenomena may constitute barriers and hazards that obstruct human ambitions. Therefore, humans must work effectively to avoid nature's obstructions and to achieve a balance between human development and the preservation of nature. One anthropocentric suggestion perceives nature as ''inanimate,'' separating it from humanity (Schultz, 2002). This view restricts the human/nature relationship to the purpose of getting resources for human life, or places for human activities. Achieving these human goals, then, is a victory worthy of excitement (Brymer and Gray, 2009). However, this vision contrasts with another, more mature, vision that argues for a well-defined association between nature and humanity, describing nature as a close extension of the self where humankind is a vital part of the great universe (Birrell, 2001; Schultz, 2002; Martin, 2009). This means that life, as Strange and Bayley (2008:8) describe:

> ''depends on a complex set of interactions between people, the natural environment, and economic systems. The unprecedented growth seen during the 20th century has affected these relationships in both positive and negative ways. Record levels of pollution have put great stress on the environment. Economic growth has created immense wealth in some areas of the globe, but left others behind. Understanding the essential elements that support healthy societies and a healthy planet is an urgent need for people and their governments''.

Inadequate understanding of the relationship between the natural environment and humanity have generated many environmental struggles that are of concern all over the world. As Escobar (2006) suggests, while it would seem that these struggles are becoming universal in many regions of our shared planet, their roots stretch back to the nineteenth century, as the industrial revolution has expanded to many region of the World. He argues against the exported terms of sustainable development (SD), distributed by ‘‘neo-liberal globalization’’, as development, if it is to be sustainable, must have concepts, standards, and measurements driven by the community, taking into account the natural environment, its vitalities, and resources, and the human willingness and capacities to carry out the burdens of sustainable development (Dongier et al, 2003). Failing to do so, communities worldwide will increasingly struggle to defend their natural environments and cultural space.

Among the challenges facing sustainable growth are the integration of environmental sustainability into core development work, maximization of synergies, critical consideration of natural resource–dependent countries, and sound resource management (World Bank, 2008). One of the key aspects of the integration of human development and preservation of the environment is to involve local people in the formulation of objectives to be achieved through protected areas; this involvement is vital to gain legitimacy and practical support at the local level (Boillat, 2007). The Convention on Biological Diversity (CBD) recognizes the importance of local participation as a key element in achieving its objectives. Consequently, it has developed many specific techniques to involve local stakeholders in all management and development projects. Stakeholder analysis is one of the techniques that identifies stakeholder involvement as key. This technique includes a clarification of all practices followed by a management system: placing issues in a systems context to create management objectives; identifies decision-makers and stakeholders; investigates stakeholder interests and

agendas; and anticipates the expected patterns of interaction to reach management output (Grimble, 1998).

Furthermore, employing natural resources within generic tools for SD demands sustainable management. In order to reach sustainability, one of the presumed challenges lies in policy consistency in which different policies and practices should support each other, and this is essential to achieving tangible and lasting development (Strange and Bayley, 2008). In other words, as Sterner (2003) put it, the policy of natural resources management (NRM) should function within the overall policy environment. If this environment has an uncompetitive economy or experiences dishonest organizations, then policy instruments to carry out NRM responsibilities will function poorly, even if staff members and leaders are educated and projects are well-funded. However, two messages are clear from the modern environmental debate about NRM. First, policies must effectively mitigate environmental and natural resources problems created by humans who interact negatively (unsustainably) with their environment, while attempting to meet the continuous demands for natural resources. Thus, efficient instruments are needed to create effective natural resources policies. Second, it is important to change more than the names of approaches or programmes of NRM. No matter how attractive the name, and regardless of solid theoretical frameworks, objectives will not be achieved without the availability of physical and human resources, the media through which these programmes must function.

Aiming at enabling local people to play a better role in decisions about the use of land and resources, predominantly state-centred control of natural resource management has moved towards more devolved models over the past decades. These models are applied, as Raymond et al (2010:1766) suggested, ‘‘in the approaches of adaptive co-management (Folke et al,

2005; Armitage et al, 2007, 2008, 2009; Berkes, 2009), trans-disciplinary planning (Tress et al, 2006), community- based natural resource management (e.g., Kellert et al., 2000; Blaikie, 2006; Robinson, 2006 1,2), transitions management (e.g.,Geels, 2002, 2005); (and) sustainability science (e.g., Kates et al, 2001 ;Clark and Dickson, 2003)''. One of the main approaches in which local people can participate in environmental decision-making is "community-based natural resource management" (CBNRM), which states, "local involvement is essential for sustainable development" and aims at creating processes to engage with management issues within local communities (Shackleton et al; Boillat, 2007). As with public participation, community-based NRM is a strategy that aims to enhance project efficiency and an approach to empower local communities to utilize their resources and ensure their rights to appropriate resource management. A basic condition for this latter option is that community initiatives and innovations are important to solving environmental problems. This does not always require outside interference, as many communities may already have established rules and structures aimed at resource management. These apply particularly to traditional communities that have long-term continuity embedded in their way of life and in their relationship with the environment. (Shackleton et al, 2002; Mansuri and Rao, 2004). However, practical results of such transfers of NRM are varied and this CBNRM approach has yielded only partial benefits for local people; the reasons for differences in performance results are still not fully understood (Shackleton et al, 2002; Behera, 2003; DeGeorges and Reilly, 2009).

In an era of knowledge explosion, choosing the appropriate knowledge could be difficult for decision makers in NRM. Whether Western scientific environmental knowledge (SEK) or traditional Environmental (TEK) knowledge is the best choice is still debatable and pairing them can produce successful solutions (Raymond et al, 2010). Moreover, although it is

difficult to integrate local stakeholder perspectives sufficiently in the strategies of NRM (Olsson and Folke, 2001), it is vital to take account of different types and sources of knowledge in order to manage the complexity and uncertainty of the landscape effectively (Olsson and Folke, 2001; Cash et al, 2003; Reid et al, 2006; Fabricius et al, 2006). However, knowledge needs to be managed and articulated across different scales of experts, institutions and local interests, and this forms a challenge for knowledge managers to facilitate two-way interactions between these actors and between ‘‘human-environmental systems’’ (Reed, et al, 2011).

Acknowledging traditional people and their knowledge, IUCN states the following in its guidelines about the relationship between indigenous peoples and protected areas: “indigenous and other traditional peoples have long associations with nature and a deep understanding of it. Often they have made significant contributions to the maintenance of many of the earth’s most fragile ecosystems, through their traditional sustainable resource use practices and culture-based respect for nature’’ (Beltran, 2000: ix).

During the last three decades, many research articles have appeared on TEK. The majority of these references are optimistic about the importance of TEK and its value, particularly in developing countries. This trend, therefore, suggests a need to integrate TEK into development programmes, plans and strategies. Meanwhile, a minority of these references question the importance of TEK for development and the ways in which it is exploited. The contribution of TEK to human civilization across both the millennia, and a wide range of fields, is of great value. Even modern science and technology have their roots in TEK and it can be seen in modern innovations such as the advancements in alternative medicine, which developed from traditional medical knowledge. From this viewpoint, this study investigates

the TEK of the local people in Al-Jabal Al-Akhdar Region (AAR) in Oman, their culture-based respect for nature, and their practices for managing their natural resources. The study relates such knowledge and practices to the governmental NRM approaches.

### 1.2 The research objectives

As Oman pursues development, it also wishes to protect its environment and traditions. Local environmental management practices, natural landscapes and Oman's land resources are vitally important and among the list of environmental treasures that the Omani government is trying to conserve/preserve. Introducing the book ''Plants of Dhofar: The Southern Region of Oman, Traditional, Economic and Medicinal Uses,'' (Miller and Morris, 1988:8), His Majesty (HM) Sultan Qaboos expressed his appreciation of the traditional knowledge possessed by Omanis concerning traditional uses of wild plants. He has this to say:

> ''Here in Oman, we still have among our people (those) who are extensively knowledgeable of medical and economic uses of many wild plants. A few years ago, we hoped that as much as possible of this valuable knowledge (would) be recorded, and all of that knowledge collected about (the plants, would) be maintained before the demise of this knowledge or the plants, or both. Indeed, this is what has been occurring in some parts of the world after indifferent socio-economic and industrial development. We are here in Oman seeking to guide the development of our natural resources toward rational exploitation, aiming at raising the living and education standards of our people, (while ensuring) the survival of these plants by continuing to conserve them, meanwhile utilizing them''.

This is the vision of the Omani leader who is thoughtful not only about the Omani environment but also the world environment. His Majesty is dedicated this commitment to the harmony between the environment and development, warning:

> ‘‘Development is a necessary process, especially in our country, but the impact of development must be skilfully directed so that our woodlands are not destroyed, our soils are not eroded, and our valuable species of plants and animals are not prevented from playing their vital roles in maintaining the environment, given to us by God, in which to live’’ (Miller and Morris, 1988:5).

H M perceives that local knowledge and its scientific counterpart in Oman, or in other similar regions of the world, contain the basic tools that equip the Oman people with guidance on the natural changes in the ecosystems of Oman. Believing that development activities will cause changes to the nature of the country, the ability of Omanis to guide these will depend on the depth of their knowledge. The skill with which they do it will determine the quality of the lives to be lived by Omanis for generations to come - whether they will live, as now, among green trees and grass, or in a desolate/barren desert.

However, the challenge is how to mitigate conflict between development and conservation, since failure in one affects the other. This has happened already in some parts of Oman and erosion of beaches and salinization of groundwater are cases in point (Sana et al, 2005). Studies reveal that environmental problems result from those development projects that did not adopt the Precautionary Principle (Victor et al, 2008; Ramanathan and Subramanian, 2008; Gebauer et al, 2007). UNESCO (2005) defines Precautionary Principle as the actions and interventions that are undertaken before unacceptable harm occurs, seeking to avoid or reduce the harm. Actions should be participatory chosen that are proportional to the seriousness of the potential harm, with consideration of their positive and negative consequences, and with a valuation of the moral implications of both action and inaction (UNESCO COMEST, 2005). Among the pressing issues that some studies have highlighted is the need for more knowledge of the socio-economic aspects. There is a need for greater

interdisciplinary analysis to get a better understanding of how to preserve the heritage of agro-ecosystems (Gebauer et al, 2007). TEK is at the frontier of agro-ecosystems that are in urgent need of conservation.

A review of previous studies reveals that the management of natural resources has received considerable attention at global, national and regional levels. Developed countries have realized the importance of sound management of resources to maintain their continuity and sustainability. Thus, they pursue management approaches that favour the sustainability of resources as much as is possible. However, many developing countries are newcomers to NRM issues and their organization. Some countries try to utilise the developed countries in order to achieve both the appropriate use of their natural resources endowment and better conservation of these resources. Hence, they may provide many facilities for researchers, scientists and experts to conduct research on NRM. Among the various approaches relating to natural resource management are communal-based NRM programmes. These approaches have been an area of debate among researchers and organizations interested in natural resources. The importance of this approach is in its linkage between natural resources, the beneficiaries of these resources, namely local communities, and the government or the State as the official proprietor of these resources.

Research that has addressed NRM is concentrated in Europe, North America, South America, Australia and some countries in Asia and Africa, where these countries are rich in natural (land) resources. Nonetheless, some countries are relatively poor in natural non-geological resources due to their location in the arid zones. For example, the Arabian Peninsula faces environmental challenges because of the irrational use of natural resources. This abuse mainly comes from those people who are unfamiliar with such sensitive resources and this

has resulted in the unsustainability of these resources. What makes matters worse is that these countries often lack studies of NRM and natural environment conservation. This creates a real gap between complementary studies and the incorporation of knowledge in these areas.

Aiming to contribute to the field of the management of natural and environmental resources, this study addresses natural resource management by examining NRM practices in the Sultanate of Oman, Al-Jabal Al-Akhdar Region (AAR). The study focuses on the administrative methods and practices adopted by the government to develop projects and programmes to utilise the resources of AAR, as a fragile region located in an arid zone. This study provides an analysis of the reality of the managerial practices in the light of recognized sustainability criteria, as set out by relevant international organizations, such as the World Bank, the World Wildlife Fund (WWF), the World Conservation Union (IUCN), and the World Commission on Protected Areas (WCPA). In addition, it analyses key criteria contained in the Omani National Biodiversity Strategy and compares modern management practices implemented by the government with traditional (local) practices that have been pursued by local people across many generations. These societies have lived in such rugged mountainous areas over millennia and have developed knowledge and practices which have enabled them to survive and take advantage of the scarce natural resources, especially in the drought seasons.

TEK in Oman, and especially in the AAR, is subject to erosion and decay, because the region itself is developing and changing various aspects of life. This study evaluates whether these TEK is sustainable. The study aims to investigate and establish the relationship between TEK and NRM that people in the AAR have long used, and the potential for its implementation to promote a sustainable resources management environment in the future.

In specific terms, the study addresses the following research objectives:

1. To audit the status of natural resources in the AAR.
2. To evaluate the environmental and socio-economic importance of the AAR.
3. To establish the nature of current practices in NRM pursued by the relevant government departments in Oman.
4. To evaluate government efforts to ensure environmental sustainability, in light of the environmental articles in the Oman National Biodiversity Strategy and Action Plan (NBSAP).
5. To evaluate TEK systems and practices in managing natural and environmental resources.
6. To identify pathways to more sustainable natural and environmental resource management, and sustainable development, by utilizing a hybrid of SEK and TEK.

## 1.3 **Research questions**

This study is guided by fife main research questions:

1. What is the current state and what are the trends in natural resources in the AAR? What are the main vulnerability factors threatening NR in the AAR? In particular, what impact has development had on the natural resources dynamics in the AAR?
2. What is the environmental and socio-economic importance of the AAR? How is this importance affected by negative environmental impacts resulting from a variety of natural and human factors?
3. How do governmental bodies manage or govern natural resources in the AAR? To what extent have these efforts yielded positive influences in preserving natural resources in the AAR? Are government management practices in harmony with the existing local

peoples' knowledge and interests surrounding NRM that aim at maintaining livelihoods?

4. What traditional practices do the local people use to manage natural and environmental resources? To what extent have these practices yielded positive influences in preserving NR in the AAR? How traditional practices have changed over the years in order to adapt to the environmental changes.
5. What are the challenges to SD in the AAR? What efforts has the government made to ensure sustainable environment and development in the AAR using criteria from the Oman National Biodiversity Strategy and Action Plan (NBSAP)? What pathways/methods can enhance the sustainability of natural and environmental resources in the AAR using a hybrid of SEK and TEK?

### 1.4 Theoretical and analytical framework.

The analytical framework used in this study focuses on how NRM can promote SD. Within this overall framework, the study links TEK and management practices pursued by local people in the AAR with government management practices to maintain natural resources in the region. In a time of increasing natural resources scarcity and climate change, the actual and possible engagement of public and private actors in governments' efforts to conserve natural resources has become obligatory (Overseas Development Institute, 2011). This situation has encouraged many researchers to examine many options with regard to NRM approaches. The options start with old methods that separately deal with different natural resources - and thus separate management entities – and move to modern methods, which recognise the connection and complexity of natural resources, and hence, the need for the integration of management entities, or at least, for effective coordination among them. These

research activities aim at proving tangible and sustainable approaches to managing natural resources and avoiding the negative effects that might obstruct NR sustainability. Nevertheless, Massuanganhe (2008) stated that institutional analysis became a prominent part of research within developmental landscapes, as policies and institutions have appeared to combine toward a new analytical direction. For example, in agriculture analysis, factors that influence efficiency are mostly qualitative, and related to institutions, politics, and policies.

Much of the literature directly links indigenous knowledge (IK)/ traditional knowledge (TK)/ traditional environmental knowledge (TEK) to the sustainable use and maintenance of the environment. Evidence is provided by several effective examples of local managers regenerating environments and supporting local livelihoods, where they have created management techniques that build on an indigenous system (IFAD, 2005; Ballard et al, 2008; Raymond et al, 2010).

As such, SD and its indicators comprise the main guide to the discussions and analyses in this study. These indicators focus on environmental development and its interactions with economic and social development. Thus, this study investigates the extent to which the government efforts that aim at maintaining the sustainability of natural resources in the region are consistent with the local practices that aim at maintaining livelihoods. Comparing this study's observations of the natural resources situation to a critical review of the developmental discourse adopted by the government and its environmental policies can promote a deeper understanding of the interaction processes among all stakeholders in NRM in Oman (nationally, regionally and locally) and the beneficiaries of the natural resources, present and future.

## 1.5 Organisation of the thesis

Chapter One is an introduction to the thesis, in which the context of the research and the key problems are examined.

Chapter Two deliberates on the theoretical perspectives of the research, reviewing the literature concerning aspects related to sustainable natural resource management, indigenous or traditional knowledge and SD. The first section of the chapter highlights the theoretical debate and some empirical examples surrounding NRM, presenting the importance of natural resources; the need for sustainable management; approaches to NRM; and predictions about the future of NRM. The second section discusses indigenous or traditional knowledge as the framework of research that embraces discussion and analysis of the local people's practices in order to maintain their livelihood. The third section connects some perspectives of SD with efforts of developing mountainous region in some parts of the World.

The third chapter describes the study area, the general geographical location of the AAR, its geographical characteristics and its historical background, before going on to provide an analytical appraisal of the socio-economic, demographic components of the AAR, the administration of the region and the natural resource governance structures.

Divided into three sections, Chapter Four introduces the research methodology. Section 4.1 sets out the foundation on which the methodology of this research is developed. Section 4.2 discusses how data were collected from secondary data resources, including official annual reports, as well as from primary source of data, including structured open-ended interviews with government officials, a questionnaire survey of government officials, focus group discussions of local people, and a questionnaire survey of local people. Finally, section 3.3

discusses the data analysis methodology applied in this research, stating how the research dealt with content analysis of official documents, quantitative analysis of questionnaires, transcription analysis of interviews, and transcription analysis of focus group discussions.

Chapter Five presents the analytical results related to the status and importance of natural resources in the AAR, emphasising the environmental and socio-economic importance of natural resources in the AAR, suggesting that these natural resources, among other factors, influence the types of economic activities in the region, which in turn, contribute to the social fabric and the culture of the local people.

Chapter Six evaluates the effectiveness of government practices in natural resources management (NRM) in the AAR, by investigating the management systems used by government agencies responsible for NRM in the AAR.

Chapter Seven analyses TEK and practices in natural resource management, emphasising the perspectives of government officials and local people concerning environmental knowledge and practices regarding water resources.

Chapter Eight gives a critical investigation of the challenges that face SD and environmental sustainability in the AAR, focusing on environmental sustainability and the challenges to its achievement. The sustainability of livelihoods in the AAR is discussed as well as government action to maintain environmental sustainability and SD in the AAR.

In conclusion, Chapter Nine summarises the key findings of this research, posting conclusions and lessons from the Omani experience in NRM that are related to similar experiences elsewhere. As this chapter presents policy recommendations for more sustainable NRM, it presents a wider perspective about inseparable relationship between development and nature.

# Chapter Two

## Literature review: Theoretical Perspectives

### 2.1 Natural resource management

#### 2.1.1 Introduction:

"The best resource is the one we don't need" (Bringezu and Bleischwitz, 2009). Bringezu and Bleischwitz (2009) published 'Sustainable Resource Management', to promote a radical perspective on how the global economy should use natural resources in intelligent ways. Following this perspective, the sustainability of natural resources depends on how the world manages these resources. However, in the current economic crisis many remain focused on financial implications, while others highlight the on-going environmental crises, most notably with reference to climate change (Bringezu and Bleischwitz, 2009). In fact, one remedy to both economic and environmental crises requires the build-up of sustainable capital (Bringezu and Bleischwitz, 2009). Moreover, as this capital is based on natural resources, its sustainability depends on the continuity of these resources and that can only come about with efficient management and utilisation.

Natural resources provide essential life support, in the form of both consumptive and public-good services. Ecosystem services sustain soil productivity, the food chain, air and water purification, and climatic cycles. Soils are the basis of agriculture, and so are fundamental to all people's livelihoods. 'At the genetic level, the diversity found in natural life-forms maintains the breeding programs necessary to protect and improve cultivated plants and domesticated animals. Wild flora and fauna form the basis of traditional medicine and a significant part of the modern pharmacological industry' (Bojo, 2000:1). Moreover, natural

resources sustain all human endeavours. Their sustainable availability is one of the pre-eminent problems and challenges of the current century (Lynch, 2009) and the impacts of ever-increasing global resource use are becoming increasingly clear. Over-use of natural resources is increasingly generating conflict at both local and regional levels. An example is the expansion of agriculture for the production of non-food biomass for biofuels. This converts natural forests and savannas into monocultures and impacts on biodiversity and the quality and functioning of the living environment (Bringezu and Bleischwitz, 2009).

The way that we make environmental and NRM decisions can be termed 'environmental governance' and what we decide is determined by how we decide and who gets to decide. The failures of our past economic and resource decisions are evident in dying coral reefs, exhausted and depleted forests, and polluted air and water systems (United Nations Development Program, et al, 2003). The following section presents an overview of the literature, with the aim of determining the key elements of natural resource management.

### 2.1.2 The importance of natural resources and the need for sustainable management

The World Bank report 'The Global Monitoring Report 2008: MDGs and the Environment, Agenda for Inclusive and Sustainable Development', likens the achievement of the Millennium Development Goals (MDGs) to the meeting of successful challenges facing the world's natural resources. Among these challenges are listed the requirements of what is critical for sustainable growth, such as the integration of environmental sustainability into core development work, maximizing synergies, a consideration of natural resource–dependent countries, and sound resource management (World Bank, 2008). All of these challenges are underpinned by the importance of natural resources.

One of the Millennium Development Goals is to ensure environmental sustainability. However, the idea of environmental sustainability goes well beyond the conservation of nature. Natural resources are different from many other economic goods and services in that they simultaneously constitute an essential part of ecological cycles, inputs to production processes, and the basis to support households and individuals (Krautkraemer, 2005; United Nations, 2011). Environmental goods can be used up or depleted to make space for produced goods, and this economic process may entail a permanent loss of useful environmental goods. "The “art” of balancing nature and development so that social welfare does not decline over time is at the core of environmental sustainability" (World Bank, 2008:179). This balance seems to be problematic given that global resource extraction is a growing trend that is causing growing environmental impact (Bringezu and Bleischwitz, 2009). For example, water scarcity is threatening agriculture and consumers in many countries (for example, in the Middle East countries), especially where the level of some of the world's major rivers are being drawn down by abstraction. Soil degradation, deforestation and coastal erosion are among the problems that are threatening the biodiversity, ecosystems and sustainability of food chains across the globe (Sterner, 2002; World Bank, 2006). To further complicate the issue, many developing countries, such as India, Indonesia, Zambia and Mozambique, are directly economically dependent on their natural resources and raw materials. The Word Bank confirmed this by stating " the environment and natural resources constitute a major source of income, especially in the poorest countries: water resources sustain agriculture and industry; forests provide construction materials and energy; mineral exports can generate foreign exchange. In low-income countries natural resources can be an important driver of growth, which in turn can provide the scope for poverty reduction" (World Bank 2008:182).

Yet poverty also creates a situation where decline in resource yield is of necessity disregarded resulting in continuing unsustainable behaviour, rather than investment in productive and sustainable technologies. For this reason, destitute people may continue to harm the environment using methods that may individually be considered acceptable due to the lack of markets yet are at the same time a signal of market failure (Sterner, 2002).

Based on the above, the management of natural resources and ecosystems is critical for global sustainability and fundamental for the economies of most developing countries. Many organizations champion the maintenance and conservation of natural resources including the Food and Agriculture Organization (FAO), UN Division for Sustainable Development, the UN Development Programme (UNDP), the UN Environment Programme (UNEP) and the UN Educational, Scientific and Cultural Organization (UNESCO). In addition, the World Bank contributes to the promotion of investment in natural resources and harmonising these activities with environmental concerns. The environment-related lending operations of the World Bank have become important, its investment lending for environment and NRM between 2002 and 2007 amounting to $10.2 billion (10.4% of total World Bank lending). Pollution management and environmental health activities make up the largest share of the lending (35%), followed by water resource management activities (29%). Development Policy Lending is another instrument through which the Bank is supporting environmental policy and institutional reforms, rising sharply, from $59 million in 2004 to $264 million in 2006" (World Bank, 2008:177).

In spite of these efforts, concerns remain regarding natural resource management, particularly in developing countries (Bruce and Mearns, 2002; World Bank 2006; United Nations

Development Program, et al, 2003; World Bank, 2008). The most worrisome, according to the World Bank (2006) are:

> "1) renewable resources are utilized beyond their regenerative capacity, which is especially troubling for the poor, whose resource base tends to be narrow and less easily shifted geographically and sectorally; and
>
> 2) non-renewable resources are depleted with insufficient savings in human, or social capital, and with minor benefits directed specifically to the poor" (World Bank, 2006:3).

Most of the organizational reports and studies indicate that the main reasons for these problems lie in the human abuse and mismanagement of natural resources. Unsustainable management techniques and practices used by humankind have abused natural resources and subjected them to exhaustion. It is worth mentioning that one of the important managerial practices is to identify a timescale over which the resource is used and renewed (replaced). This determines whether the resource is sustainable or not. The following paragraphs seek to highlight some approaches that are currently being taken regarding NRM.

### 2.1.3 Approaches to natural resource management:

It is clear that natural resources are important. What is not clear is why the world is responding so poorly to the issue of NRM, and why natural resources are facing challenges regarding efficiency of use and sustainability. The question is whether this is due to the lack of management policy or to inappropriate implementation of this policy. Sterner (2003) asserts that the main reason is the latter since:

> ‘‘policy does not function in a vacuum; it is heavily dependent on the overall policy environment. If the economy is not competitive and if the bureaucracies are not

> honest, well-informed [and] well-funded to carry out their responsibilities, then no policy instrument will work perfectly–although some will work better than others'' (Sterner 2003:67).

A range of studies have aimed at generating better practical knowledge to help to improve current management policies, methods, techniques and implementation. The terms environmental governance (United Nations Development Program, et al, 2003; Murphree, 2004) and sustainable NRM (McLain and Jones, 1997; Bocoum, et al, 2003; Lynch, 2009; Bringezu and Bleischwitz, 2009) are now used to focus on appropriate approaches for NRM. Environmental governance encompasses a wide range of practices, including sustainable natural resource management, and is simply defined as "the exercise of authority over natural resources and the environment" (United Nations Development Program, et al, 2003:4).

Moreover, the term 'sustainable natural resource management' (SNRM) identifies the management methods that result in the sustainability of natural resources. The World Bank (2006:1) definition is "the sustainable utilization of major natural resources, such as land, water, air, minerals, forests, fisheries, and wild flora and fauna". This means ensuring better efficiency in our use of natural resources, protecting and enhancing their important characteristics, including wildlife and landscapes, and minimizing pollution and waste (SEEDA, 2002). It also means leaving options open for future generations (McLain and Jones, 1997). Relating to this notion, Bringezu and Bleischwitz (2009) identify a way by which we can develop a vision and appropriate institutions to govern change in natural resources. In this way, the use of natural resources is restricted to a sustainable level by activating the inherent tools of human beings. This means societies should use their intrinsic discernment to not only enlarge their stock of knowledge and social capital, but also utilise it

to use fewer natural resources (Bringezu and Bleischwitz, 2009). They invite a development vision and the institutions needed to govern this type of change.

This change requires a switch to sustainable resource management protocols, which need to achieve the following seven principles:

> ‘‘1) secure adequate supply and efficient use of materials, energy and land resources as a reliable biophysical basis for creation of wealth and well-being in societies and for future generations; 2) maintain life-supporting function and services of ecosystems; 3) provide for the basic institutions of societies and their co-existence with nature; 4) minimise risks for security and economic turmoil due to dependence on resources; 5) contribute to a globally fair distribution of resource use and an adequate burden sharing; 6) minimise problem shifting between environmental media, types of resources, economic sectors, regions and generations; and 6) drive resource productivity at a rate higher than GDP growth’’ (Bringezu and Bleischwitz, 2009:8).

These principles could be directed – in some manner – by the seven elements of environmental governance that are cited in the book of the United Nations Development Program (2003). Some of these elements are:

> ‘‘1) Institutions and Laws: Who makes and enforces the rules for using natural resources? What are the rules and the penalties for breaking them? Who resolves disputes? 2) Accountability and Transparency: How do those who control and manage natural resources answer for their decisions, and to whom? How open to scrutiny is the decision-making process? 3) Property Rights and Tenure: Who owns a natural resource or has the legal right to control it? Land titles; water, mineral, fishing, or other use rights; tribal or traditional community-based property rights; logging, mining, and park recreation concessions; and 4) Markets and Financial Flows: How do financial practices, economic policies, and market behaviour influence authority over natural resources?’’ (United Nations Development Program, et al, 2003:7).

In order to apply these principles and elements, more effort is needed to circulate their benefits to ensure environmental sustainability. The framework for monitoring environmental sustainability suggested by the World Bank (2008) in turn could properly guide these strategies. This framework illustrates the relationship between the economy and the environment: on the one hand is the production of people-made goods and services, which contributes to household well-being; while, on the other hand, is the wealth that sustains production and may also contribute directly to well-being. Wealth in such a framework unavoidably goes beyond physical and monetary resources, to include natural resources and intangibles such as human capital. Production processes may involve the exhaustion of resources, as may the direct use of resources by households, whereas other uses of resources are non-exhausting, fallowing the agricultural land is an example of which. Production and consumption both lead to pollution and waste, and modify the quality of natural resources (World Bank 2008:179-180). This means that in order to safeguard future wellbeing the existing unsustainable patterns of production and consumption have to be radically changed.

Although the management toolset is important, other elements should also be taken into account. These elements might be gathered in a set of governances that could include the decision-making framework – the laws, policies, regulations, bureaucracies, and formal procedures – within which managers make their decisions. It sets the larger context that either enables or constrains management (United Nations Development Program, et al, 2003). Murphree (2004) examines communal approaches to NRM of wildlife in Africa. He presents a conceptual conflation and acronymic profusion, which are among the major drawbacks of policies and programmes that suggest the tag of communal approaches, for example,

> ‘‘Community Based Conservation (CBC), Community Conservation (CC), Integrated Conservation and Development Projects (ICDPs), Community Wildlife Management

(CWM), Community Based Natural Resource Management (CBNRM), Co-Management (CM) and Adaptive Co-Management (ACM), all perceived as falling within a general family of related perspectives but each exhibiting differences of intent, emphasis and substance'' (Murphree 2004:203-204).

Applied to Africa, he suggests three congruent and synergistically interacting objectives: conservation, economic development and adaptive institutional capacity. He indicates that the approach cannot contribute to these objectives unless there is a 'good' understanding of the whole situation. His argument about rural institutional and organizational development proposes it as an instrumental input to the other objectives of conservation and economic development. He asserts that if the communal system is to contribute to these objectives, it must be organized and trained to do so (Murphree 2004:207). This means, that communal approaches can create viable regimes of communal property use and management if collectives of land and resource users are institutionally well-trained to interact at local levels. By this, they can ensure a relatively normative consensus. His argument continues with the suggestion that conservation could be correctly understood in terms of changeability, ''predictable states; it is better perceived of as resilience in a complex, evolving biophysical-cum-social system comprised of structures which interact across scales of place and time and which move through adaptive cycles of growth, accumulation, restructuring and renewal'' (Murphree 2004:209). In his view, communal approaches can be important for the evolution of governance in Africa in cases where these approaches are to address effectively the arena of governance and civil organization, requiring the collective management of common pool resources. It needs also to recognize the relevant tradition of this institution, integrating into it capacities to deal with a modern African world, with changes shaped by 'commoditization, rural market penetration, socioeconomic differentiation and globalization' (Murphree, 2004:210).

This introduces us to another diagnosis raised by Bruce and Mearns (2002) who analysed common property regimes. They see that NRM as a developmental concern, particularly on developing countries, requiring poverty eradication. This focuses on the success of natural resource projects that pose special issues for land policy and administration. They asserted that:

> ‘‘Natural resource management has thus taken its place alongside agriculture as a major rural development concern. New insights have emerged, which include a more integrated picture of rural livelihoods, and the understanding that they depend to a significant extent on forest and animal products extracted from beyond the farm. There is also growing appreciation of the viability of production systems that make extensive but sustainable use of fragile resources, such as those of pastoralists’’ (Bruce and Mearns, 2002:1).

Such common resources can create their own challenges for management such as:

1. The resource accessibility with the need to create stronger user incentives for sustainable use and management;

2. The struggle between common property managers and the state system being undermined by outside pressures to re-engineer the existing system or to partition the resource users;

3. The unsuccessful state management of the resource and its use, as management, and maybe tenure, is devolved to smaller community units or households (Bruce and Mearns, 2002; Quinn et al, 2007).

Consequently, these scholars argue for the workability of common property regimes. This acceptance is attributed to its simplicity, which is much the same as individual property, ‘‘to increase security of expectations while reducing externalities and internalizing the costs and

benefits of use decisions, thus increasing incentives for efficient and sustainable use. The incentives are for the group, rather than the individual'' (Bruce and Mearns, 2002:3) (see also Mehta et al, 200; Quinn et al, 2007). However, they caution about the complexity of common property regimes, as these can exhibit many of the problems of collective action. In order to solve these problems and ensure the success of these regimes, legal empowerment over the resources is required, adequate institutional capacity for decision-making and enforcement should be arranged, and sufficient community capital is needed to operate it. They suggest that interactive choices can be made to scale control over the resource. The community must be empowered to manage the resource, and that implies the power both to control use by members, and to exclude or limit access by non-members. The state and its management institutions tend to mistrust local users and seek to maintain a residual title and ultimate control over use of the land. Conversely, local users distrust the motives of such attempts to maintain control (Bruce and Mearns, 2002:3-4).

Rasmus (2002) agrees that common ownership has distinct advantages, such as equity and insurance functions, but he mentions the 'free rider' problem that has to be overcome for communities to establish effective management. Management creates enforcement and conservation rules to prevent the risk of degradation and overuse. Generally, Rasmus believes that common property management systems deserve respect. Policy makers should avoid ignoring them and should support them with legal recognition. He wonders if common property institutions can be reasonably formed by policymakers and donors to undertake resource conservation, in case of the failure of sustainable management techniques to emerge spontaneously (Rasmus, 2002). In addition, in some studies the risk of degradation and overuse of natural resources is linked to the collapse of the regional and local common

resource management regimes and the correlated individualization of use rights to resource units. Gerber et al,(2008) describe the situation after this type of a collapse in Switzerland as:

> ‘‘A heterogeneity of practices which proved difficult to coordinate at that level of resource systems (e.g. the hydrological cycle, landscape, ecosystem, biodiversity, climate, endangered plant and animal species, etc.). Because it prevents the definition of use quotas at the resource system level, the uncoordinated attribution of use rights is one of the main causes of overexploitation’’ (Gerber, et al, 2008:225).

They concur with Murphree (2004) that it is vital to take into account the fundamental role that public policies play in the regulation of natural resource use.

In short, the main theoretical approaches that clarify the evolution of NRM include the classic, the neo-liberal and neo-populist paradigms, community-based management, and integrated management. These approaches have a significant influence in the development paths of SD around the world (Pelesikoti, 2003). Table 2.1 illustrates some of these approaches and their main characteristics.

In the case of Oman, particularly the AAR, communal approaches can generate viable regimes of communal property use and management if cooperatives of land and resource users are institutionally well-trained to interact at local levels. However, to re-engineer the existing system in the region or to partition the resource users could result in a struggle between common property managers and the state. This could be solved by the successful state management of the resource and its use, as management, and maybe tenure, is combined with the traditional practices in terms of NRM.

Table 2.1 Approaches in Natural Resources Management and their main characteristics.

| **Main characteristics** | **The Approach** |
|---|---|
| Its sources are from notions relating to rural development and environmental management. It was dominant from 1950-1975.<br><br>External agents (government officers, donors, researchers etc.) identify perceived problems.<br><br>External agents formulate the technical measures but the measures require community cooperation.<br><br>A combination of encouragement, persuasion, and subtle threats provide motivation to implement the plan.<br><br>This approach views local knowledge as defective and non-scientific; it prefers to replace it with expert-led knowledge. | The 'classic' approach. |
| The neo-liberal approach is associated with the World Bank.<br><br>This approach relies on incentives and regulations and is related to the economics of externalities and property rights. | The neo-liberal |
| The neo-populist paradigm rejects the top-down, techno-centric, and state-led model of technology transfer.<br><br>It promotes a participatory style, and it became central to the development agencies by the 1980s.<br><br>The approach uses a 'demand-driven' model and local management or co-management of resources and services.<br><br>It chooses applicable aspects of the local knowledge. | The neo-populist paradigms |
| As the name suggests, this approach integrates various measures (e.g. for pollution prevention, nature conservation, and the creation of environmental facilities).<br><br>It establishes environmental policy objectives agreed-on by all stakeholders (local authorities, the local people and developers).<br><br>This approach needs quality information, monitoring, flexibility, greater environmental awareness, and good leadership.<br><br>It sees local knowledge as an integral part in the management plan. | Integrated Environmental Management |
| This approach allows greater community involvement in policy formulation and decision-making processes.<br><br>It promotes a transparent and accountable management authority.<br><br>It creates a responsive community in implemented management programs.<br><br>Local knowledge is conveyed through community involvement. | Participatory Management Approaches, or 'Community based' management. |

Source: Adapted from (Barrett, 1994; Fisher, 1995; Berkes, et al., 1989; Varady, 1999; Imperial, 1999; Imperial, 1999; Bruce and Mearns, 2002; Pelesikoti, 2003).

### 2.1.4 The future of natural resources management:

Some scholars, researchers and related organizations summarize their future visions to approaches of common resource management regimes in terms of the key characteristics that resource management regimes should possess to ensure their continuous workability (McLain, and Jones, 1997; United Nations Development Program, 2003; Murphree, 2004). Drawing on Murphree (2004), some of these characteristics are:

1) "Institutional Resilience", a key variable for communal approaches in determining their success or failure. This resilience should consider the local landscape, where the necessary social capital provides for the emergence of natural resource regimes with consensual legitimacy. However, such emergence demands decentralization of power, a transformation where power and desirable change are not heading to conflicting directions;

2) "Selective Application", which means to select the proper realm of communal approaches. Because these approaches are not a panacea for the problems of environmental governance, the paramount consideration should be whether they are applicable for aligning institutional and ecological landscapes;

3) "Systemic Integration", which means the need for communal approaches to be dealt with as strategies that ‘scale out’ natural resource governance. In order to guarantee its workability, continuity and consistent ecosystem management, resource control needs to be dispersed between regimes of authority and responsibility. These regimes require institutional linkages between each other and between other (state or private) regimes, which could promote coordination and collaboration;

4) "Adaptive Contextual Disaggregation", which is a requirement of communal approaches, on the one hand, to disaggregate their endeavours to accommodate the variation involved,

such as the local contexts and the contexts of national macro-economic systems. On the other hand, care needs to be taken not to adapt these approaches as an operation in abstract typology but rather to avoid misplaced emphases and to enhance their responsiveness to change; and

5) "Interdependent Reciprocity in Learning", meaning the co-dependence between communal actors and the community of scholars, practitioners, donors and policy makers. Local institutions and scholarship need each other, because the local institutions is a real lab for research in communal institutional resilience, in addition, scholarship needs to learn from local contexts, and this learning in turn needs to be relocated above the current sterile debate.

The success of communal approaches to NRM regimes rely on society participation (McLain, and Jones, 1997; United Nations Development Program, et al, 2003; Bocoum, et al, 2003; Murphree, 2004). However, Algotsson (2006) argues that these approaches, or 'people-centred approaches' as he designates them, fail to deal with violations of natural resource laws (particularly wildlife laws, because of a misdirected emphasis on subsistence poaching). In his view, these programmes have been ineffective to activate the policy goals of biodiversity conservation and SD as a transparent plan for implementation. Instead of addressing the important issues of resource utilization, legal instruments and implementation plans tend to focus on the benefit-sharing factors of community participation. He differentiates between 'benefit-sharing paradigms' in which society members are given a share of the profit from wildlife, and 'power-sharing paradigms' in which society members are given rights and responsibilities to manage parks and protected areas. He believes that in the latter case, ‘‘people-centred approaches to NRM can significantly contribute to the sustainable management of wildlife’’ (Algotsson, 2006:85). Thus, effective communal participation, described as 'social inclusion', in the decision making process is a pre-requisite

for equitable and sustainable NRM (Bocoum, et al, 2003). People-centred approaches can be seen as an attempt to re-label NRM and to get people engaged and participate in the existing strategies of NRM.

In addition, with regard to land resource management, social factors are most influential in the adoption of land management technologies. Based on research in two mountain watersheds in Nepal, farmers adopted several types of structural and biological land management practices to control land degradation (Giridhari et al, 2004). However, this adoption depends on many factors, the most important being social, such as ‘‘caste affiliation of farmers, household agricultural labour force, training in land management, schooling period of the household head, participation in joint land management activities’’ (Giridhari et al, 2004:35). These issues are difficult to achieve unless there is good environmental governance in which citizens, government managers and business owners can foster better NRM decisions – decisions that meet the needs of both ecosystem and nation, with justice and equilibrium (Cousins, 2000; Mehta et al, 2001; United Nations Development Program, et al, 2003).

### 2.1.5 How to ensure an efficient and sustainable natural resource management?

It is clear that a consequence of economic growth and the failure of institutional policies emphasises the need for an environmental and natural resource policy. Such a policy, on the one hand, must effectively mitigate environmental and natural resources problems created by humans who misunderstand how to interact correctly (sustainably) with their environment. On the other hand, the policy must meet the continuous demands for natural resources. Thus, efficient instruments are needed to create effective natural resource policy. Designing more

sustainable NRM systems and implementing these is the existing purpose of many research institutions, development agencies, NGOs and other stakeholders (Lopez-Ridaura, et al., 2005). Among the important elements that should be contained in a NRM policy are policy instruments for environmental and natural resource management, including ‘‘direct provision, detailed regulation, flexible regulation, (tradable quotas or rights), (taxes, fees or charges), subsidies and subsidy reduction, creation of property rights, voluntary agreement, information provision, labels, and international treaties’’ (Sterner, 2002:69).

In response to the decisions of the Earth Summit in Rio de Janeiro in 1992, 166 UN Parties developed National Biodiversity Strategies and Action Plans (NBSAPs), in order to create general measures for conservation and the sustainable use of biodiversity, including natural resources (Prip et al, 2010). However, as always, the practical application of these strategies is the accurate measure of their success in achieving their targets. Successful policy development and implementation should consider programme evaluation and policy analysis as critical elements. The formation of policy processes, institutional preparations and NRM practices, which contribute towards achieving sustainable and equitable resource use outcomes, requires rigorous evaluation and is among the challenges of the change process (Bellamy et al, 2001; Secretariat of the Convention on Biological Diversity, 2010). To meet the challenge of change, a fundamental evaluation is needed to identify change, to support an adaptive approach that is flexible enough, and to enable progressive learning at individual, community, institutional and policy levels. Nonetheless, ‘‘evaluation in natural resource management policy has been neglected and a substantial gap is emerging between theory and practice’’ (Bellamy et al, 2001:408). However, some questions should be taken into account while designing and implementing this type of policy; for instance, how to assess to what extent a system is sustainable, the degree to which the options will increase the sustainability

of the system; and the ways to evaluate or assess the sustainability of NRM (Lopez-Ridaura, et al, 2005).

In favour of fulfilling the targets that have been set, many countries and organizations have developed frameworks of criteria and indicators to improve the evaluation of natural resource management. A good example of this framework is the forest sustainability indicators developed by the Ontario Ministry of Natural Resources. An adaptive approach was used to design a complete sustainability evaluation and reporting framework to meet Ontario's legal and policy obligations, and to provide a structured and documented guide outlining how to accomplish sustainability evaluation. Miller and Nelson (2003) suggest that:

> ''an indicators framework provides a comprehensive, continuous and seamless system, from high-level goals at the criterion level right down to the indicators themselves, all anchored in public policy. A rationale for the selection of each indicator provides a scientific grounding for the indicator monitoring and assessment carried out under the criteria and indicators framework'' (Miller and Nelson, 2003:4).

Lopez-Ridaura et al (2005) present a "novel multi-scale methodological framework" for sustainability evaluation in NRM system (NRMS). They describe their production as a framework that:

> ''employs a systems approach that results in the identification of five basic attributes of sustainable systems based on scale- and discipline- independent properties of NRMS. The framework aims at building a multi stakeholder and objective-driven platform, in which the objectives and constraints of the stakeholders are coupled to the attributes in order to arrive at useful sets of criteria and specific indicators, meaningful to the stakeholders at different scales'' (Lopez-Ridaura et al, 2005:53).

They suggest a set of five characteristics of sustainable systems, two relating to the functioning of the system itself – productivity and stability – and three linked to the

behaviour of the system in the face of changes in its internal functioning and in its surroundings – reliability, resilience and adaptability.

Some studies mention that natural resources are facing challenges of change, including that of climate change (Abramovitz, et al, 2001; Ramakrishnan, 2003; Tompkins and Adger, 2004; Nechodom, 2005). Thus, most of the studies, particularly the studies that are interested in linking NRM to climate change, support adaptive management processes (Tompkins and Adger, 2004; Nechodom, 2005; Moser and Luers, 2008; Holman, and Trawick, 2011). These processes should firstly increase present-day resilience, which can in turn increase the ability to respond to the threats of long-term climate change. Secondly, this type of adaptive management can be used to follow the twin goals of greater ecological stability and more flexible institutions for resource management (Tompkins and Adger, 2004).

The suggestions and recommendations for the different efforts to ensure sustainable resource management need to be comprehensive, and their implementation depends on the institutional context and the economic, time and information resources available. Moreover, the proposed sustainability evaluation of a NRM system will allow identification of criteria for the development of indicators. The definition of impact scales, the use of objectives for deriving criteria, and their discussion with stakeholders, are basic features of sustainability evaluation (Lopez-Ridaura, et al, 2005). Eventually, a global governance system for sustainable resource management should become an urgent priority for all organizations related to environment and natural resources. Such an approach is needed to combat the negative impacts arising from resource use as well as to overcome the co-ordination problems of decentralized action (Bleischwitz and Bringezu, 2008).

## 2.2 Indigenous Knowledge: the vast space

### 2.2.1 Introduction:

Over the past three decades, Indigenous Knowledge (IK) has become an increasingly important component of the development project, especially in rural areas. This has occurred via an acknowledgment of the validity of indigenous peoples' geographies and resource management practices by aboriginal and marginal societies and the evident inadequacy of the way much scientific investigation has proceeded (Frank, 2003; Kolawole, 2001; Batiste, 2005).

The 1990s witnessed international interest in indigenous peoples and indigenous knowledge, particularly after Agenda 21 in 1992, and the United Nations 164 declaration in 1993 about the 'International Year of the World's Indigenous People'. Since then, hundreds of IK centres and networks have been established in order to strengthen international cooperation, and to address the problems faced by IK in fields such as the environment, ecology, natural resources, development, education, medicine and intellectual property. At present, entering key words such as traditional knowledge, indigenous knowledge, or local knowledge into internet search engines indicates the vast quantity of information, publications, research, working papers, conferences, seminars and workshops dealing with IK across the world. IK has importance in development and natural resources management and in the protection of intellectual property rights of the original owners of IK and their practices.

### 2.2.2 Indigenous knowledge: the disputed definition

There is a rich literature relating to IK produced over the past three decades, especially after the appearance of the term of 'sustainability' (sustainable development, sustainable natural resources management). As the literature reveals, aboriginal people in all continents, most of them with firm cultural connections and strong relations with the natural world, have built up a rich knowledge and complex understanding of their environment (e.g., Berkes, 2001; Nakashima and Roué, 2002). Furthermore, their behaviour and ''knowledge are stranded in a sequence of ethical, spiritual and cultural values that indigenous societies give to nature and that are used by them in their decision making process'' (Hermann, 2005:121). However, there is no agreement in this literature of a single definition of IK (Boven and Morohashi, 2002; Battiste, 2005). To some the term indigenous knowledge is limited to the knowledge of indigenous people, referring to it as a cross-cutting issue embedded in the culture of a people. Thus its existence is dependent on, and determined by, the maintenance of this culture. An important element is the close interrelationship between culture, spiritual values, knowledge and the natural environment (Biber-Klemm, 2004:96). Others use a broader context, such as with farmers in developing countries (Batiste, 2005). This difference seems logical to a certain extent, as the term is used in different disciplines such as anthropology, ecology, development agrology, medicine and education. Members of these disciplines adopt a definition appropriate to the purposes of their studies and their functions. The term indigenous knowledge has also been used by global, continental, national and local organizations, most notably from the United Nations (UNESCO, FAO and UNEP), the International Labour Organization (ILO), the World Bank and the World Intellectual Property Organization (WIPO) (Agrawal, 1995; UNESCO, 2009). The greater the multiplicity of IK definitions, the more perspectives emerge that enrich the field with more critical and constructive ideas.

When discussing indigenous knowledge systems, several terms can be found in the literature for this knowledge, such as indigenous science (IS), local knowledge (LK), environmental knowledge (EK), traditional ecological/environmental knowledge (TEK), indigenous ecological knowledge (IEK), indigenous botanical knowledge (IBK) and rural people's knowledge (RPK) (Berkes, 2001; Nakashima and Roué, 2002; Farooquee, et al, 2004; Hermann, 2005; Pligrim, 2006; Burgess, 1999). Batiste (2005) indicates other names for IK (or closely related concepts), including 'folk knowledge,' 'local knowledge or wisdom,' 'non-formal knowledge,' 'culture,' 'indigenous technical knowledge,' 'traditional ecological knowledge,' and 'traditional knowledge' (Batiste, 2005:4).

Anthropologists were the first to study this field and the term has since been borrowed by other disciplines (Purcell, 1998; Berks, 2001; Bicker, et al, 2004). The story begins with the term indigenous, which was used to refer to, as Purcell (1998:260) stated,

> "existing descendants of non-Western people who in general continue to occupy their ancestral lands even after conquest by Westerners, or who have been relocated forcibly in the process of colonization. Indigenous people maintain a cultural complex that sets them apart from Western socio-cultural tradition."

Since the 1980s, the term was expanded to include the term knowledge to signify a social science perspective, as well as a philosophical and ideological position that rests on recognizing the role of knowledge in the power relations comprised of the European expansion (Purcell, 1998). This means the term knowledge was applied and inserted into the political discourse as a component of power relations, beyond the notion of the cultural division of labour and beyond ethnicity. Thus the definition of IK logically derives partly from the definition of indigenous people. It is widely accepted to describe IK as accumulated knowledge acquired, used and transformed by a group of people over the long-term during

their interactions with the environment. Purcell (1998:260) provides a useful definition when he illustrates indigenous knowledge as "the body of historically constituted knowledge instrumental in the long-term adaptation of human groups to the biophysical environment." Preece (2005:53) also gives a wide definition to indigenous knowledge when she states: "knowledge that people have developed over time, which has to do with their context and immediate environment and which continues to develop." In addition to this definition, there are others who concur with such a definition: see, for example, Farooquee, et al (2004:33). Nakashima and Roué (2002:318) suggest a further detailed definition that is:

> "Indigenous knowledge systems are the complex arrays of knowledge, know-how, practices and representations that guide human societies in their innumerable interactions with the natural milieu: agriculture and animal husbandry; hunting, fishing, and gathering; struggles against disease and injury; naming and explaining natural phenomena; and strategies for coping with changing environments."

The United Nations Educational, Scientific and Cultural Organization (UNESCO) refers IK to a specific area that has a common practice observed in indigenous communities, focusing on the long history of the practices making it synonymous with traditional knowledge (TK). This appears in the following definition:

> "indigenous knowledge, also referred to as traditional or local knowledge, refers to the large body of knowledge and skills that has been developed outside the formal educational system. IK is embedded in culture and is unique to a given location or society. IK is an important part of the lives of the poor. It is the basis for decision-making of communities in food security, human and animal health, education and natural resource management." (Boven, and Morohashi, 2002:31).

UNESCO's best practices in IK stated seven characteristics of Indigenous Knowledge, namely that IK is: 1) generated within communities; 2) location and culture specific; 3) the basis for decision making and survival strategies; 4) not systematically documented; 5)

concerning critical issues of human and animal life: primary production, human and animal life, natural resource management; 6) dynamic and based on innovation, adaptation, and experimentation; and 7) oral and rural in nature. (Boven, and Morohashi, 2002:31).

Similarly, the World Bank website uses a definition quoted from Warren (1991) and Flavir (1995), who present a typical definition which includes: 1) IK is local knowledge, that is unique to a given culture or society; 2) IK contrasts with the international knowledge system generated by universities, research institutions and private firms; 3) IK is the basis for local-level decision-making in agriculture, health care, food preparation, education, natural-resource management, and a host of other activities in rural communities; and 4) IK systems are dynamic, and are continually influenced by internal creativity and experimentation as well as by contact with external systems.

Boven and Morohashi (2002) emphasize an identical specification of the previous definition of IK labelling it 'Indigenous information systems' and emphasise features such as changeability and continuity. Their definition is as follows:

> "Indigenous knowledge is the information base for a society, which facilitates communication and decision-making. Indigenous information systems are dynamic, and are continually influenced by internal creativity and experimentation as well as by contact with external systems" (Boven and Morohashi, 2002:12).

Several scholars, institutions and indigenous peoples' organizations have been studied as a component part of IK, that is the ecological, environmental and biodiversity component. They labelled this type as traditional environmental knowledge (TEK), and local ecological knowledge (LEK) (Burgess 1999; Berkes et al, 2000; Usher, 2000). TEK has also been

termed Traditional Ecological Knowledge and the acronym "TEK" has appeared frequently in the literature (Huntington, 1998; Ford and Martinnez, 2000; Berkes et al, 2000; Brodnig, and Mayer-Schonberger, 2000). Huntington (1998) has described TEK as:

> "A system of experiential knowledge gained by continual observation and transmitted among members of a community. It is set in a framework that encompasses both ecology and the interactions of humans and their environment on physical and spiritual planes" (Huntington 1998: 237-8).

Working definitions have been developed attempting to cover the range of meanings associated with traditional knowledge (TK). This means that these definitions are confined to the cases which are being studied, and could not be generalized to other cases which could be different in some characteristics. Berkes (1983:8), defined TEK as:

> ''A cumulative body of knowledge and beliefs, handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment. Further, TEK is an attribute of societies with historical continuity in resource use practices; by and large, these are non-industrial or less technologically advanced societies, many of them indigenous or tribal''

Burgess (1999:15) mentions the Dene Cultural Institute of Canada's definition of traditional environmental knowledge (TEK) as:

> "A body of knowledge and beliefs transmitted through oral tradition and first-hand observation. It includes a system of classification, a set of empirical observations about the local environment, and a system of self-management that governs resource use. Ecological aspects are closely tied to social and spiritual aspects of the knowledge system. The quantity and quality of TEK varies among community members, depending on gender, age, social status, intellectual capability, and profession (hunter, spiritual leader, healer, etc.). With its roots firmly in the past, TEK is both cumulative and dynamic, building upon the experience of earlier generations and adapting to the new technological and socio-economic changes of the present"

Usher (2000:185) refers the term specifically to 'all types of knowledge about the environment derived from the experience and traditions of a particular group of people'.

Some academics have termed TK: 'Traditional Knowledge Systems' (Hoppers, 2005; Hammersmith, 2007). According to Hoppers (2005), categories of this traditional knowledge include agriculture, meteorology, ecology, governance, social welfare, peace building and conflict resolution, medicine and pharmaceuticals, law and jurisprudence, music, architecture, sculpture, textile manufacture, metallurgy and food technology. The cultural context surrounding the practice of these fields of knowledge includes songs, rituals, dances and fashion. It also includes technologies that range from garment weaving and design, medicinal knowledge, food preservation and conservation, and agricultural practices to fisheries, metallurgy and astronomy (Hoppers, 2005:3).

From the preceding definitions, several common characteristics emerge. These include IK being: 1) locally bound and rooted to a particular place and set of experiences, and hence it may not be functional in other area; 2) non-formal knowledge, as IK is the consequence of practical engagement in everyday life, and is constantly reinforced by experimentation and trial and error; 3) orally transmitted through imitation and demonstration, and generally not documented; 4) dynamic and adaptive, and therefore constantly changing, being produced as well as reproduced, discovered as well as lost, but often represented as being somehow static, hence it is traditionally a flowing and transforming agent with no real end; 5) holistic in nature, and encompassing the sophisticated arrays of information, understanding and interpretations that guide interactions with the natural milieu such as agriculture, fishing, hunting, forest resource exploitation, atmospheric management techniques, knowledge transmission systems, architecture, medicine, pharmacology, law and spirituality; and 6)

closely related to survival and subsistence for many people worldwide. It is shared to a much greater degree than other forms of knowledge, including global science. It is empirical rather than theoretical knowledge.

This large number of definitions and terminology that attempt to describe what indigenous knowledge encourages open debate. Some argue for the use of the term "indigenous" because they really mean the aboriginal knowledge of the aboriginal community. Others, such as Briggs (2005), Dove (2006), and Horsthemke (2008), argue against using the term "indigenous." They see that the term "indigenous" should be treated with caution and should not be used other than the cases which is including a real aboriginal knowledge, not the cases which could be influenced by external knowledge. Others refuse the term "indigenous" to describe a specific knowledge to distinguish it from other knowledge. As a case in point, Horsthemke (2008:135) firmly rejected the term when he said: "I consider blanket appeals to the concept of indigenous knowledge, and its 'legitimization' or 'validation,' as a remedy or countermeasure, to be completely misguided." He perceives that the knowledge of indigenous people should be called "knowledge" and not be differentiated from the other form of knowledge, as long as it meets the criteria of knowledge (Horsthemke, 2008). In a similar way, Warren (1996) asserted that ''The knowledge system upon which farming decisions are based must be both reactive and proactive, relying on indigenous experimentation and innovation, as well as technologies made available through external channels to cope with and adapt to changes'' (Warren 1996 in: Kolawole, 2001:14). Nonetheless, Kolawole (2001:14) identified three stages of local knowledge development as: ''observation (of the environment leading to insight), experimentation and validation (through results)''.

Beckford and Barker (2007) present the empirical way in which local knowledge has been tested and proven over many generations, embedded in environmental and socio-economic realities (Beckford and Barker (2007:118). This point of view is opposed by others, such as Brooke (1993) and Stevenson (1996) who cite lack of documentation for this type of knowledge because it has not been subjected to laboratory testing. When it comes to discussing the empirical and factual issues within IK, Briggs (2005) has pointed out that it must in some way be related to formal science and that for IK to be accepted, it must somehow be scientifically testable in a formal sense (Briggs, 2005:101). Furthermore, Leach and Mearns (1996, in Briggs, 2005:102) suggest that IK is often critiqued to be "methodologically weak or unproven… populist or politically naïve; and that it generates findings that are too complicated to be of practical use to policy makers".

Others, such as development experts, argue against the use of the term '"traditional' to qualify the knowledge peculiar to a people, since in some circles 'traditional' evokes 19th-century conceptions of ''simple, savage and static societies'' (Kolawole, 2001:13). Furthermore, the term 'traditional' could be confusing as it emphasizes knowledge accumulation and transmission through past generations, but obscures its dynamism and ability to change and adjust (ICSU 2002). For this reason, some scholars favour the less value-laden term ''indigenous knowledge'' (Warren 1995 in Berkes et al, 2000:1251). It has also been pointed out that some communities possess knowledge that is not 'traditional' but contemporary (ICSU 2002). Indeed, it can be argued that all types of knowledge are contemporary, and have been given meaning and value from a frame of reference that is being continually updated and revised. Others have been more direct in their criticism of the term 'traditional', that it "sounds the same as some type of handicraft that we make and then sell to tourists" (Burgess, 1999:13). Abele (1997) stressed that truth and all knowledge are

both adaptive and evolutionary, as all societies learn as a result of experience and learning from others (Abele, 1997, cited in Burgess, 1999; Ruiz, 2002). With regard to whether indigenous knowledge should be described as traditional, Ruiz (2002:3) stressed that:

> "it does not imply static nor necessarily old knowledge. Rather, traditional knowledge is often dynamic and adaptive to changing cultural patterns and a wide range of external influences, including occupation of indigenous people's lands, market pressures over certain resources, re-settlement".

In conclusion, the definition of IK is disputed, this is because of the views of the multiple disciplines of scholars and academics who study this field. The meaning or definition of the term IK differs, depending on the particular case and on the specific aspects the writer wants to stress (Boven and Morohashi, 2002). However, the various definitions overlap related to certain characteristics. Just as scholars do not agree on a common definition of IK, they also differ to some extent on the use of words that describe this knowledge.

### 2.2.3 The importance of Indigenous Knowledge for sustainable development

Bicker, Sillitoe and Pottier (2004:i) write:

> "A new field of 'indigenous knowledge' is emerging which aims to make local voices heard and ensure that development initiatives meet the needs of ordinary people. Indigenous knowledge, an aspect of participatory approaches to development, offers an alternative to schemes and strategies that are imposed on lesser developed countries by international agencies and state organizations. The philosophy behind the indigenous knowledge initiative is straightforward. It is based on the belief that effective assistance

will benefit from some understanding of local knowledge and practices, by promoting culturally appropriate and sustainable interventions".

The objectives of this field are 'straightforward'; to assist the success of developmental programmes and plans. But to what extent have these objectives been achieved? Are the IK bearers already involved in these plans? To what extent has sustainability been achieved? What is its success in preserving the IK inherited culture? James D. Wolfensohn, President of the World Bank in Gorjestani (2000:1), said: "Indigenous knowledge is an integral part of the culture and history of a local community. We need to learn from local communities to enrich the development process." There is no doubt that IK has value as it can be a means of survival for some communities, as has been described by Sumner (2006): ''Indigenous knowledge not only preserves the past, but can be vital to ensuring a sustainable future'' (Sumner, 2006:1).

Based on these statements, many indigenous scholars, advocates and researchers have discussed the conditions that make the incorporation of indigenous knowledge into development work successful. Most of them recommend utilizing, integrating and harnessing IK/TK for development and trade, to benefit the TK-holding communities and countries (Karbolo, 2004; Sahai, 2004; Blanco, 2004). Examples from Uganda (Gorjestani, 2004), India (Twarog and Kapoor, 2004), Kenya (Karbolo, 2004), Ethiopia (Fenta, 2004), and Philippines (Blanco, 2004) have been used in regards to the development case for indigenous knowledge. Gorjestani (2004) argues for the value of IK/TK, describing it as a substantial aspect of sustainable development. This means that using IK in development programmes would better succeed if the local people felt that they were not overlooked. Moreover, empowerment of local communities is a precondition for the integration of IK into the

development process. The incorporation of appropriate IK systems into development programmes has already proved to contribute to effectiveness, efficiency and sustainable development. Gorjestani (2004) compares IK to any other knowledge to be constantly used, challenged and further adapted to the evolving local contexts. Similarly, Karbolo (2004) supports basing indigenous development paradigms on indigenous values. His research on Maasai pastoralists showed that IK's purpose, values, philosophy and strategy are heavily influenced by the cultural milieu of the local people.

In another context, Sahai (2004) argues that the share of profits from the commercialization of the skills and knowledge of traditional communities is not returned to these communities. He discusses TK relating to bio-resources, namely agriculture and the Indian systems of medicine. He examines the commercialization of TK, including the market for herbal products, the commercialization of forest products, developing a virtual marketplace for TK, making commercialization sustainable, using biotechnology for conservation, and using state support for the commercialization of TK. He provides an Indian example of benefit sharing with national and international users. In other words, Sahai thinks that benefit and revenue sharing from trade in traditional materials is necessary for the development and prosperity of local communities, which in turn leads to the prosperity of the state. The continuity of utilizing TK would prevent it from becoming irrelevant, because this will keep it transferring through the generations. Kief (2001) and Lopez (2005) agree on the previous judgment in the context of development programmes which must stem from the local communities. TK must be integrated within these programmes, thus guaranteeing the continuity of the use of this knowledge and its protection from extinction and decay (Kieft, 2001; Lopez, 2005). Similarly, Blanco (2004:293) provided evidence from the Philippines, pointing out that:

> "the indigenous knowledge systems and practices work well and are both integral to the efficient management and to the preservation of the ecosystem and to sustainable development… awareness of the need to protect TK was spurred by economic development at the end of the twentieth century".

Agriculture is a vital economic sector, and genetic resources have shaped developments in agriculture for at least the last 10,000 years (Lettington and Nnadozie, 2003). There is no doubt that all the communities in the world accumulated a rich local agricultural knowledge that has ensured their survival. Beckford and Barker (2007) argued for local and traditional knowledge, describing it as valuable, adaptable and necessary in coping with risk and uncertainty in a changing world. They concluded that local traditional knowledge is indispensable in the context of the socio-cultural, economic, political, environmental and global realities of small-scale agriculture in Jamaica. Moreover, they stressed that domestic agriculture plays a vital role in employment, food security and foreign exchange earnings and savings. Beckford and Barker illustrated the prejudices against this sector and the continued negative attitudes towards traditional knowledge that are an injustice to farmers and unfavourable to rural development. In a supporting view, Fenta (2004) and Middleton (2007) attributed the success of soil and water conservation measures and practices in rural areas in Ethiopia and Peru, respectively, to TK and practices that have been integrated into every stage of project planning and implementation (Fenta, 2004; Middleton, 2007). However, Beckford and Barker (2007) cautioned against a misguided view of TK as a panacea to all the evils of local agriculture (Beckford and Barker, 2007).

In the agricultural context, Guedes and Sampaio (2004) presented Brazil's experience in preserving the genetic resources of agriculture through the reintroduction of corn into the Kraho territories. This successful experience helped improve nutrition, community bonds,

and a sense of identity for the people due to the 'resurgence of native pride' in agriculture, which will enable them to transfer their local knowledge across generations (Guedes and Sampaio, 2004). This means that, on the one hand, TK has a basic function to maintain and preserve genetic resources, especially through organic plants. It plays a significant role in facilitating the identification of useful genetic resources for the development of pharmaceutical products in both developed and developing countries. On the other hand, the world can implement genetic resources not only in the fields of agriculture and medicine. It could go beyond that, as Lettington and Nnadozie (2003:3) pointed out:

> "A combination of micro-organisms could be used to clean up pollution spills. Micro-organisms have also recently begun to be applied in the mining industry, where they have the potential to dramatically decrease smelting costs and minimize the associated pollution and energy consumption by biologically separating ore from its surrounding rock. Extremophiles, organisms found in extreme environments such as hot springs or on ocean floors, have also been found to have significant commercial applications".

Given that IK is a resource that can help solve local problems (Leautier, 2004), help grow more and better food (Larson and Sibana, 2004), maintain healthy lives (Green, 2004), prevent conflict (Fred-Mensah, 2004), and manage local affairs (Oviedo, 2004), IK could assist many developmental schemes. In general, many initiatives have proven the importance of IK to enhance and strengthen development throughout the developing countries, where development activities work with and through indigenous knowledge and organizational structures. The foundation for decision-making at the grassroots level is provided by indigenous knowledge, much of which has happened at the community level through indigenous association to determine appropriate solutions to local problems (Warren, 1992; Gorjestani, 2001).

Despite the huge number of case studies, research and strategic projects presenting persuasive arguments for IK's importance in developmental regimes, it is still difficult to convince many scientists and development experts of the important role IK plays in the development process (Mkapa, 2004). IK scholars have argued that indigenous peoples possess unique systems of knowledge that can serve as the basis for more successful development interventions (Dove, 2006). Many scholars have encouraged the recognition of the limits of IK, as it is frequently conceptualized in the literature as unproblematic. Scholars have cautioned about the possibility of IK turning out to be less helpful as a development tool than has been supposed or hoped for (Briggs and Sharp, 2004; Briggs, 2005; Dove, 2006; Briggs et al, 2006). Nevertheless, a number of authors consider some challenges in order to increase integrating IK in development projects, such as:

> "Encourage more countries to formulate and implement strategies for IK integration; Enhance the capacity of national and regional IK networks; Promote the local exchange and adaptation of indigenous knowledge; Identify innovative mechanisms to protect IK in a way that fosters the further development, promotion, validation, and exchange of IK" (Gorjestani, 2001:5).

### 2.2.4 Utilizing Indigenous Knowledge in Natural Resources Management

The international community has demonstrated its commitment to recognize the "contribution of traditional knowledge, particularly with regard to environmental protection and the management of natural resources, and fostering synergies between modern science and local knowledge" (UNESCO, 2006:2). At present, many international documents that relate to sustainability or the conservation of biodiversity indicate the importance of indigenous knowledge, traditional knowledge or traditional ecological knowledge and local knowledge. The World Conservation Strategy (IUCN et al 1980; Our Common Future, WCED 1987;

Agenda 21 from the UN Conference on Environment and Development, Rio de Janeiro in 1992; and the Convention on Biological Diversity which also was a product of the Rio conference) are all illustrations of where local and indigenous knowledge have achieved international recognition. Consequently, IK has been widely recognized as relevant in regard to NRM (Wohling, 2009), especially in areas such as water (Shrestha et al, 2005; Boelens and Gelles, 2005; Bang-Oa, 2006), soils (Liniger and Schwileh, 2002; Joshi et al, 2004; Shrestha et al, 2005), biodiversity and conservation (Oviedo et al, 2000; Berkes, 2001; Farooquee et al, 2004; Steiner and Oviedo, 2004; Hill et al, 2012), forest (Herrmann, 2005; Charnlay, 2007), wildlife (Phuthego and Chanda, 2004; Moller et al, 2004; Gilchrist et al, 2005), and plants and vegetation (Farooquee et al, 2004; Cleophas, 2004; Sumner, 2006; Ladio and Lozadaa, 2009). Shrestha et al (2005) present experiences of soil and water management in Nepal which applies a participatory technology development approach to generate suitable soil and water management involvement that decreases nutrient losses from the land. This approach includes combining farmers' local knowledge and practices with scientists' knowledge, and the study recommends the incorporation of farmers' knowledge and perspectives to develop and use new technology. Giving farmers and their communities a leading role in experimentation and decision-making, ''not only ensures development of appropriate technologies, but also increases farmers' empowerment and participation'' (Shrestha et al, 2005:47). Oviedo et al (2000) explain the relationship between the ecoregions identified by the World Wildlife Fund (WWF), their biodiversity and inhabitants, pointing out that the conservation of these ecoregions should take into account indigenous peoples and their traditional knowledge. Moreover, he assumes that there is likely to be a strong correlation between areas of high biodiversity and areas of high cultural diversity, and this is explained by the extreme ecological, and therefore subsistence, conditions existing in such

environments. ‘‘These interactions and TK systems reflect unique adaptations and successful specialization in the use and management of landscapes’’ (Oviedo et al, 2000:74).

Herrmann (2005) gives an example from field research that investigated ecological knowledge, uses and management of the Araucaria Araucana forest by indigenous Mapuche Pewenche people who inhabit the Andes Mountains in Chile. This was based on the sociocultural, spiritual and ecological relationships they have with the Araucaria forest. He argues that native forest conservation and management objectives need to include, rather than exclude, indigenous people. However, he sees that there is a challenge to bring together indigenous knowledge, values and management practices and western science in order to form collaborative management strategies of the Araucaria Araucana. These should be suitable culturally, socially, and economically for indigenous resource use and can be adapted to ecological changes. Nonetheless, he asserts that this also would be of benefit to western societies in conserving a valuable species and part of biodiversity commitments (Herrmann, 2005). This argument brings to mind the idea of Chun and Tak (2009), when they attribute the success of sustainable forest management in Korea to a traditional knowledge system which is known as ‘songgye’ (Chun and Tak, 2009). This supports the arguments of Oviedo et al (2000), Shrestha et al (2005), and Herrmann (2005) that IK is an important component in managing and conserving forest areas in a sustainable manner. It also means that the participation of local people of forest regions in the decision-making process is vital to ensure the success of management strategies.

In contrast, Charnley et al (2007) question the integration of traditional and local ecological knowledge into forest biodiversity conservation in the Pacific Northwest. They describe the application of this knowledge to forest management and biodiversity conservation as being

difficult, and they attribute this difficulty to a number of social, economic and policy constraints that have prevented this knowledge from being applied into forest management and biodiversity conservation. However, they acknowledge that IK could be integrated in forest management and biodiversity conservation, as long as the local forest practitioners agree to share their knowledge with western scientists and forest managers, provided that they are interested, and they will get mutual benefits (Charnley et al, 2007).

In their study of projects in a controlled-hunting area in Botswana, Phuthego and Chanda (2004) examined the integration of traditional ecological knowledge (TEK) in community-based natural resource management, and illustrated that the projects acknowledge and demonstrate the utility value of TEK in sustainable natural resource management. They concluded that TEK systems and institutions could serve as access points into sustainable natural resource management. They extended their argument seeing that:

> ‘‘local communities are principal beneficiaries of traditional resource management regimes based on knowledge systems, whereas the formal, non-indigenous sectors, especially governments and private enterprises favour large economic and commercial institutions as principal beneficiaries. The formal systems are controlled through market outlets and universal Intellectual Property Rights systems’’ (Phuthego and Chanda, 2004:74).

The work of Phuthego and Chanda (2004) points to the potential of the exploration of cultural practices of the local people and of incorporating constructive features into the modern NRM expertise to ensure sustainable utility of the wildlife.

However, Gilchrist et al (2005:1) stated that ‘‘management decisions based primarily on local ecological knowledge (LEK), in the absence of scientific scrutiny, should be treated with

caution''. Despite this, they strongly advocate integrating local ecological knowledge into efforts to manage and conserve wildlife, but they thought it necessary to set rigorous testing of LEK prior to its incorporation into management plans. They reach this conclusion after they reviewed four case studies of marine birds in which they collected LEK for each species, and then compared this information to empirical data derived from independent scientific studies of the same populations. They found variable success after integrating LEK into their own conservation and management efforts for these bird species. They confirmed that LEK was a useful source of information for three of four species (Gilchrist et al, 2005). In this case, it could be argued that the validity of LEK, after it been subject to rigorous testing, will be similar to scientific knowledge. Hence, it is easier to use already valid scientific knowledge rather than go through repeated a experimental process. Otherwise, LEK could be used combine with scientific management to provide joint management or co-management. This is what Moller et al (2004) recommended when they evaluated ways of combining science and traditional ecological knowledge to monitor populations. They mentioned that in scientific practice, ideal population monitoring methods are accurate and easily measured in a repeatable manner. Yet, scientific research and monitoring can be expensive, often requiring specialized skills or technology and often not practicable in the remote places in which traditional processes are utilized. In places like these, local communities possess neither science ability, nor tradition and trust in science. In addition, traditional users need time to switch to complex monitoring methods, especially if the methods are not related to their customs. In contrast, they thought that the majority of traditional monitoring methods used by native people are fast, low-cost and hence, Moller et al (2004:31), conclude that:

> 'Traditional and scientific management systems may prove complementary, and differences between them more theoretical than real. Because science is expensive and many customary harvests take place in developing countries or in poor regions, simple, rapid, and inexpensive yet robust monitoring methods are needed. Scientific

> methods must be congruent with traditional management and acceptable to local resource users. Complementing the limited scientific monitoring information in such regions with traditional ecological knowledge is potentially workable and cost-effective, and adaptive management may provide a framework for joint use'.

However, there is remaining worldwide debate of the validity of IK in NRM which reveals much about its applicability within NRM (Wohling, 2009). Illustrating an example from northern Australia, Wohling (2009) asserts that it has been widely acknowledged that indigenous association with the landscape has many levels and interrelationships with ecology, identity, kinship, social organization, governance and economy. Even though it is undeniable that local knowledge is an important storehouse of information about the natural history of specific indigenous estates, there is increasing empirical and theoretical evidence that IK is not ''adapted to the scales and kinds of disturbance that contemporary society is exerting on natural system''(Wohling, 2009:2).

These examples demonstrate that the key issues in the literature are the encouragement and strengthening of indigenous practices regarding NRM methods, and building indigenous people's capacity in order to empower them to manage their territories in a sustainable manner through effective practices and techniques (Bang-Oa, 2006). Moreover, some researchers argue for the importance of combining and interlacing modern scientific and indigenous knowledge to produce a more realistic and sensitive understanding and effective management of natural environmental resources for SD (Cleophas, 2004; Gilchrist and Mallory, 2005; Gilchrist et al, 2007). Doing so will foster the influence of traditional knowledge in environmental decision-making in order to promote more socially egalitarian and environmentally sustainable relationships between human societies and nature (Nakashima and Roué, 2002; Ellis, 2005; Gilchrist and Mallory, 2007). It will also enhance

the role of IK in subsistence economies and the utilization and conservation of natural resources of wild plants crops, and wildlife species (Farooquee et al, 2004; Gilchrist and Mallory, 2007).

### 2.2.5 Problems and challenges for IK

Increasing loss of IK is a key problem. A primary reason for this is among indigenous peoples themselves, as elders pass away without transferring their knowledge onto younger generations who have been facing accelerated social change owing to the multifaceted effects of globalisation (Burgess, 1999; Oviedo et al, 2004; Wohling, 2009). Oviedo et al (2004:75) describe the problem as a crisis which is of far greater magnitude than the biodiversity crisis, correlating it to culture and language loss. This loss is a result of the market economy and can be seen in many side-effects such as ‘‘Changes in habitat, restrictions on mobility, alteration of subsistence economies owing to the loss of traditional land rights and the decline in biodiversity, breakdown of social structures and acculturation’’ (Oviedo et al, 2004:75). These trends threaten the survival of many indigenous people and their cultures. Moreover, the impact of globalization on the world’s cultures increases, as both cultural and biological diversity reduce. Posey (1996), cited in Oviedo et al (2004), argue that ‘‘these processes affect both indigenous and industrial societies and that the two are in fact interdependent, so that what happens in one is reflected in the other’’ (Oviedo et al, 2004: 75).

Nonetheless, it can be argued that there are direct impacts regarding the loss of IK, which reflected in changes in land use, and shifting traditional systems of resource use. Linking that with decline, or loss, of traditional values attached to lands and resources, weakens the relations of individuals to their homelands. Generally, as a result of IK degradation, the

opportunities to learn more about local environments from people who have managed them for a long time could be lost (Oviedo et al, 2004). Pilgrim's (2006) study suggests reasons which result in the loss of local ecological knowledge. He states that ecological knowledge is currently facing progressive loss, as ''a result of a shift in knowledge transfer methods with economic development, from word-of-mouth and direct experience to reliance upon the media and formal education'' (Pilgrim, 2006:229). Pilgrim also blames the current system of formal education and curriculum, attributing them with a negative effect on student's ecological knowledge levels and their attitude toward ecoliteracy (Pilgrim, 2006).

Another worry relating to concerns about the rapid loss of IK and global cultural diversity is that of misappropriation, unauthorized and inappropriate patenting and use of IK, with little or no sharing of income benefits with the original holder of IK (Twarog, 2004). This issue is being discussed in a range of international bodies, including the conservation and sustainable use of biodiversity, that is the Convention on Biological Diversity (CBD), the International Labour Organization, the United Nations Commission on Human Rights and the United Nations Permanent Forum on Indigenous Issues, the World Intellectual Property Organization, (WIPO) and (UNESCO), as well as in trade-related forums such as the WTO and United Nations Conference on Trade and Development (UNCTAD). Indeed it is the international community's responsibility to come up with means of protecting IK (Twarog, 2004; Oviedo, 2004). However, one could question that, if this solution were to be enacted, to what extent would it be applied, which international organization would be responsible for it, and would this organization have the authority to inspect and regulate countries? Political support is an essential issue which also should be considered.

Other critical issues facing IK revolve suspicions about IK's credibility, validity and operability over time and space. A key question is whether IK is capable of operating at different scales, especially NRM and development, particularly if it has been acquired in other places, and at a prior time. Many studies of IK have focused on its empirical and practical elements, but this emphasis possibly undermines a more comprehensive understanding of the epistemology of IK (Briggs 2005). Briggs (2005) argues that many empiricist approaches often disconnect local knowledge from its context and, whilst recognizing the importance of the empirical, he bemoans the lack of economic, social and political contexts in which such knowledge has been acquired and utilized. Some researchers are demonstrating the usefulness of IK outside specific locations in which it was structured (Briggs 2005; Briggs and Sharp 2004; Wohling, 2009). However, others, for instance Beckford and Barker (2007), strongly argue that there are many benefits to be achieved by considering IK as a knowledge system complementary to scientific research which has proved the capability of IK in co-management and as a key factor in survival for some local communities in developing countries. Beckford and Barker (2007:120) state ''we regard local knowledge as a necessary adaptation to well-recognized resource constraints in a physical, economic and political environment rife with risks and uncertainties''.

Briggs (2005) suggests that there are number of problems that resulted in IK not being as helpful as expected. Firstly he states that western science and indigenous knowledge are represented as binary competing knowledge systems, the two systems being separated as a result of their epistemological foundations (Briggs, 2005). One could argue that it is correct that the basis of each system is different, scientific knowledge resulting from an experimental logic methodology, and IK resulted from trial and error and experimentation processes, but both are authenticated throughout the life practices. Therefore, they should be seen as

complementary knowledge systems, particularly in the development arena (Karbolo, 2004; Sumner, 2006). Secondly, Briggs (2005) discusses the problem of differentiation and power relations which evolve from factors such as age, experience, wealth, production priorities, household circumstances, political power and gender. He states that:

> ‘‘this problem of power relations cannot be sidestepped; there is a real need for the power and positionality of players in these indigenous knowledge debates to be evaluated critically, as Twyman (2000) has suggested in the context of community-based natural resource management initiatives. Although the current received wisdom seems to be that the ‘local’ is the immediate future for development, in terms of participation, indigenous knowledge and so on, if it is to be successful there needs to be a much fuller engagement with the underlying power relations involved’’ (Briggs, 2005:107).

## 2.3 Sustainable development in mountain areas

### 2.3.1 Introduction

While ecosystems deliver goods and services of great value to the people (Pearce and Moran, 1994; Daily, 1997: Daily et al, 2009), intensive land and water use, overexploitation of natural resources and chemical emissions into the environment are dramatically affecting world biodiversity and the natural, effective functioning of the ecosystem (Hooper et al, 2005, Millennium Ecosystem Assessment, 2005). The dramatic inconsistencies of climate have made this human-environment interaction more problematic and tends to be more severe in mountain regions (Michalidou and Rokos, 2011; FAO et al, 2011) where topographical complexity and altitude make mountain ecosystems especially sensitive to global alterations (Becker et al, 2007; Bugmann et al, 2007). In addition, lowlands also feel the effects of the changes affecting mountain areas, as they benefit from the ecosystem services provided by

mountain such as clean water, flood control, reduced sedimentation, scenic beauty and many more. This clear relationship between human well-being and nature makes it imperative to create a balance between using nature's products and the good management of ecosystem services to keep different topographical locations, healthy and sustainable for present and future generation.

### 2.3.2 Sustainable development: the theory and practice

The United Nations introduced sustainable development to the international community when it released the Brundtland Report, 'Our Common Future,' in 1987. Since then, this report has shaped the international political agenda concerning SD as a framework for linking the preservation of the environment and successful development (Mfune, 2011). The definition of SD suggested in the Brundtland Report is now among the most recognized definitions of the concept: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Although this definition might look obvious, it presents two main conditional concepts: that of needs and that of limitations - limitations that are inherent in the present state of technology and the present social organization affecting the environment's ability to meet present and future needs. IUCN et al (1991:10), however, defined SD as a strategy for "improving the quality of human life whilst living within the carrying capacity of the ecosystems." Similarly, Pearce (1993) thought that SD concerned measuring SD of a society where the costs of development are not transferred to future generations or, at least, an effort is made to compensate for such costs.

Hasna (2007), on the other hand, considers sustainability to be a process of development that touches all aspects of human life. It is mainly about resolving the conflict between various competing goals while carrying on with the simultaneous pursuit of economic prosperity, environmental quality, and social equity, famously known as the three dimensions (triple bottom line) within the framework of a common technological denominator. In this definition, sustainability is an important yet evolving process; it is only a path to follow to get to the destination (the goal to achieve in the future). Unfortunately, the 'destination' of sustainability is not a well-known or clearly defined goal. Instead, "it is a set of wishful characteristics of a future system" (Hasna, 2007:6)

The United Nations' 2005 World Summit Outcome Document refers to the interdependent and mutually reinforcing pillars of SD as economic development, social development and environmental protection. Indigenous peoples, however, have argued that to achieve a more satisfactory intellectual, emotional, moral, and spiritual existence, cultural diversity is as necessary for humankind as biodiversity is for nature. In this vision, cultural diversity, which was further elaborated upon and confirmed by the Universal Declaration on Cultural Diversity (UNESCO, 2001), becomes the fourth policy area of sustainable development. This is because "Cultural diversity widens the range of options open to everyone; it is one of the roots of development, understood not simply in terms of economic growth, but also as a means to achieve a more satisfactory intellectual, emotional, moral and spiritual existence" UNESCO (2002:62) moreover, sustainable development, in effect, is an eclectic concept with many and varied views, concepts, attitudes, definitions, and scopes of vision and actions falling under its umbrella. In addition, too many situations today use the word 'sustainable'. Everything is sustainable (Temple, 1992) and we speak today of sustainable economies,

sustainable agriculture, sustainable hot areas, and sustainable mountainous areas, the focus of this research.

### 2.3.3 Sustainable development in mountain regions

Mountain regions have great natural, biological and cultural wealth (Michalidou and Rokos, 2011). The cultural diversity of mountains regions continues to attract many visitors (FAO et al, 2011). After the Earth Summit in Rio de Janeiro 1992, which singled out a chapter on mountains in Agenda 21, the following five topics became the most important for the mountains of the world and their resources: ‘‘(1) water towers for an increasing world population and food production; (2) biological diversity and protected areas: treasures for future generations; (3) cultural diversity and sacred mountains: knowledge and heritage; (4) recreation areas for a rapidly growing urbanized world population; and (5) climate change and its effects on ecosystems and water resources – mountains as highly sensitive indicators’’ (Messerli et al, 2009:12).

Recognition of the special status of mountains was boosted with the World Summit on SD in Johannesburg and the launch of the “Mountain Partnership” in 2002, when national governments began to understand that land use, forest management and biodiversity preservation were fundamental for the quantity and quality of water for populations in both the highlands and the lowlands. Additionally, the International Year of Mountains, 2002, and the International Year of Freshwater, 2003, contributed to an awareness about mountains and their significance as the water towers of the world. In contrast to this vision, some perceive mountain regions negatively and mostly characterized by “limited access, remoteness, (and) limitations in land and natural resources’’ as well as being prone to disasters and catastrophes

(Erik et al., 2006), Such areas face environmental and socio-economic problems, seen in the difficulties presented for agriculture of intense and intensively changing topographic relief, the “dispersion of small land holdings’’ and climate changes (Michalidou and Rokos, 2011:1).

Nevertheless, there is a worldwide call for the need to develop mountain areas in a sustainable manner, arguing that because mountain populations have their own cultural heritage it is important to preserve and sustain the cultural heritage mountainous regions (Messerli et al, 2009). According to the FAO (1992) levels of economic development in mountain regions is lower than the acceptable norms claiming that, out of poverty, natural disasters, national armed conflicts, pollutions, deforestation, and many other ecological threats, the demographic outlook of such areas is being subjected to a ‘‘continual gradual distortion’’. This would soon, if it had not already, lead to a dramatic lack of balance in "socio-economic systems", serious ecological problems and dangerous "demographic irregularities". Consequently, the United Nations Assembly (2011), on the status of SD in mountainous regions, stated that great stress be placed on increasing countries’ and governments’ awareness of the importance of SD to improve life conditions in these disadvantaged areas.

Kout (2002) asserts that new policies are needed in order to achieve equitable development in mountainous regions and to provide financial resources for conservation and sustainable development. It is important that people understand the needs of mountainous areas so that intensive SD can occur and so it is essential to have local strategies that target the general guiding tenets, actions and tools in such a manner that maximize benefits to the community.

However, there are several strengths and weaknesses in the application of mountain policies (Engjel et al., 2006). For example, in Zemo Svaneti, Georgia, in spite of great potential for sustainable development, much of the region remains underdeveloped due to the unwillingness of some members of society and government to carry out sustainable activities. Yet, Engjel et al, (2006:93) assert that:

> ‘‘resource management is of crucial importance if the occurrence of disasters and their negative effects on the population are to be reduced. It will also ensure the future availability of resources. For efficient long-term resource management, complex planning processes have to be engaged, balancing the needs of the population with the use of forests and agricultural land as well as land for settlements and construction by elaborating appropriate regulation schemes’’.

Maintaining stability in guiding development in mountain regions requires sustained financial support.

The United Nations Commission on SD (1995) recommended NRM as essential for sustainable mountain development and to include the integration of social and environmental costs in their management by local groups, in order to distribute the benefits to local inhabitants as profit. Pitoska (2009:715) identifies priorities that should be taken into consideration to maintain SD in mountainous regions: ‘‘transformation of agricultural activity; extensive development of soft tourism; establishment of mountain development centers per micro-region; and improvement of access to mountainous areas”. Thus, sustaining natural resources becomes a need to match rational “foreseeable needs” of future generations with present capabilities to save the life supporting capacity of air, water, soil, and entire ecosystems and, of course, to avoid any undesirable activities in the environment.

One of the main concepts that the European Commission (EC) promotes for the development of mountainous areas is cohesion policy. According to the European Union, ‘‘territorial cohesion is a means of transforming diversity into an asset that contributes to SD of the entire EU” (Commission of the European Communities, 2008:3). According to the EC's vision, SD is necessary in different regions to ensure harmonious development in all places. Such cohesion would also establish good coordination in social, economic and ecological trends. Additionally, Springett (2003) noted that organizations implement SD in mountainous areas to reflect themselves as well-managed and eco-efficient. By doing this, the organizations translate the concept into one which suits the continuity and existence of traditional business notions (Pezzoli, 1997).

Rory (2009) highlighted the importance of society and its cultural concepts in achieving sustainable resources management in the Indian tribes of Wisconsin in the USA. The tribes’ cultural beliefs regarding respect for the community and their spiritual aspects influenced the management of their natural resources reflecting the spiritual relation that tied the people to their land. Together, a balanced relationship was established between the humans and their environment. In the Greek mountainous community of Nymfeo in Florina, Pitoska (2009) felt there existed a perfect example of a small mountainous community that “managed to create a successful system” where economic and social benefit was balanced with environment protection and the promotion/preservation of local cultural features. This example constituted the case of a community that had “regenerated” through strategic planning of sustainable management of local development resources after abandonment in 1990.

However, with the exception of a few cases, of which the community of Nymfeo was one, Pitoska (2009) showed that mountain regions were not fully capable of achieving integrated and sustainable development since the existing level of mechanisms to support these areas was insufficient for the full utilization and exploitation of the funds provided by the various programmes.

Implementing SD initiatives needs many instruments to be successful. At the community level, it is vital to use effective institutions and technology to maintain and manage sustainable development. Astha (2006) supports the need for effective institutional arrangements at all levels of project design, implementation and monitoring, suggesting that with effectively managed natural resources, SD could achieve social equity, economic security and ecological integrity.

In the Southeast Asian mountain areas, Ramon (2011) identifies a major obstacle in the deep-rooted path of the brown economy that depends mainly on fossil fuels and unsustainable exploitation of natural resources. This obstacle includes land use conversions of forests to chemical-based monocultures. Moreover, the impact of armed conflicts are yet another challenge facing development in mountain areas (e.g. rebel factions in Cambodia and Myanmar). Climate change also influences all countries in southeast Asia resulting in the melting of snow and glaciers in the Himalayas and an increase in floods, landslides and reduced water supplies and food resources. Thus, gradual democratization and good governance is seen as the route to bring SD to mountain communities, as the gradient in democracy may bring peace to the region, and this is a prerequisite for development. Mountain communities needed to be involved in the development by forming community

organizations and cooperative societies. Ramon (2011) asserts that a policy of green growth would promote sustainability.

According to Pedro et al (2008), strategic guidelines and key conservation and development standards should have been priorities to start action plans for Mediterranean mountain chains, a region that is ecological varied and geologically diverse. It suffers from unbalanced usages of its natural resources due to the absence of clear policies and strategies in protecting the regional ecosystems. An intensive state of deforestation due to aggressive use of the mountains' forest resources suggests a need to adopt sustainable management practices to prevent the loss and sustain the use of forest natural resources.

Many mountain areas in the world still maintain strategic and natural reservoirs to support the economies of other regions. Such support advantages the people of the lowlands, while mountain people, who make up about 13% of the world's population with a further 14% living in their immediate vicinity (ICIMOD, 2010), generally are disadvantaged by a lack of the basics of life and a lack of involvement in development strategies for their regions. In recognition of this, comprehensive policies and strategies are now being pursued to promote sustainability and development in mountain systems (Pedro et al, 2008). Among several guidelines for developing Mediterranean mountain action plans, the principles of an ecosystem approach and SD are key. Moreover, the restoration of locally adapted management practices for mountain ecosystems is still an element of great importance for the protection of mountain water resources. Keeping the mountain inhabitants on their lands must be a priority if the policies of SD are to be effective. This can be achieved by providing employment opportunities for local people, improving the standards of living, and reducing emigration from mountain areas.

A promising mechanism toward achieving the aims of the international agenda for SD in mountain regions is the Mountain Partnership formed in 2002. This partnership is a voluntary association of national governments, intergovernmental organizations, local and regional authorities, non-governmental organizations, the private sector, academic communities, and other major group representatives who are working together to improve livelihoods, conservation and stewardship throughout the world's mountain landscapes (McGuire, 2009). A mechanism for networking, communication and information sharing, the partnership functions to serve as an advisor for joint initiatives and has successfully facilitated legally binding conventions on mountain development aimed at improving mountain communities' livelihoods and conserving fragile mountain ecosystems. ''Efforts in the Carpathians, Balkans, Central Asia, and other mountain regions are ensuring that governments and other stakeholders are working together effectively on mountain issues'' (McGuire, 2009: p21).

## 2.4 Summary

Natural resources management should always be linked to SD as echoed by many scholars. This is because achieving SD's aims can be secured through a planned programme with intended goals and necessary processes (Plange (1996) in Pelesikoti, 2003: 25). Since the Brundtland Commission published its landmark SD report in 1987, many theories have investigated the directions and explanations of the development process. These theories assume that nations continuously seek ways to transform their economies from 'subsistence to cash-based', relying on these theories as the context in which nations would become developed (Pelesikoti, 2003). However, if development is to serve the needs of a community, it should be constructed on appropriate strategies that incorporate all stakeholders, and it

should benefit from technology suitable to the project and to community needs. This has been called the integrated management approach (Jorgensen 2008; Pelesikoti, 2003). With this vision, many countries have made important progress to incorporate SD into their planning and policies. However, despite these efforts, transferring the principles and theories of SD into practice has proven daunting (Sillitoe et al, 2002; Strange and Bayley, 2008; Victor, 2012).

Reviewing the literature on SD reveals support for both perspectives: SD as a guiding principle and SD as a tangible target that can be measured, evaluated, and deemed achieved (Strange and Bayley, 2008; Akramov, et al, 2010; Akramov and Shreedhar, 2012). Sustainable mountain development should manage mountain ecosystems in a manner that allows them to continue to deliver goods and services, existing and future, for both local livelihoods and lowland people (FAO et al, 2011). By holistically considering the environment, economy, society, culture and political pillars of sustainable development, sustainable mountain development can improve the lives of mountain people while maintaining the life support systems of the surrounding lowlands.

In terms of utilizing IK in development programmes, experts and development managers, particularly in developing countries, are encouraging the participation of local people in development programmes. This recognises IK is an important contributor to the success of such programmes. In contrast, many researchers urge caution when dealing with IK since extracting IK from its cultural context carries dangers and so it may be preferable to use IK as complementary to western knowledge. It remains that the effectiveness and efficiency of IK in many aspects of life are yet to be fully substantiated. A more extensive test of the

hypothesis that IK circumstances develop is required and, if confirmed, should pave the way for the more general use of IK as being equally valid to scientific knowledge (Mkapa, 2004).

The result of studies and analysis in NRM and SD has shown that NRM and its practical applications need both human capacity and government policy obligation. However, only partial understandings of NRM and SD have been achieved, since NRM work have been mainly concentrated in Europe, North America, South America, Australia and a few countries in Asia and Africa. Oman lacks studies that address NRM and natural environment conservation, particularly in the AAR and thus there is a real gap between scientific study and the incorporation of IK in these areas. The following chapters aim to address this knowledge gap.

# Chapter Three

# The study area

## 3.1 Introduction

The Al-Jabal Al-Akhdar Region (AAR) (Figures 3.1 and 3.2) in the Western Hajar mountain range of Oman is state-protected, and the World Wildlife Fund for Nature (WWF) has recognized it globally as an eco-region of importance.


Figure 3.1 The location of the Al-Jabal Al-Akhdar Region in Oman.

Source: http://geography.about.com.

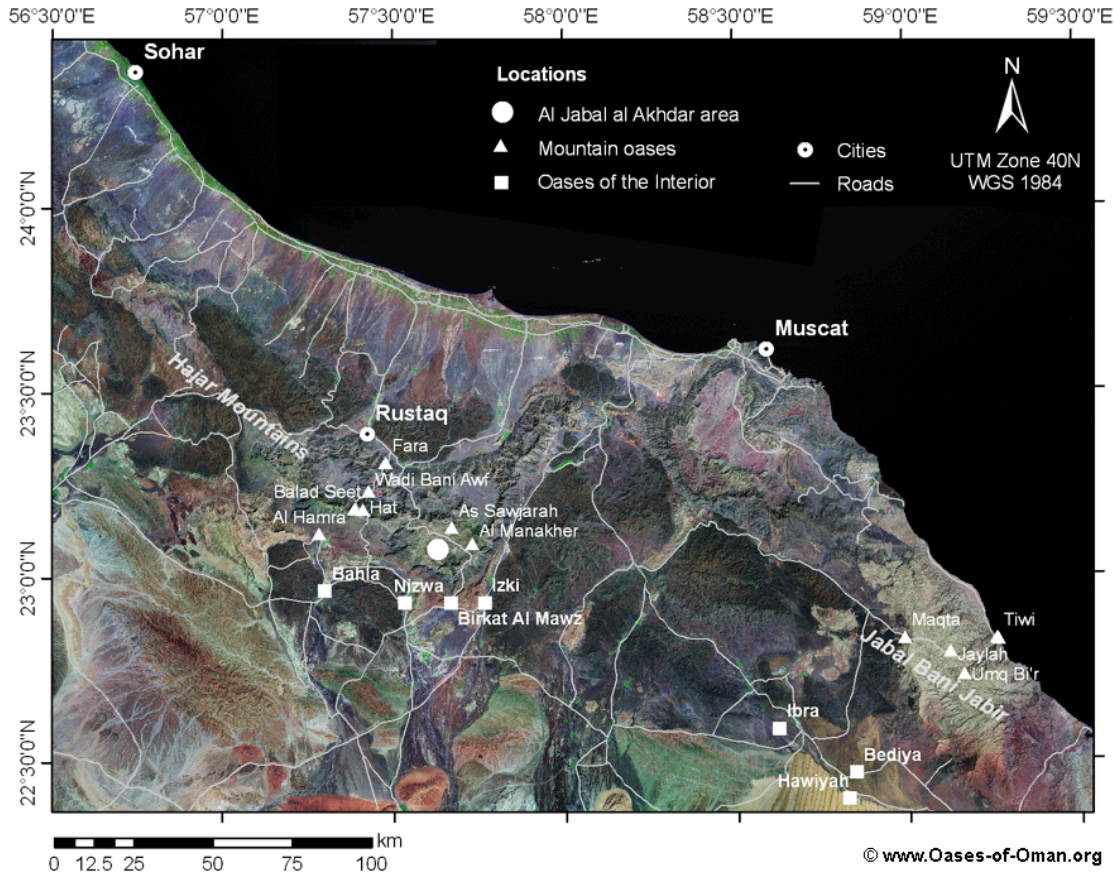



Figure 3.2 Al-Jabal Al-Akhdar Region in Al-Dakhiliyah Province.

Source: adapted from (Dickhoefer, 2000)

Besides its geographical, geological, environmental and demographic importance, the AAR is of recreational value, promoting activities that are economically and socially important, tourism activities is a case in point. There are rich natural resources in the AAR, both renewable, such as water, plants and wild animals, and non-renewable, such as marble, granite and chrome ore. However, the region's fragile ecosystems are under stress. In the last decade, AAR has transformed from an isolated region of well-regulated, untouched and protected wilderness to a major area of development (Victor and Robinson, 2008), and from a region of rural, conservative and inward-looking communities, based largely on agro-pastoral activities, to an area where communities are open to the outside world, and influenced by national and international events. The most notable impact of these transformations is the

change in local life styles, as local communities change towards a consumption life-style over a production one. This is of great concern to conservationists in both government and academic arenas who strive to raise environmental awareness and contribute to efforts to preserve the rich heritage and culture in the region, including TK. They promote greater efforts to mitigate the negative consequences of change on the natural resources of the AAR. An appropriate NRM system must be an essential element of the conservation efforts in this area (Victor, 2008). This chapter focuses on the geographical and population characteristics of the AAR, in order to understand the administrative organization that governs the natural resources of the region.

### 3.2 General location of the AAR

The Sultanate of Oman is located in the South Eastern corner of the Arabian Peninsula between latitudes 16°39′ and 26°30′ N and longitudes 52°00′ and 59°30′ E. Its land borders with Saudi Arabia and the United Arab Emirates in the West and with the Republic of Yemen in the South. The eastern side of the Sultanate borders the Sea of Oman and the Arabian Sea and has a coastline of nearly 3165 kilometres. The high rugged Al- Hajar Mountains in northern Oman, which are separated by Wadi Samail into a western and an eastern range, extend southeastward, parallel to the coast of the Sea of Oman, from the Musandam Peninsula to Ra's Al-Hadd at the easternmost corner of the Arabian Peninsula, forming a 600-km-long arch. The AAR lies between 22°30′ and 23°15′N latitude, and between 56°50 and 57°45′E longitude (Peterson, 1990; Al-Azri, 2006; Luedeling, 2008; Al- Busaidi, 2010). The line between areas that have distinctive mountain characteristics, such as deep wadis (Figure 3.3) and those that form a natural part of the lowlands and the foothills of the Al-Jabal Al-Akhdar, defines the study area boundary (Figure 3.4).

### 3.3 Geographical characteristics of the AAR

The present topography of the AAR is extremely rugged, suggesting that the shape is a result of many geologic processes. Luedeling (2008:17) describes this, saying:

> ‘‘Plate tectonic processes, glaciation, submergence, sediment deposition, and erosion by ice, wind and water is evident all over the range. Because of the different susceptibility of the various rock formations to erosive processes, the topography of the mountains is complex, with large sediment fans on either side of the range, extensive limestone plateaus on its flanks, an eroded basin in the centre, and deeply incised valleys in the transitional zones between high and low terrain’’ (Luedeling, 2008:17).

The AAR is unique in several respects, as it occupies a strategic location within the country, and it is described as the ‘backbone of Oman’ due to its central point in the physical geography of Oman, overlooking the coastal province of Al-Batinah plain to the north. Although the AAR is regarded as the highest elevation of the western range because it rises to 3,000 metres, its deep wadis (Figure 3.3) form the most impressive features in the AAR, not only due to the severity of their relief, but also due to the importance of these wadis to the economic life of the population, as they are the watersheds that feed the neighbouring regions (COWI Consult, 1991; Al-Azri, 2006). As these are water catchment areas with higher than average rainfall for Oman (300 mm per annum), the wadis (single wadi: Arabic term traditionally referring to a valley. In some cases, it may refer to a dry (ephemeral) riverbed that contains water only during times of rainfall or simply an intermittent stream.) are crucial for supplying the groundwater of the adjoining regions.

Figure 3.3 The deep wadis in the AAR.

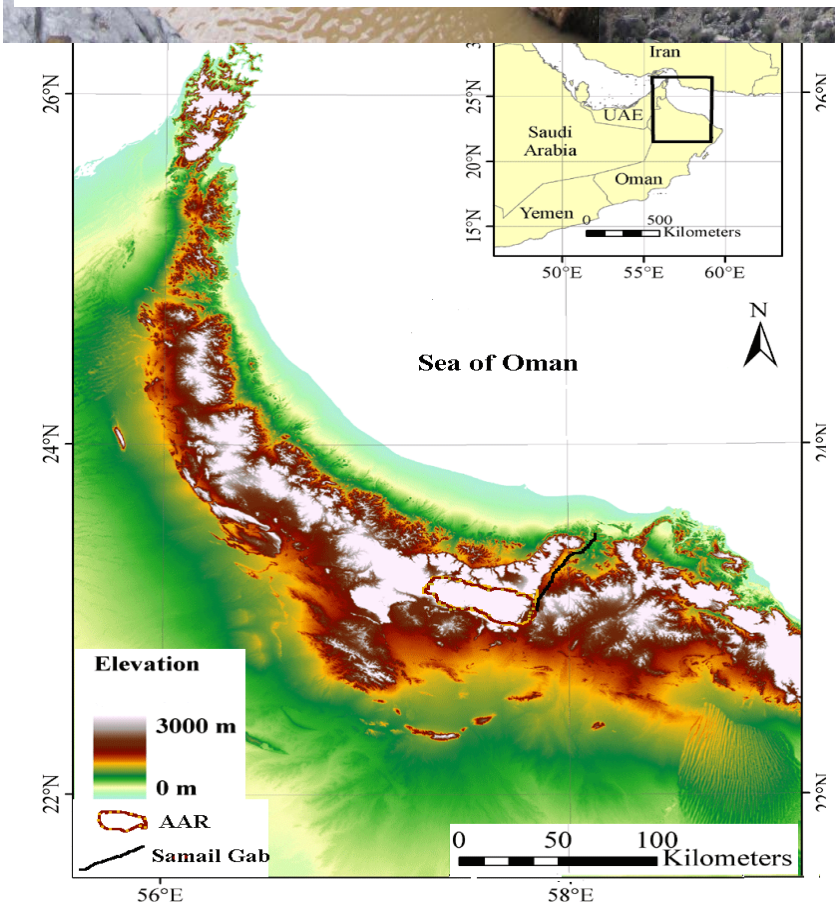



Figure 3.4 The study area and its geographical characteristics.

Source: adapted from (Luedeling, 2007)

The mountains of the region are barriers to transportation and communication between the northern coastal and interior provinces. There is only one major road link across the

mountains linking Al-Dakhiliyah province with the provinces of Muscat and Al-Batinah through the Samail Gab (Figure 3.4).

The regional geography contributes to variation in climatic conditions, making it the only region in Oman in which the year can be clearly divided into four seasons (winter, spring, summer, and autumn). The climate of the AAR is similar to the climate in areas of the Mediterranean. In general, average winter temperatures range between 1 to 21.5 °C occasionally droping to below −3 °C in some years. However, temperatures tend to be hot in summer with an average range of 31 to 34 °C, exceeding 35 °C in some years. Figure 3.5 illustrates the monthly mean air temperatures in Saiq in the AAR.

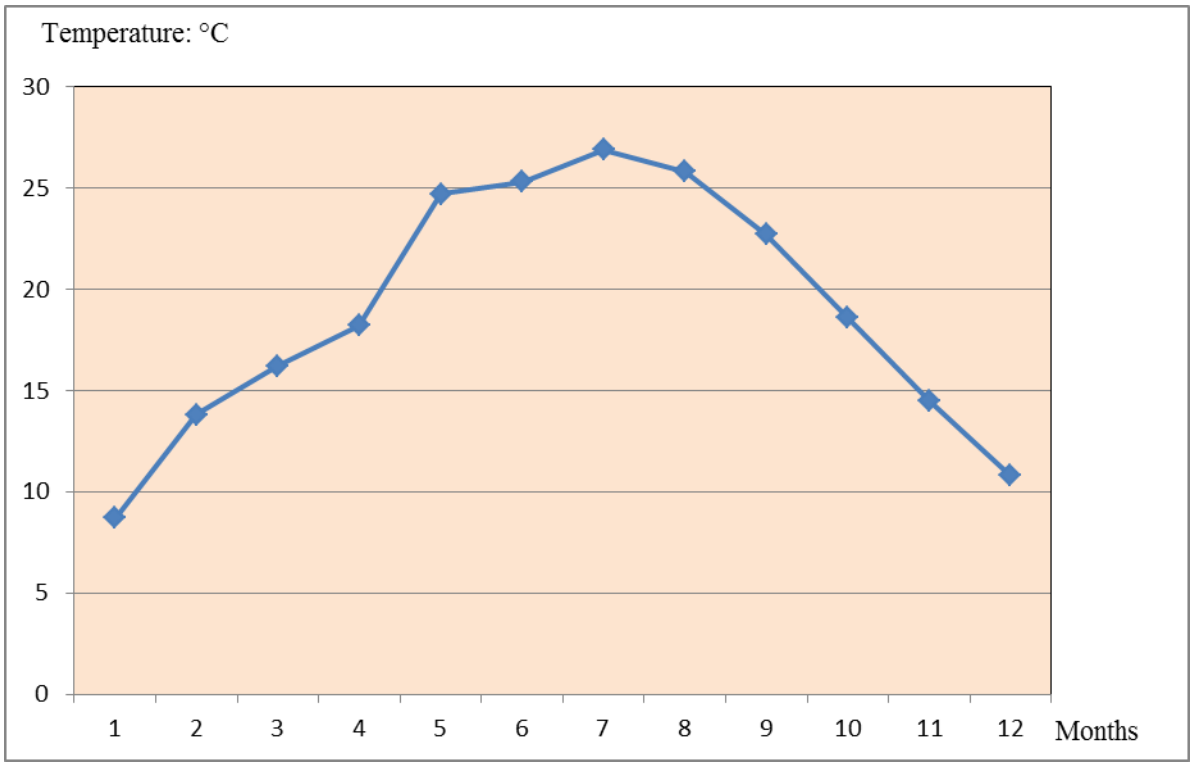



Figure 3.5 Monthly mean air temperatures [°C] in Saiq in the AAR in 2009.

Source: (MTC, 2009).

During the summer, humidity levels are low (22% in June, on average) and intermittent southern breezes help to keep conditions bearable. Humidity reaches its maximum

(approximately 55%) in December and January. The transit of depressions from the Mediterranean Sea affect the AAR in winter as they irregularly cross the region. This means that the region gets enough rainfall to cause wadis flow and to fill the dams. Rainfall occurs again in the summer (between June and August) when the monsoons from the Arabian Sea affect the area, but the rain is sporadic, and varies in amount from one area to another. This means that while the rain falls in some areas, others remain without any rain. The annual rainfall ranges from 115-413 mm (Figure 3.6). Additionally, cyclones and tropical storms from the Indian Ocean affect the area. These cyclones hit Oman in June and October (Al-Azri, 2006; MTC, 2009). This happened in 2007 when Hurricane Gunu hit the eastern coast of Oman, as well as during Hurricane Phet in 2010. In short, the climate of the region depends heavily on external climatic influences from the Mediterranean Sea and the Indian Ocean and their effects at altitude produce heavy rain during the period from December to April and from June to August.

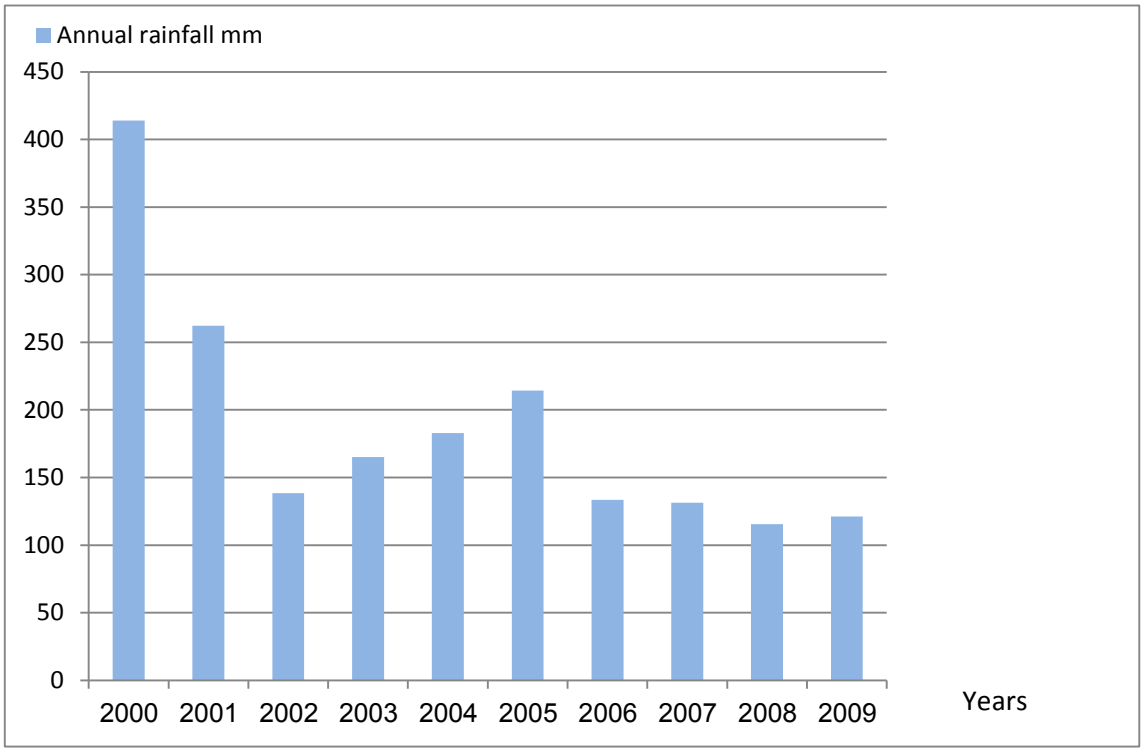



Figure 3.6 Annual rainfall in Saiq in the AAR from 2000-2009.

Source: (MTC, 2009).

Despite their classification into red, grey volcanic, and brown, the soils of the AAR are identified as Torriorthents, which range from calcareous, very gravelly and loamy soil (a mixture of sand, clay, silt, and organic matter) to sandy soils with a shallow depth, not more than 70 cm. However, the soils of the AAR are regarded as part of the fragile environment due to their water-holding abilities and their susceptibility to erosion as they are shallow, coarse and loosely anchored (MAF 1990; Al-Azri, 2006; Robinson and Al-Nabhani, 2009; Al-Wardy, 2009). Al-Wardy (2009) suggested that the dominant provenance of the AAR soils are the ophiolitic and carbonitic geologies of the mountains with soils forming on Ophiolites being gravelly and coarse whereas carbonitic soils tend to be finer (Al-Wardy, 2009:172).

### 3.4 Historical background of the AAR

The place of Al-Jabal Akhdar in the history of Oman is significant. The difficult accessibility of the mountains and the central isolated plateaus have often been referred to as one of Oman's natural defences and seeking places of refuge or defence has influenced patterns of human settlement throughout history. Many confrontations between opposing groups have taken place in and adjacent to the mountains of Jebel Akhdar, with the latest taking place in the 1960s (COWI Consult, 1991; Al-Azri, 2006; Luedeling, 2008).

There are traces of early settlements in Oman dating back to the Palaeolithic Age, in the third millennium BC. Throughout Oman's early history, there have been influences from East Africa, Asia, and Europe (COWI Consult, 1991; Luedeling, 2008). The settlements at the foothills of Al-Jebel Al-Akhdar have played an important role in the Islamic period of Oman History. The settlement in the interior, particularly around the AAR, included towns like Nizwa, Bahla, and Izki to the south and Rustaq to the north. They all, at one time or another, had the distinction of being capitals of Oman. The interior of Oman was the home of traditionalists, both in the sense of tribal structure and religion and this part of the country became more and more isolated in terms of political and social contact. In general, this led to a number of internal problems which over the centuries gave rise to armed confrontations. The tribal structure was a dominant feature in the history of Oman, especially in the AAR, and it represented an influential and complex power structure. The Imamate insurrection of the 1950s probably represented the last thrust of tribal authority. Moreover, Al-Jabal Al-Akhdar represented the last stronghold of the Imamate, where Imam Ghalib and his followers barricaded themselves in remote places in the mountains after their insurrection, and where the war between him and the Sultan of Muscat and Oman - later known as the Jabal Al-Akhdar War – took place in 1957. The war ended in 1960 after the Sultan requested British

assistance, referring to a treaty between the United Kingdom and Oman in 1951 (Philips, 1970; COWI Consult, 1991; Al-Azri, 2006). Figure 3.7 shows one of the abandoned villages affected by the Jabal Al-Akhdar War in the Wadi Bani Habib region.

Figure 3.7 An abandoned village in Wadi Bani Habib.

In recent history, with the exploitation of oil and gas providing the country with its main revenue, and finally, with the introduction of modern developments into Oman by the sultan, history is again focused on Al-Jebel Akhdar. However, this time, the aim is to integrate the mountain areas and their people into Oman, and more broadly, into the whole world, both socially and economically.

### 3.5 Demographic and socio-economic characteristics of the AAR

The AAR's population was 6950 on the latest Census of 12 of December 2010. This is 10% of the total population of Nizwa (the centre of Al-Dakhiliyah Province), which in turn has a population of 326,651. The latter number is 11.8% of the total population of Oman

(2,773,479 in the 2010 Census (Ministry of National Economy, 2011)). While there has been a general trend of population growth in the AAR since the first Oman National Census, 5227 persons in 1993 increased to 6250 persons in 2003, a 17.8% growth rate compared to the 17% growth rate of Oman, no information exists about historical demographic trends in the region prior to 1993.

However, population growth in the AAR can be explained by the arrival of the achievements of Oman's modern Renaissance after 1970, which improved the economic situation of local communities, improved per capita incomes, and caused the return of many of the region's migrants who were working in neighbouring Gulf countries (Al-Azri, 2006). In addition to convergence of childbearing and lack of birth control combined with improving health services.

Migration and absentee workers are a phenomenon of the region, as it has been a tradition for some local people to work away from their native villages for extended periods. Owing to their superior fitness, men of the region tended to be the best soldiers and have played a leading role in local inter-tribal conflicts. They also worked as paid soldiers for other potentates who maintained standing armies, such as the Imamate army. Therefore, when work opportunities opened up in the neighbouring gulf countries during the 1960s, it was an opportunity for many local people to go to work there. When development took off in Oman in 1970, men of the region were able to find work in Muscat and Nizwa (COWI Consult, 1991).

After 40 years of modernisation in Oman, road communications have been substantially improved in the AAR, a factor which has led to increased weekly travelling instead of long-

term absences. Direct observation of some of the villages in the AAR indicates the absence of men, particularly younger men. In many villages, younger men are now away and many of the traditional tasks surrounding agriculture and livestock are done by expatriate workers under the supervision of the elders.

The population of the 40 settlements of the region depends on traditional economic activities relating to agriculture, grazing, local trade, and handicrafts as sources of livelihood. Beside those livelihoods, the region's population today is also employed by government institutions and private sector organizations that provide services to people in the fields of agriculture, education, health, municipal services, social development, and tourism. The major traditional economic activity in the region is the interdependence of livestock and agriculture, the balance between the two depending on available water and agricultural land, with settlements at higher altitudes mostly oriented towards livestock. Livestock and agriculture are intimately linked: the goats depend on fodder (mainly alfalfa and dates) and cultivation depends on goat manure.

According to data from the Census of Agriculture 2004/2005, about 85% of the total the AAR population work in agriculture, and the total area of cultivated land is estimated at 275 acres (111 hectares). This is approximately 55.6% of the total area of arable land in the AAR, which is estimated at 496 acres (170 hectares) (MAF, 2006). The cropping patterns in the area show a remarkable flexibility, which has been adapted over the centuries to the precarious availability of water. The first crops to be sacrificed in times of water shortage are vegetables, followed by summer cereals and then alfalfa. Trees, such as pomegranates, due to their importance as an initial source of income, are preserved at all costs. Moreover, the agricultural system is extremely resilient, having evolved as an adaptation to sustained

periods of drought, sometimes lasting three years, and often followed by periods of relatively abundant rainfall.

The villages of the Al-Jebel Al-Akhdar appear to be highly self-sufficient in farm inputs, the most extensively used fertilizer being goat manure. It has proved difficult to gauge the extent to which agricultural production is exported out of the planning area. The cash crops appear to be mainly pomegranates, apricots, peaches, garlic, wheat, sorghum, and rose. The region is also well known for distilling aromatic flowers and herbs to produce rosewater and other therapeutic preparations.

In terms of livestock, goats are the primary local animal in the villages of the AAR, where most individual farmers raise at least 40 goats (Dickhoefer, 2006; Al-Busaidi, 2010). Depending on goats, cattle, and chickens, households aim at producing meat, milk, and eggs, and selling textiles that are weaved from goat and sheep wool (Al-Busaidi, 2010). In the high-ground areas and the wadis of the region, which are unsuitable for agriculture and extremely rugged, the raising of goats becomes increasingly important. As with land cultivation, the system of herd rearing needs to be extremely flexible and adaptive to the changing availability of rainfall and water. The animals graze on common rangeland in the uplands and wadis during the daytime and return to be kept in barns overnight, where supplemental feeds of dates, dried fish, and cultivated green fodder are offered (Dickhoefer, 2006). Herd sizes vary considerably in the medium to long term according to the availability of grass and fodder, which makes it difficult to assess long-term trends. The number of goats in the study area, estimated by the Ministry of Agriculture and Fisheries' (MAF) vaccination programme, was 20,000 in 1989 (COWI Consult, 1991), while Al-Busaidi (2010:40) estimated a total herd size of 17,000 in 2009. However, this is only an estimated figure that cannot be an evidence to prove that the number of animals is reducing.

Although communities of the AAR are largely self-sufficient, farmers and goat herders market about 70% of their production (Al-Azri, 2006). Direct observation indicates that commerce in the sense of retail trade establishments is gradually increasing as the region witnesses population growth and increasing tourism demands. Wholesale establishments are almost non-existent in the region, and the inhabitants of the region do wholesale shopping at weekly intervals in the neighbouring towns, such as Nizwa. However, street marketing features promising opportunities, as local people marketing farms produce such as pomegranates in the streets of the villages (Figure 3.8).

Figure 3.8 Local people marketing pomegranates in the street of local market (Souq) in Saih Qeteneh in AAR.

Local people are involved in many craft industries that required the availability of raw materials from the local environment. The most significant industries are the distillation of rosewater (Figure 3.9), the weaving of wool, and the creating of leather.

Figure 3.9 Distillation of rosewater in Saih Qeteneh in the AAR.

The Al Jabal Al Akhdar region has potential for sustainable tourism development, and, as tourism is one of the fast emerging sectors in Oman, the government has proceeded to utilize the potential of this sector to improve its foreign exchange and Gross Domestic Product (Ramanathan and Subramanian, 2010). The major characteristic that promotes tourism in the AAR is its Mediterranean climate and picturesque mountain scenes. Traditional villages are spread across the mountains where agricultural terraces produce fruit, such as pomegranates, apricots, plums, figs, grapes, apples and pears, as well as almonds, walnuts and saffron - classified among the finest of their kind in the world (Ministry of Tourism, 2010). However, direct observations showed that there are limited tourist facilities to sustain the development of tourism. Only two hotels are fully booked in the high season (Summer). The restaurants are limited in capacity and provide a short menu of meals. There is no tourism centre in the region to provide guidance services. Meanwhile, the government is concerned about the negative impact of tourism, requesting avoidance of tourist developments that will have an adverse impact on traditional ways of life, and in particular, that could be intrusive and

distressing in rural areas, placing undue strain on the local custom of hospitality towards visitors (COWI Consult, 1991). Today the government works to advertise and market the AAR as the first tourist destination in Al-Dakhiliyah Governorate.

Nevertheless, some studies, such as COWI Consult (1991), Ramanathan and Subramanian (2010) and the Ministry of Tourism (2010) have found that tourism development can have a positive impact in the area if the government takes into account the need to protect the inhabitants from the damaging effects of tourism, and promotes its efforts to preserve the environment and the biodiversity of the region. Tourism could generate more revenue of about 16 million Rials (25.6 million GBP) and it could provide employment for about 1750 people (COWI Consult, 1991; Ramanathan and Subramanian, 2010; MoT, 2010).

### 3.6 Administration of the AAR

To understand the administration regime in the AAR, it is crucial to mention the whole Oman administrative structure, starting with the central government administration, identified by The Basic Statute: "The White Book". The Statute that was enacted in 1996 is the most important piece of legislation in Oman. Article 1 of the Basic Statute declares: “The Sultanate of Oman is an independent, fully sovereign, Arab, Islamic state. Its capital is Muscat”.

The Oman organisational structure includes His Majesty and a series of specialized councils, institutions and authorities. His Majesty Sultan Qaboos bin Said is the Head of State. He has the highest and final authority and he is the Supreme Commander of the Armed Forces. Laws and decrees are authorised by His Majesty. In addition, international treaties, agreements, and

charters signed or approved by His Majesty become law from the date of their publication in the Official Gazette.

The highest executive authority below His Majesty is the Council of Ministers. This body draws up and implements general state policy on economic, political, social, executive and administrative matters of concern to the government. The Council also sets out the general goals and policies for economic, social and administrative development, and proposes methods and procedures for implementing measures to ensure the efficient use of financial, economic and human resources. There are thirty ministries in Oman, which aim to provide essential services for the public, protect the interests of citizens, and improve the economic, health and cultural standards of the population.

The Sultanate of Oman has 11 governorates: Muscat, Dhofar, Musandam, Buraimi, Batinah North, Batinah South, Dhahirah, Dakhiliyah (in which the AAR is located), Sharqiyah North, Sharqiyah South, and the Wusta. The governorates are divided into sixty-one administrative areas (wilayats, singular wilayah). The Ministry of the Interior oversees this organization and the governors of these governorates, who are responsible to the Interior Minister, as well as to the walis (chief administrators) of the wilayats (one wali per wilayat), oversee local administration, and link the governorates with the country's government, its institutions and the public. Among the ministries that provide services relating to the natural resources in the AAR are the Ministry of the Interior, the Ministry of the Environment and Climate Affairs, the Ministry of Agriculture and Fisheries Wealth and the Ministry of Regional Municipalities and Water Resources.

The general directorates in Nizwa (the centre of the Al-Dakhiliyah governorate where the AAR is located) represent the above-mentioned four ministries in the regional government administration. These directorates are the Office of Wali Nizwa, the Directorate General for Agriculture and Animal Wealth, the Directorate General of Regional Municipalities and Water Resources, and the Department of Environment and Climate Affairs. These Directorates are responsible for overseeing the implementation of the ministry's policies, which are planned and decided centrally in Muscat, and for overseeing the implementation of programmes and projects according to annual plans.

These directorates are locally represented in the AAR by a department or an office, such as the Office of Na'ib Wali Nizwa (the deputy of the chief administrator) in Al-Jabal Al-Akhdar, the Office of Nizwa Municipality in Al-Jabal Al-Akhdar, the Department of Agriculture in Al-Jabal Al-Akhdar, and the Department of Environment and Climate Affairs in Nizwa. Figure 3.10 illustrates the organizational structure of the government authority responsible for water resources in the AAR. This structure, however, resembles the natural resource governance structures in the AAR.

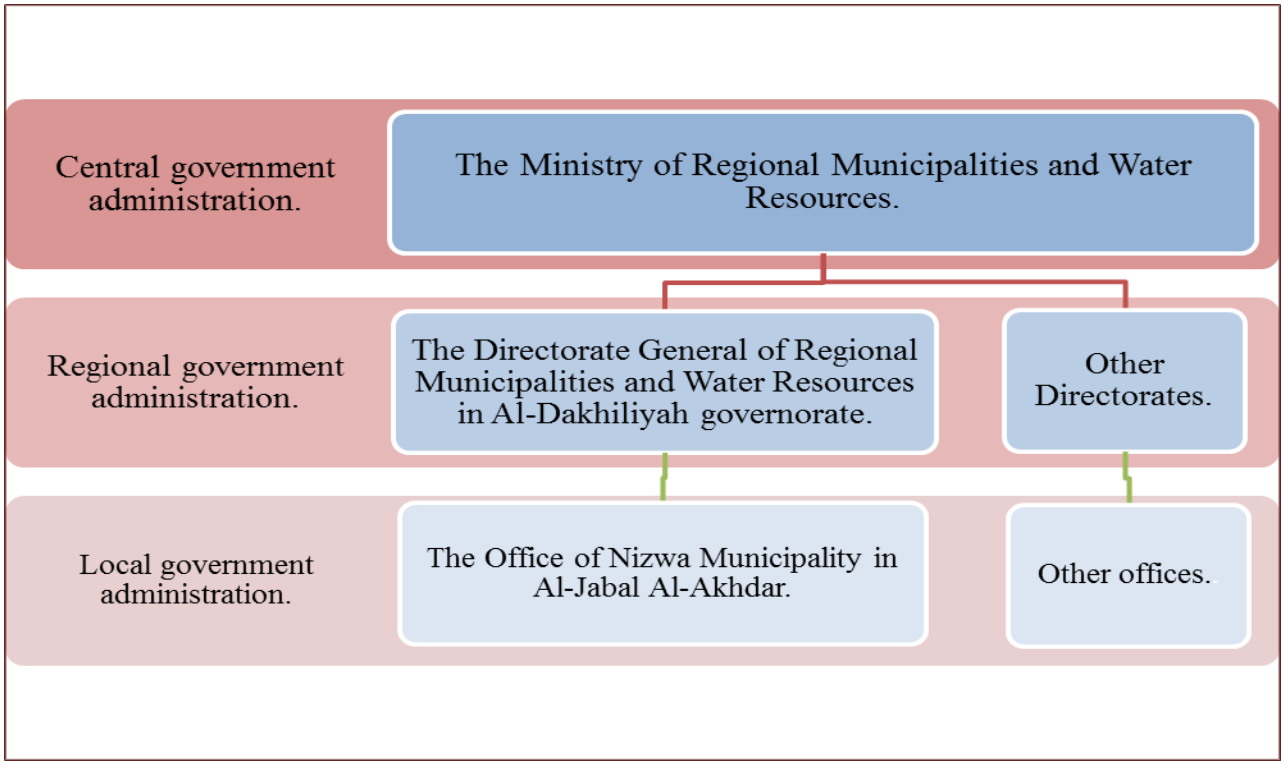



Figure 3.10 An example of the organizational structure of the government authority responsible for water resources in the AAR.

Traditional authority was very important in Oman. The patterns of the Sheikhs' authority and power in the AAR, as in the entire country, were well-recognised and every village had a leader, called a 'Sheikh'; (other villages which include more than one tribe could have more than one sheikh). These authority patterns enabled Sheikhs to carry out their responsibilities to serve as intermediaries between the government and the people. However, after 1970, the powerful tribal Sheikhs were largely superseded by the growing role of modern government establishments, which began offering services to people without the mediation of Sheikhs. Since then, the chiefdom system (Al-Mashykheh) has been gradually eroded. Its political and social power, and the Sheikhs' power and ability to control the tribes, began to weaken (Peterson, 1984). Thus, the Sheikhs' roles have now become honorary ones, where they receive respect and appreciation for being members of the family of Sheikhs, but not for their authority and power. Today, the government occasionally uses Sheikhs as advisers to pass an

information about development and service projects. This means that although government seeks a Sheikhs opinion, it does not mean necessarily it will be taken into account when deciding development and service projects.

### 3.7 Natural resources in the AAR (Surface land resources)

#### 3.7.1 Water resources

In contrast to the neighbouring lowland area, the Al-Jebel Al-Akhdar mountain range benefits from relatively higher precipitation and it is crucial for recharging the aquifers, both to the north on the Bettina plain and in the Al-Dakhiliyah governorate to the south. Rainfall reaches an average of up to 300mm per year in parts of the area above 2000 metres, in the Saiq area, and along the main east-west ridge, but generally declines to 200 mm or less around the boundaries of the region, which are mostly between 700 metres and 1000 metres above sea level (MTC, 2009). Springs and natural seepages at higher altitudes, above 2000 metres, attracted people to settle around them, and about 20 villages have been formed there. In the upper wadis, normally at altitudes between 1000 and 1700 metres, mixed pastoral and agricultural communities have developed. Water availability and agricultural potential tends to increase progressively further down the wadi (Al-Busaidi, 2010).

Ground water in the region is derived from hard rock springs or, more commonly, from aquifers in the alluvium in the wadis. Stanger (1986), who studied the hydrology of Northern Oman in 1986, commented that the concentration of the groundwater into streak or stripe sources has historically facilitated maximum exploitation of water in irrigated agriculture in the form of Aflaj (single Falaj) which are a traditional irrigation systems (see Chapter seven

for more details), which have evolved as creative systems of groundwater management in a climate of alternating droughts and floods (Stanger, 1986). It is crucial to associate the amount of rainfall and the subsequent runoff with the falaj water discharge. Figure 3.11 illustrates water discharge in the Falaj Lokbairi in Al-Ayn in 2007. The figures indicate that the discharge was only 0.002 $M^3$/S at the beginning of June, but that it rose to 0.006 $M^3$/S by the end of that month after a rainfall of about 83.5 mm on 6/6/2007. The rainfall was due to the indirect influence of cyclone Gonu that hit Oman's coastal areas during the period from 5-9/6/2007.

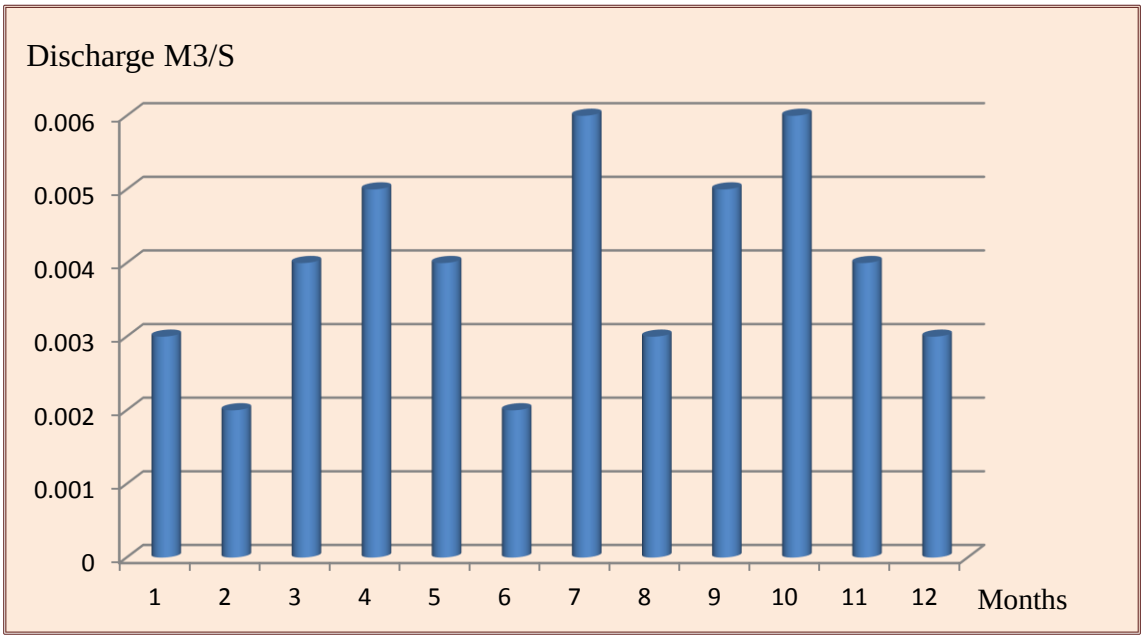



Figure 3.11 The water discharge in the Falaj Lokbairi in Al-Ayn in 2007.

Source: unpublished figures from the Office of Nizwa Municipality in Al-Jabal Al-Akhdar.

The small amount and the unpredictable character of rainfall is a major constraint on human activities, as well as on vegetation cover and wildlife. The ground surface on the mountain slopes is not able to retain moisture and only in the wadi beds and on the plateaus can sufficient water be retained for cultivation. Responding to this situation, the government has

constructed about 46 small dams in the region (Figure 3.12), and is currently undertaking a study for the construction of other dams. These are intended to permit a recharging of the underground water that, in turn, enhances the recharging of aflaj and can contribute to the expansion of agricultural and/or herding areas, and, where needed, to the provision of a reliable water supply for domestic use (MRMWR, 2009).

Figure 3.12 One of the many surface storage dames in the AAR.

### 3.7.2 Pasture resources

Although pasture conditions are better in the mountains than in the plains, the majority of the slopes of the region become too dry and exposed to nurture perennial species in the dry season and during drought periods. The livestock survey of 1982, conducted by the Ministry of Agriculture and Fisheries (MAF), and recent studies and reports, such as those by Dickhoefer (2006) and Victor (2011), make a clear assessment of the rangeland of the Al-

Jabal Al-Akhdar. They agree that it is in a generally degraded state and in need of a programme to protect and increase the perennial tree and shrub cover (MAF, 1982; Dickhoefer, 2006; Victor, 2011). Overgrazing is a serious factor in rangeland degradation in the region. Feral donkeys compete with goats and sheep for forage plants, as shown in Figure 3.13. Moreover, urban development activities are among key human factors (see Chapter 5) that put direct pressures on those pasture resources (Robinson et al., 2009).

Figure 3.13 Feral donkeys compete with goats and sheep for forage plants in the AAR.

Despite the severe situation previously discussed, the region is characterized by a diversity of perennial plants and grasses that grow in the rainfall seasons, especially in the wadis where plant diversity is more abundant (about n=12 species) than in the plateau areas (n=10 species). Consequently, wadis are important grazing areas for livestock (Dickhoefer, 2006). Saiq plateau, which is at a height of about 2000 m, is dominated by pasture tree species, such as:

> ‘‘Juniperus excelsa ssp. polycarpos, (Figure 3.14) Olea europea ssp. Cuspidate and Sideroxylon mascatense (syn. Reptonia mascatensis), accompanied by Dodonea

viscosa, Euryops arabicus, Grewia erythraea and Sageretia thea, as the abundant shrubs. In the wadis, Acacia gerardii, Ziziphus spina-christi and a so far unidentified wooden species, which is most likely related to the date palm, complemented the shrub and tree strata. The ground vegetation was composed of grass species, such as Aristida adscensionis, Cenchrus ciliaris, Cympopogon spec., Cynodon dactylon and Tetrapogon villosus. The main herbs were Heliochrysum glumaceum, Salvia aegyptica and Teucrium spec'' (Dickhoefer, 2006:31).

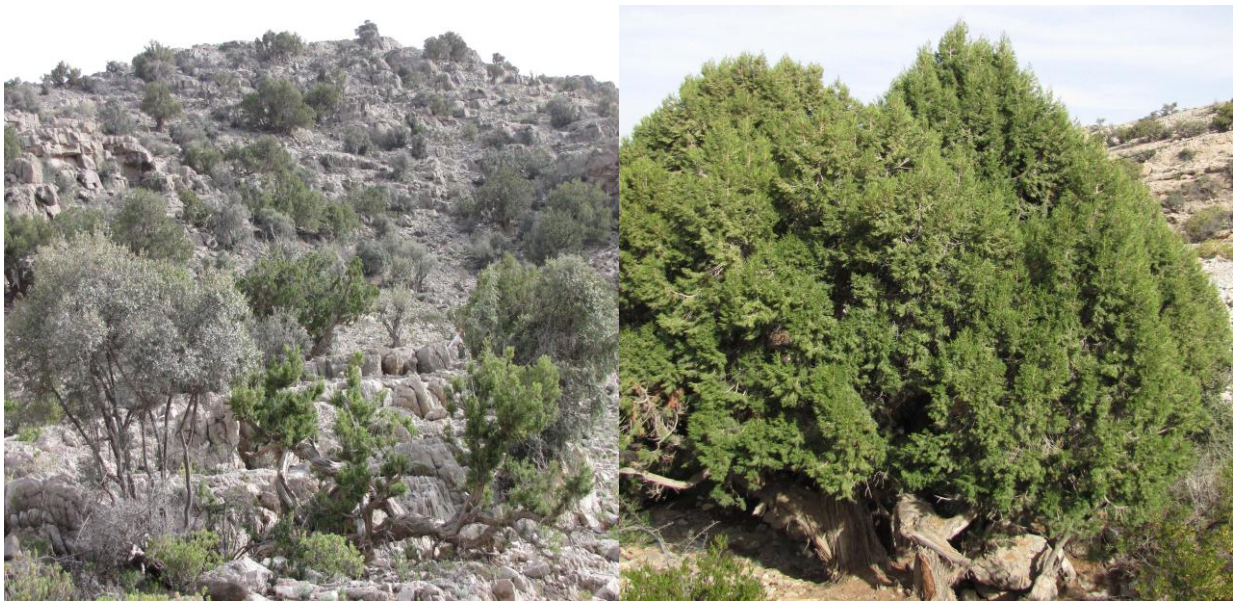


Figure 3.14 Pasture tree species such as Juniperus that is dominant in the AAR at altitudes over 2000 m.

It is worth mentioning that the natural pasture plants are significantly important for the local people. The Director of the Department of Natural Pastures in the Ministry of Agriculture and Fisheries describes this:

''There are several types of Omani pastoral plants in the AAR, which include trees, herbs, and grass. These grasslands are considered as nature assets that may grow in certain areas and not in others but they survive the lack of water, drought and dry winds. They are a major source of balanced biodiversity; a rich source for medicines;

and source of food for both domestic and wild animals, as well as natural resource human beings. The most important types of these plants are: Acacia tortilis (as-Semr in local term), Juniperus macropoda (Al a'lalan) and Olea Africana (Atem in local term). with understorey cover dominated by annual grasses such as Eragrostis barrelieri and Tetrapogon spathaceus, and perennials such as Hyparrhenia hirta. There is, also, an understorey cover dominated by annual grasses such as Eragrostis barrelieri and Tetrapogon spathaceus, and perennials such as Hyparrhenia hirta''.

Households depend strongly on wild olive (Olea Africana) (called Atem locally) in many ways. As the olive wood is extremely hard, the local people use it to construct house ceilings (Figure 3.15) and to make valuable sticks; those decorated with silver may be sold for £100. In addition to being an excellent fodder tree for the grazing animals, its fruit is edible as a pickle olive. In short, Olea have played an important role in the historic development of the mountain villages in the AAR.

Figure 3.15 Traditional house ceiling made out of olea (wild olive) wood in Al-Ayn in the AAR.

### 3.7.3 Agricultural land resources

The harsh natural topography of the AAR influences the distribution of agricultural land. The arable land can be found at agricultural terraces that are created by the local people. These terraces require tremendous human effort to construct and maintain, and are widely distributed over the 40 villages of the region. According to the Omani Agricultural Census (2004-2005), the total number of holdings in the AAR was 2459 properties; 2084 of them were agriculture-related properties, while 370 of them were animal-based ones, and five properties were mixtures of agriculture and animal rearing. However, agricultural properties, inspite of their classification, are usually used also for animal rearing. Figure 3.16 presents the agricultural areas in the region's villages.

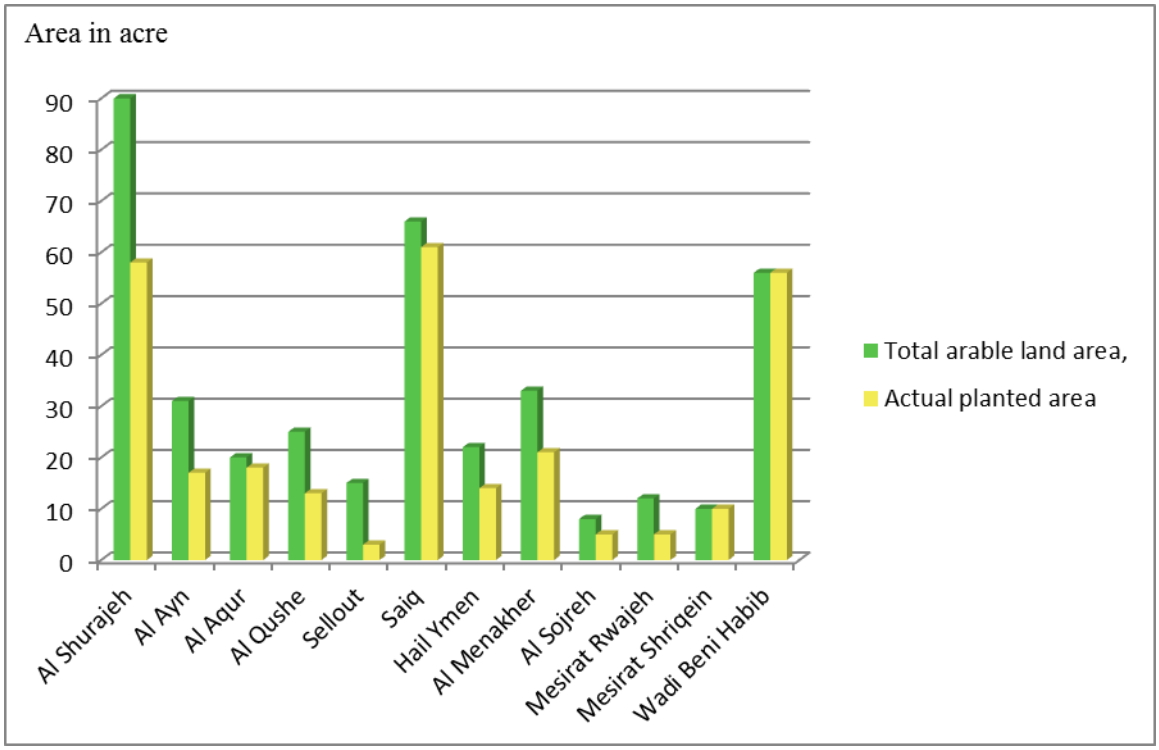



Figure 3.16 The agricultural land area in the AAR.
Source: Ministry of Agricultural and Fisheries, 2006).

The results of the Omani Agricultural Census (2004-2005) also indicated that the total area in the AAR planted with fruit trees was about 220.2 acres, while about 43 acres had field crops, 13 acres had vegetable crops, and about 1 acre grew perennial forage crops. It should be noted that the results also showed that the total number of deciduous fruit trees was 49,511, 39% of which were pomegranate trees, in addition to 3437 date palm trees. The proportion of the local people who depend on agriculture as their main source of livelihood (50%) clearly indicates the significant importance of this sector in the region (Al-Azri, 2006). Thus, local people are keen to get the most out of the limited agricultural land area, optimizing productivity of agriculture by improving soil quality, maximizing the full value of water for irrigation, and practising intensive agriculture. These agricultural practices are discussed fully in Chapters 7 and 8.

### 3.8 Land ownership/tenure in AAR

The Basic Statute of the State (the constitution) ruled that the lands' ''natural resources and revenues therefrom shall be the property of the State which will preserve and utilize them in the best manner taking into consideration the requirements of the State's security and the interests of national economy'' (MLA, 1996:5). Despite this, the Land Law of 1972 and its amendment of 1980 codify the existing land ownership situation in Oman. Those laws generally specify that only Omani nationals are allowed to own free land, while other Gulf Cooperation Council (GCC) nationals may also own land subject to certain restrictions. Foreign companies and individuals are generally not permitted to own land in Oman, except for real estate in areas designated as Integrated Tourism Complexes (ITC) by the Oman government (Morison Muscat, 2010). However, these laws do not apply entirely to the title and ownership of land in the AAR. The highest command of His Majesty Sultan Qaboos

ruled to grant land ownership only and exclusively to the original residents of the region (Al-Busaidi, 2010). However, the continuing of granting housing land to the local people has increased gradually, and this represents one of the threats to the natural resources, particularly the perennial trees.

Nonetheless, it is important to note that the issue of land tenure in the AAR, as in all of Oman, is subject to Islamic Law, with its most important implications for inheritance, ownership and endowment (waqf). Waqf means that the land is in the form of a trust; the property is considered to belong to God, while its proceeds may be used to support either the family of the man who created the waqf, or the maintenance of mosques, or charities supporting the poor. The specific character of the AAR with a pattern of scattered small village communities has led to a rather strict adherence to the traditional land tenure system.

The major issue regarding the land tenure system in the AAR is its adaptation to new forms of human settlements, which have already interfered with traditional ways of life. With the establishment of government facilities, combined with the limited availability of flat area, there is a need for a review of land tenure in the area to find an effective use of available space in a manner that preserves the land's natural resources.

Existing policies are probably more appropriately expressed as present practices carried over from Islamic tradition and law. These practices relating to land tenure and land inheritance follow Islamic Law in a complicated formula. However, with the expansion of development projects encouraging more tourists to visit the region, and with the growth of specific key villages with semi urban housing, it will eventually be necessary to assess the need for titling the land.

The ownership of agricultural land is important but it should be noted that this is part of a complex interrelationship between people, water and land, meaning that land is classified according to its usefulness in cultivation; that is, according to the availability of water. In brief, land related to settlements can be classified into five groups: (1) land with permanent cultivation (tree crops); (2) land with permanent cultivation from a less reliable water base (fodder); (3) land with seasonal crops (vegetables); (4) land for village grazing, and finally, (5) land for mixed herding by nomads (COWI Consult, 1991). Property also includes falaj water share and channels related to the land. Wells, falaj systems, and irrigation channels are three elements of agricultural production that may be bought or sold as property.

Of special relevance to those living at high altitudes in the AAR, with very little land under cultivation, are the vast areas of common grazing used either by the villagers' own herds or by herds belonging to nomadic people (Al-Shawawi) who wander between the highlands and the piedmonts. Most of the villages in the foothills of the AAR and in the lower parts of the wadis follow a land pattern showing all or most of the above-mentioned land categories. The villages in the mountains (some seasonal, though many now permanent) have very little or no cultivation; all land, with the exception of the settlement itself, falls within the last two categories, village or family grazing and general grazing (COWI Consult, 1991).

### 3.9 Development, rural development and the environment in the AAR

Before 1970, Oman's economy was largely dependent on a workforce employed in agriculture, and the per capita income was very low (159 OMR = £261.8). All this changed dramatically as His Majesty Sultan Qaboos bin Said, on July 23, 1970, became the Sultan of Oman. The per capita income rose to 5648.9 OMR (£9,118) in 2007 (MONE, 2008). This

coincided with commercial exploitation of oil which brought the real start of development planning in the early seventies. Since then, Oman has witnessed diverse increases in the Gross Domestic Product and in per capita income. The notable economic and social achievements in the period are reflected in the development of modern infrastructure, an improved education system, improved basic health provision, and rising living standards of the Omanis (MNE, 2008). This is also the case in the AAR, where all the residents in the region now have access to the government's basic services (education, health, housing, electricity, drinking water, roads, social insurance, and communications).

As far as education is concerned, Table 3.1 illustrates the number of schools, teachers, and students in the AAR in the school year 2009 – 2010. Schools are located in three villages only, and this could lead to non-enrolment of six-year-old children because of the scattering of the schools, the travelling distance, and the difficulty in making transitions to those circumstances at that age (Al-Azri, 2006). However, student class size in different education stages (basic education and secondary school) did not exceed the standard average in the region (30 students in each class), while the students per teacher ratio does not exceed the standard average of the region (16 students per teacher) (MOE, 2009).

Table 3.1 The number of schools, teachers, and students in the AAR in the school year 2009 – 2010.

| Name of School | Location or Village | Students No | | Classes No | Class size | Teacher No | Student/ Teacher |
|---|---|---|---|---|---|---|---|
| | | Gender | Total No | | | | |
| **Abu Zaid Al-Ryami** | Saiq | Male | 563 | 19 | 30 | 36 | 16 |
| **Al-Jabal Al-Akhdar** | Saih Qeteneh | Female | 553 | 18 | 31 | 35 | 16 |
| **Rebo'a Al-Jabal** | Saih Qeteneh | Male<br>Female | 232<br>215 | 16 | 28 | 31 | 14 |
| **Al-Gheleil** | Al-Gheleil | Male<br>Female | 217<br>99 | 13 | 24 | 17 | 19 |
| **Total** | 4 | | 1879 | 66 | 28 | 119 | 16 |

Source: Ministry of Education, 2009, Section of Statistics, unpublished data.

Health services provide one hospital in Saih Qeteneh with a capacity of 24 beds divided into four sections: for men, for children, for women, and for childbirth. This means that there are six beds in each section, plus an equipped childbirth section. A number of outpatient clinics, such as the Clinic of Internal Medicine, the Diabetes Clinic, and the Children's Clinic, and a diagnostic X-ray and laboratory, are also available to patients. The hospital operates to provide all basic health services to all residents in the region, offering free treatment, medicines, and immunization.

The government is keen to equip the region with infrastructure, such as road networks (Figure 3.17), drinking water networks (Figure 3.18), and telecommunications (Figure 3.19).

Figure 3.17 The road network linking residential neighbourhoods in the AAR.

Figure 3.18 Water tank at a high altitude at Saiq in the AAR.

Figure 3.19 Telecommunications tower and the new hotel (Sahab) overlooking a spectacular view of the agricultural terraces at Al-Shuraijeh in the AAR.

The Director General of the Directorate General of Agriculture and Animal Wealth in Al-Dakhiliyah Governorate described the agricultural development programmes provided by the Department of Agriculture in the AAR:

> ‘‘The government has many programmes to enhance the cultivation methods and production such as: agricultural mechanization programs through which the government provide the farmer with farm tractor/tiller (Figure 3.20) that suited to the nature of the region, as well as pruning shears and machines of picking fruit; plant protection programs to control diseases and pests of trees in a timely and appropriate manner to reduce the damage of those crops; Provide veterinary services (Figure 3.20) for animals through veterinary treatments and prevention programs for diseases that affect animals and through the implementation of national immunization project for livestock; and provide agricultural extension programs for the sectors of plant and animal production, these programmes aim at educating farmers and breeders to follow the modern farming and livestock methods that lead to maximizing the income from this sector’’.

Figure 3.20 The agricultural development programmes provided by the Department of Agriculture in the AAR. Source: (Al-Riyami, 2006).

The Social Development Department is making appropriate efforts for the advancement of rural women in the region, making them aware of their roles, as they live in accelerated changes in life patterns, in the family, in society, and in the nation. Along with literacy classes run by the department, it offers several workshops in order to maximize women's time to contribute in raising the family income. There are workshops held in sewing, embroidery, weaving and distilling aromatic flowers and herbs, in cooperation with the Omani Women's Association and the Centre of Aromatic Plants Distillation (Figure 3.21).

Figure 3.21 A workshop on distilling aromatic herbs for rural women in the AAR.

Source: the Social Development Department in the AAR.

Today, notwithstanding the successes achieved for the development of the region, unfortunately, this was at the expense of success in maintaining the region's environment and its natural resources. Chapter 5 will detail the environmental situation and the factors that positively or negatively influence the environmental changes in the AAR.

# Chapter Four

# Methodology

## 4.1 Introduction.

The methodology detailed below is aimed at addressing the key research questions outlined in chapter 1. These questions target the nature of sustainable natural and environmental resources management practices in AAR by examining the attitudes and practices of both local people and government officials.

Contemporary geographers study a variety of topics, such as geographical locations (places), people, bodies, discourses, and fragmented landscapes. The interlocking or intertwining of subjects raises different research questions that geographers have dealt with in different ways to bring together both quantitative and qualitative methods and approaches. Increasingly, qualitative approaches have become more common in terms of human environments, individual experiences, and social processes (Graham, 2005; Winchester, 2008). Debate surrounding the methodology of doing research has existed for a long time (Kitchin and Tate, 2000) and is mainly aimed at creating a homogeneous set of rules and procedures to investigate certain phenomena or situations. Geographers often resort to multi-method approaches to fill the gaps between qualitative and quantitative methods and to avoid any defects that may exist in each. On one hand, the personality and characteristics of the respondents (memory, experience, knowledge and attitude) can affect the acquired data and there is no guarantee that respondents will deliver their opinions and convictions accurately. On the other, detachment, objectivity, and a statistical approach can often ignore important "soft", more subjective, data. Qualitative researchers, in particular, tend to use multi-method

approaches as instruments to improve the internal validity of their research (Meijer et al, 2002). As the interpretation of the data secured through such methods is open to personal bias and misunderstanding between the researcher and the (written or spoken) discourse (Phillip, 1998), using a multi-method approach avoids some of the defects of qualitative methods, which suffer from accusations of subjectivity and small samples. This should limit researcher-bias in data collection, with sources or subjects may being equally credible. Therefore, this study uses the multi-method approach to achieve the research aims.

### 4.2 Data collection methods:

#### 4.2.1 Secondary data gathering (Official documentary resources):

A number of secondary data resources are required to provide the information context for some areas related to Oman, and specifically to Al-Jabal Al-Akhdar. These sources provide essential background on aspects such as water, agriculture, economy, population, history, and culture. These facets provide references supporting the theoretical framework of this study. The most important of these secondary resources are those collected, documented, and categorized by the government, most of which derive from the available data in the archives of the governmental institutions related to the management of natural resources in Oman. These sources include annual reports, summaries of conferences and workshops held by these ministries, as well as reports to international organizations and with which Oman has signed agreements, such as the Convention on Biological Diversity. The following secondary data resources were accessed and used:

(1) The Oman General Census of Population, Housing, and Establishments (1993, 2003, 2010), which the Ministry of the National Economy produces every ten years. These censuses

provide data on populations, households and family sizes and compositions, and information on sex and age distribution. They often include other demographic indicators, including economic and health-related topics. From these censuses, demographic data about the total number of the population in the research area, the family sizes, and the rate of the population growth are extracted. This information allows an assessment of the population and housing conditions at the time of the census, allowing comparison with previous censuses and the identification population trends and predict future situations.

(2) The agricultural census carried out by the Ministry of Agriculture and Fisheries in 2004 and 2005 to record data related to farming land and the amount of crops and livestock in the research area. The agricultural census is usually conducted every ten years in Oman to provide statistical data on the components of the agricultural sector. The data give a general picture of the developments, progress and changes made in the agricultural sector in various parts of the Sultanate of Oman.

(3) The records and documents of the Ministry of Tourism provides figures about the number of tourists and visitors to the Al-Jabal al-Akhdar area during the 2010 field research period, and the prior year. The Ministry of Tourism records information about the Sultanate's tourist destinations and publishes documents and leaflets that provide a wide range of statistics about the Sultanate of Oman.

(4) The climatic and weather archives of the Ministry of Transport and Communication for Nizwa Municipality in Al-Jabal al-Akhdar to provided climatic data (temperature and rainfall) about Al-Jabal al Akhdar. The Ministry of Transport and Communication represented in the Directorate General of Meteorology and Air Navigation is responsible for issuing and verifying weather forecast products and for maintaining a climatic database.

(5) The archives of the Ministry of Environment and Climate Affairs were accessed to gather information related to the fauna and flora in Al-Jabal al-Akhdar and to clarify the environmental situation in terms of natural resource deterioration and the efforts of the ministry to address this. The main competences of the Ministry of Environment and Climate Affairs in Oman include establishing policies, preparing plans and programs for protecting the environment, controlling pollution and nature conservation, and managing, following-up, implementing and evaluating climatic affairs for better outcomes. They also include protecting the wildlife, conserving nature, preserving renewable resources, and working on utilizing them for sustainable use.

(6) The archives of the Ministry of Regional Municipalities and Water Resources provided data related to water resources in the region, such as numbers of Aflaj, wadis, dams (surface storage dams), and establish the Ministry's efforts to maintain traditional knowledge of the traditional irrigation system in Al-Jabal al-Akhdar.

(7) The archives of the Manuscript Department in the Ministry of Culture and National Heritage provided historic, traditional and cultural data about the Al-Jabal al-Akhdar region, as well as old manuscripts recording the aflaj of the region. The Ministry of Culture and National Heritage in Oman deals with varied aspects of culture and national heritage, including the care and maintenance of archaeological sites, museums, and historic buildings, and the collection and archiving of historical documents and manuscripts, protecting them from damage and loss, as they are major elements of Omani heritage.

(8) The results of the Al-Jabal al-Akhdar initiative project run by Sultan Qaboos University (2004-2008) were a useful source of information on the environmental features (flora, water, soil, and ways of boosting tourism ) of Al-Jabal al-Akhdar region.

(9) The outcomes of the Omani Oases Project devised by Sultan Qaboos University in collaboration with German universities including the University of Tübingen (Oriental Institute), the University of Stuttgart (Institute for Urban Planning), the University of Kassel (Institute of Crop Sciences) and the German Institute of Archaeology in Berlin (Orient Department). The Royal Court sponsored this project with an aim to study the historical trade routes and the modern changes in the northern Omani oases.

(10) Reliable websites were accessed to search for data related to the research area. Such references, however, were of limited help in terms of direct and precise data about the research area as they present only general data and figures about the whole country. This also holds true for the websites of the ministries mentioned above. For this reason, such websites were used only to gather contextual information about the natural resources in Oman, the challenges that these resources face, and the efforts exerted by the different government ministries to overcome them in the framework of the annual administrative plan.

Three points sum up the reasons behind using secondary data: conceptual, methodological, and economic (Kitchin and Tate, 2000). From a conceptual point of view, there is no alternative to data available in secondary sources: such historic data are available only from books and manuscripts in the archives of the Ministry of Culture and National Heritage. From a methodological point of view, this work has used secondary data resources to analyze and explain the research results appropriately and to find the most precise answers to the questions raised by the research, such as those related to government efforts and programmes to manage the natural resources in the region during the past decades. These efforts can be unearthed in the annual reports issued by sections responsible for the management of the natural resources. The climatic reports that the Directorate General of Meteorology and Air Navigation in the Ministry of Transport and Communication issues have offered an

opportunity to investigate the analytical climatic results and to predict the approximate future climatic situation of the region.

From an economic point of view, use of secondary data resources reduced the cost of collecting data. Collecting data for research can be time consuming and expensive and the use of secondary data resources saves both time and effort in collecting, organizing, and preparing the necessary tools for analysis of the research material (Kitchin & Tat, 2000).

Although secondary sources are useful, their limitations have to be recognized. The need to evaluate the quality of secondary data sources stems from the fact that the establishment or individuals who are responsible for secondary data gathering might have reasons for illustrating a more optimistic or pessimistic results for their establishment. For instance, it is known that officials in charge of estimating food shortages tend to overstate figures before sending aid requests to potential donors. Likewise, trade groups have been known to inflate estimation of their market shares (Crawford, 1997). The reliability of secondary data such as published statistics may differ over time. ‘‘It is not uncommon, for example, for the systems of collecting data to have changed over time but without any indication of this to the reader of published statistics. Geographical or administrative boundaries may be changed by government, or the basis for stratifying a sample may have altered’’ (Crawford, 1997: p20).

### 4.2.2 Primary data gathering (Fieldwork activities)

Field data gathering has been conducted in different stages. The first stage started in January 2010 and lasted for seven months. This length of fieldwork was required because the five objectives of the research were ambitious. To achieve them, data needed be collected on

different levels: locally, regionally and nationally in the Sultanate of Oman. Second, the research required about 40 visiting trips from Muscat (175 kms distance from the AAR) to Nizwa (40 kms distance from the AAR) and the mountainous nature of the research area made travel difficult. Third, documenting the traditional, local practices concerning the annual cycle of farming and grazing operations had to span one year. Fourth, the slow responses and the reluctance on the part of some government officials in completing the questionnaire necessitated visiting them more than three times in Muscat and Nizwa.

The first stage of the fieldwork operations started in Nizwa city, Muscat and the village of "Saih Katnah" in Al-Jabal Al-Akhdar. Its aim was to get acquainted with the governmental institutions related to the management of the natural resources offices in these regions and to collect the appropriate secondary data in governmental annual reports and documents for the programmes and projects carried out in AAR. These documents were useful in formulating a questionnaire presented to the government officials and to the local people, and in elaborating on issues in the interviews and focus group questions; a techniques used in this study. The second stage was the precise delimitation of the research and target fieldwork operations area. As discussed in Chapter 3, the peripheral borders of the research area were identified within the administrative official borders of the district Wilayet of Nizwa in Al-Dakhiliyah governorate. The area extends over 22000 $km^2$. (For more details, refer to Chapter 3).

The main mission in the fieldwork operation was not only to become familiar with the regional conditions, its nature, culture and the types of administrative and governmental procedures found there, but also to ensure quality and reliable sources of both primary and secondary data. Consequently, it was necessary to make a great number of phone calls, arrange visits, and hold several short meetings with local people and government officials at

the local, regional and national levels. These visits explained the objectives of the research, the reasons behind the fieldwork interviews, focus groups, and questionnaires, and, at the same time, gained the confidence of the local community leaders (sheikhs) and the local officials. They helped to reduce any misunderstanding or misinterpretation, and encouraged the interviewees to respond positively in the discussion group sessions.

The fieldwork preparation phase consisted of devising questionnaires for government officials and local people, interviewing 50 officials (90% of them were male) in the different government institutions responsible for the management of the natural resources in the region, interviewing 30 local people (all of them were male), and holding five stages of discussion group sessions for the local people (three sessions for male and two for female). All these operations were aimed at collecting the primary data of the study. In addition, a great number of photos were taken to illustrate the natural characteristics of the region, documenting its cultural and environmental facets, and capturing some of the traditional farming practices. Figure 4.1 is an example of one such farming practice.

Figure 4.1 Picking Al-Jabal flowers in the very early morning in Saih Qeteneh in AAR, the first phase in rose water distillation.

#### 4.2.2.1 Structured open-ended interviews with officials

During the fieldwork operations, interviews were held with a chosen purposive sample of government officials (90% of them were male) from the different governmental establishments responsible for NRM in the region. The sample procedure was based on the non-probability sampling method wherein the subjects are selected because of their government positions as managers, department heads, and experts in their government establishments. Depending on the organization structure of the ministries responsible for the management of natural resources as well as considering the reliability of officials in their positions, officials from six establishments participated. Ten officials were interviewed from the Ministry of Regional Municipalities and Water Resources in Muscat, with different responsibilities related to the management and development of natural resources, the management of the aflaj, and the construction and maintenance of dams in the region. Five more officials responsible for the management of water resources in Nizwa and Al-Jabal Al-Akhdar were also included. Ten officials were interviewed from the Ministry of Agriculture and Fisheries in Muscat with different responsibilities ranging from the management of agricultural lands, the development of farming crops, and the development of livestock, to the management of pasture resources and the agricultural and veterinary quarantine. Five more officials responsible for the management of agriculture and livestock resources in both Nizwa and Al-Jabal Al-Akhdar were interviewed. Seven officials were interviewed with different responsibilities ranging from the management of the natural reserves to environmental planning and desertification containment, from the Ministry of Environment and Climatic Affairs in Muscat. Three environment officials in Nizwa and Al-Jabal al Akhdar were also interviewed.

The Deputy Governor from Nizwa in Al-Jabal Al-Akhdar was interviewed to gain primary data about a government-coordination bureau in the region. As part of this the general conditions of the region's natural resources, the environmental impacts from urban development and tourist flow, and the role of the bureau in tackling the challenges facing the region were acquired. One official each from the Ministry of Tourism and the Ministry of Housing was interviewed to gather some information and figures about the tourist situation in the region and the Ministry's plans to boost regional tourism. Information about the housing development plans of the Ministry of Housing, and its role in protecting the natural resources, influenced setting the objectives of the interviews.

Two experts from the Sultan Qaboos University were interviewed to identify their perspectives about the environmental conditions in the AAR, and their experiences in the research project entitled "Al Jabal al Al-Akhdar Initiative", a strategic research project that aimed to identify the components of the natural environment and evaluate its status for the purpose of sustainable development.

The interview process applied a structural technique. This technique follows a list of questions prepared in advance according to objective standards (Dunn, 2008). All the questions used in this study were asked in the same way and in the same order in all interviews. The interviewing method was chosen, since it is a robust method that is frequently and widely used in qualitative types of research (Brymen, 2004) and its flexibility and efficiency provides detailed data. The distinctive features of such a method, in terms of helpfulness and power, can be used as a complementary method to infill missing parts in knowledge and data that could not be provided by other methods, such as observation or secondary resources. In addition, it can lead the researcher to an understanding of the

different opinions and arguments within the group of interviewees. It also gives the interviewees an appropriate framework in their efforts to put ward on knowledge and information. Likewise, it permits the researcher to add to the interviewees' experiences and provides the opportunity to find out more about the research project, rather than simply watching or waiting for respondents to fill in the questionnaire (Dunn, 2008).

Most of the questions in the interviews were open-ended in comparison to the closed questions, requiring 'yes' or 'no' answers, in some questionnaires. In this way, every respondent could give his/her own recommendations about the different opinions and topics in his own words. Thus, the interviewing method enabled the researcher to find out more about the respondents. Face-to-face interviewing also gives the researcher the opportunity to find out whether a question is appropriate or not from the voice tones and facial expressions of the respondents. Moreover, the researcher can expand and elaborate on opinions and notes, in light of what is learned. Consequently, this type of interviewing may draw attention to previous misunderstandings or misinterpretations (Dunn, 2008).

Only some of the interviews were recorded, as most of the participants refused to have their interviews recorded. One possible reason was that government policies in some ministries prevented employees from disclosing or talking about the work of the ministry and its programmes, in anticipation of any errors by employees or failures to portray the programmes of the ministry in anything other than a good light. In this case, extensive notes were taken in the interview, with those who have been convinced by the researcher that their response will be anonymous, and then transcribed. The transcriptions included the names of the respondents and their answers, following the order of the questions asked and the answers

given. The transcriptions were completed the same day of the interview or the day after to ensure that nothing was forgotten or misunderstood.

#### 4.2.2.2 Open-ended interviews with the local people

These interviews aimed to collect primary data about local traditional practices and knowledge related to the environment and the management of natural resources, such as water, agricultural lands, and pasture. They also aimed to gather quantitative data about the number of household members, the number of agricultural holdings and their areas, and the amount of livestock each household possessed.

The interview questions were aimed at collecting detailed data about common traditional knowledge and practices related to the exploitation and management of regional natural resources, so it was necessary to secure useful and valid responses by selecting those practising farmers and graziers known for their great experience. For this reason, the sampling method chosen was the 'snow-ball' technique using contacts provided by the Nizwa Deputy Governor's office in Al-Jabal al-Akhdar augmented with other suggestions from individuals in the region. All were asked to identify people who were well experienced in traditional practices of NRM. A total of 30 people (all of them were male) with plenty of experience were interviewed – mostly older people with memories from witnessing many historical, natural and economic developments in the region. It is worth noting that, in respect to the local traditions, most of the interviewed people were males, since interviewing women in person was not appropriate. Also, the information sought did not require personal interviews with women. The required information about the roles of women in exploiting and managing the natural resources in the region was secured in the discussions of focus groups, which are discussed later. The interviews with the local people were fruitful, and allowed a

great deal of important data to be gathered. Most interviews were recorded and transcribed and field notes were taken when appropriate, particularly for interviews undertaken on the farms (Figure 4.2) or in home factories of local people, such as the rose water still-house (Figure 4.3). Appendix 4 contains the questions put to the local people.

Figure 4.2 A local farmer explaining how to control pests on the pomegranate trees.

Figure 4.3 One of the local people explaining how to distil rose water in a rose water still-house in Saiq in AAR.

#### 4.2.2.3 Questionnaire survey of government officials

This questionnaire aimed at identifying the ideas and opinions of the officials about the natural resources management plan in the region and was conducted between February and May 2010. One hundred and twenty (120) government officials from the ministries responsible for the management of the natural resources and experts from Sultan Qaboos University responded. The questionnaire gathered primary data related to the factors affecting natural resources in the region and the details of any administrative plans. The sample procedure with officials, as with the structured open-ended interviews, was based on the non-probability sampling method, wherein the subjects were selected because of their government positions as managers, department heads, and experts. Table 4.1 shows the distribution of respondents and ministries involved.

Table 4.1 Ministries involved in the questionnaire survey for government officials.

| No | The name of the government agency | The number of respondents |
|---|---|---|
| 1 | Ministry of regional Municipality and water resources. | 35 |
| 2 | Ministry of Agriculture and Fisheries. | 35 |
| 3 | Ministry of Environment and Climate affairs. | 20 |
| 4 | Sultan Qaboos University. | 20 |
| 5 | Ministry of Tourism. | 5 |
| 6 | Ministry of Housing. | 5 |
| Total | | 120 |

#### 4.2.2.4 Questionnaire survey of the local people

The surveys for the local people aimed at collecting data related to traditional environmental knowledge and practices followed by the local population to manage their natural resources (water, farmland, and grazing resources). Between February and May, 2010, 120 local people were surveyed about these matters and about what the governmental institutions provided for them in terms of programmes and services related to the management of the natural resources in the region.

Based on the objectives of this study, those people who worked in agriculture and grazing and resided in the villages of the AAR were targeted. An estimate of the number of farmers and grazers was obtained from the Office of the Vice Governor in Al-Jabal Al-Akhdar. Depending on the circumstances of the people, at least 10% of the targeted population were sampled (Table 4.2).

Table 4.2 Villages involved in the questionnaire survey for local people.

| villages | Total population | *Targeted population | Sample size | Percent (%) |
|---|---|---|---|---|
| Saiq | 800 | 100 | 20 | 20 |
| Wadi Bani Habib | 940 | 100 | 17 | 17 |
| Al-Shuraijeh | 214 | 70 | 15 | 21 |
| Al-Manakher | 260 | 70 | 15 | 21 |
| Mesierat Al- Rewajeh | 111 | 50 | 7 | 14 |
| Saih Qeteneh | 1600 | 100 | 16 | 16 |
| Hail Al-Ayn | 120 | 50 | 9 | 18 |
| Hail Al-Yemen | 280 | 70 | 7 | 10 |
| Al-Ghleil | 142 | 40 | 7 | 17.5 |
| Mesierat Al- Gewamid | 120 | 40 | 7 | 17.5 |
| Total | 4587 | 690 | 120 | 17 |

*Local farmer and herd-raisers

It is worth noting that the questionnaire was reviewed and revised by experienced people working in this field of research in order to identify the ambiguity of some of the questions' language. Among those experienced people two experts in geography from the Ministry of education, two experts from the Sultan Qaboos University, the manager of the Department of Pastoral resources and the manager of Planning in the Ministry of Regional Municipalities and Water Resources. The questionnaire design, the questions, and the questionnaire as a whole were tested for validity in a pilot study. The pre-testing procedure used a minor sample of the study population (officials and local people). It evaluated the homogeneity of the questionnaire design, its appropriateness to the target interviewees, and its alignment with, and service to, the objectives of the research. The pre-testing procedure gave an opportunity to understand the difficulties and complications in some of the questionnaires' questions. In light of the pilot study, some questions were revised and reformulated. For example,

questions in section 3 of the questionnaire ‘‘Pressures and Threats on Natural Resources (Vulnerability)’’ were reduced from 20 to 15. Thus, the experimental copy of the questionnaire underwent several iterations. Most of the prominent observations about the items of the questionnaire rotated around the ambiguity of some of the questions’ language. The number of questions was also challenged, as some required a long time to answer. Moreover, some people thought that the section related to administrative corruption was strange. This is because both officials and locals are not used to answer questions about corruption. However, corruption remained one of the questions in section 3 of the questionnaire ‘‘Pressures and Threats on Natural Resources (Vulnerability)’’

The questionnaire was delivered by hand to all the target people. This delivery method ensured that the questionnaire reached the subjects, as the postal services in Oman are limited in rural areas, and it allowed an explanation of the questionnaire to those of the target group who were illiterate. Moreover, it gave the subjects a feeling of importance and respect, which created increased participation satisfaction in the target group. Agreement was reached with the participants to fill in the questionnaire within 3 weeks and the questionnaires collected personally.

#### 4.2.2.5 Focus groups involving local people

As in the methods outlined above the focus groups aimed to collect primary data related to TEK and practices (past or present) in managing the natural resources in the region. It also gathered opinions of the groups about the available government services to manage natural resources in the region. This method was used because of its distinctive advantages in securing varied primary data about the subject of the study. An attractive feature of this

method, which distinguishes it from other research methods, is its ability to include the interactions among the different members of the group (Cameron, 2008). Group interactions are often characterized by vitality and energy as most of the members respond positively to each other's contributions. Crang and Cook (2007) explained that the participants cast their opinions on topics from the reality of their experiences and their understanding of the world, as each experience varies from person to person. For instance, a contribution on the part of one of the group's members can generate a series of responses and observations among the others. Participants in focus groups were divided into two groups: men and women, taking into consideration that the communities in the region were still largely controlled by men. This meant that the opinions of men were still most prevalent in this rural community. Division of these groups ensured that the perspectives of both men and women were effectively considered.

Figure 4.4 Male focus group participants after the first session in the Vice Governor's Office in AAR.

Three discussion group sessions were held for men; two of them were held on 25/02/2010, with the first lasting one hour and a half and the second lasting one hour. The third one,

however, occurred on 20/06/2010, lasting one hour and a half. The dates matched the dates of the farming seasons in the region, in both winter and summer. The first session discussed the local knowledge and the traditional practices related to water resources, especially those concerning the traditional irrigation system (Aflaj). The second session, however, focused on the local knowledge and the traditional practices related to the exploitation and the management of the farmland and pasture resources. (The questions of the sessions are displayed in appendix 5).

During one of the discussion sessions for men (Figure 4.4), the initial subject was about local practices and traditional knowledge related to the falaj system. However, the discussion soon moved to the idea of maintaining the environment that supported the falaj and the ways followed to keep it. After a while, the discussion moved again, to the problems facing the traditional irrigation system (Aflaj) during drought seasons and the government's role to alleviate the impact on local people and their livelihoods.

The prevailing atmosphere in the women's focus group discussions (Figure 4.5) had two aspects. One approach to the situation came from before the Renaissance when no government help was available, when people were suffering the consequences of war, poverty and hard climatic conditions, and when people moved by foot or by donkeys from village to village to secure their livelihoods in the harvest seasons. The other approach came from the times of the renaissance when tremendous changes took place in the country, and even in the local rural region, which improved people's living conditions and their lives.

Figure 4.5 Woman focus group participants after the first session in the Department of Social Development in AAR.

Seven women were invited to participate in the women focus group, and responded positively; two did not attend because of health reasons. Two sessions were held for the women. The same women presented in the two sessions except one who apologized for health reasons and was replaced with another. One session lasted one hour and a half on 26/02/2010 and the other lasted the same amount of time on 21/06/2010. The first discussed the local women's knowledge and traditional practices concerning the exploitation and management of water resources and the role of local women in farming and grazing. The second session, however, focused on the role of country women in livestock keeping as this had always represented one of their primary tasks, along with livestock traditional healthcare and hygiene. This session also discussed the role of country women in exploiting the local plants for traditional medicine.

Because the discussion groups were an important means to secure primary data, it was important to respect the theoretical and methodological requirements of such an approach. Cameron (2008) attributed the success of focus group discussions to the amount of care given to the first stages of preparation and organization. Following this procedure, the participants were chosen according to their experience concerning the subject of the research following the purposive sampling technique. Here, the help of the Vice Governor's office was sought, as well as that of locals in the region, to identify those with experience and knowledge of the farming and grazing operations. Letters of invitation invited them to attend the discussion group sessions. All this took place two weeks before holding the sessions. The women's groups were coordinated by the Omani Woman Society in Al-Jabal Al –Akhdar, as it was the body most in contact with the women of the region and the organization also helped in identifying the most appropriate women for the purpose of the research.

The structure of the discussion groups was organised to investigate of the state of the natural resources in the region and the nature of the local practices in exploiting and managing these resources. The participants were chosen from those having different local and practical expertise in management of the natural resources. For example, this included a farmer, a shepherd, a craftsman, and a government official with the ages of the participants ranging from 35 to 65 years old. Most of them were from different villages in order to strengthen the sample and cover as many local practices as possible. The group size was important. Both the men's and women's groups had five participants each. Smaller groups might reduce the opportunities for discussion and the number of ideas exchanged, while bigger groups might reduce the opportunities and time allotted to each participant to present his/her perspectives or deprive some of the participants of an equal and fair share of the discussion time (Cameron, 2008).

The number of the discussion group sessions was another important issue. Two sessions were held for both groups. Because the ideas discussed by the men's group were too numerous for just one hour and a half session, there was unanimous agreement among all the participants, that a second one should be held. All the attendees of the discussion session continued to participate with great satisfaction. Most of the men thought that the recommendations emanating from the discussions might reach the officials, and might urge them to improve their environmental policy and the management of the natural resources in the region.

Before holding the discussion sessions the topics and the questions to be asked during the course of the discussion were prepared according to four major topics: the present state of the natural resources in the mountain, the exploitation and management of water resources, the exploitation and management of farmland resources, and the exploitation and management of pasture resources. The twenty questions used in the discussion sessions were simple, direct and understandable to everyone, as some of the attendees were illiterate. This atmosphere led the discussion to extend to more than one hour and the attendees showed more enthusiasm than expected, which sometimes obliged the researcher to intervene to keep the discussion on track. The procedure of setting up discussion groups was discussed with the Vice Governor who offered his meeting room for the focus group discussions. Although the men's discussion group sessions were held in the deputy governor's office, which might have led to a perception that these were official formal meetings, the discussion was conducted in an informal relaxed atmosphere. The attendees were informed that the sessions would not be formal or official, but were informal meetings for the purposes of study and collection of data about their traditional practices. During the discussion session, coffee was served with dates, fruits and Omani (halwa) sweets. The researcher moderated the discussions because, as Cameron (2008) puts it, the researcher is more informed about the topics discussed that serve

the research aims, and he/she is best positioned to play this role. To ensure that the discussion group sessions went well, the researcher started by giving the attendees a general overview about the research and the role of a discussion group in the project. After that the discussion topics and the questions related to them were introduced. How the discussion would precede and the way in which issues would be introduced that related to the aims of the discussion sessions was summarised. The attendees were asked for their permission to record and film the discussion sessions. With their approval, the discussion sessions were filmed using a digital camcorder and a mobile phone to ensure that no technical problem occurred, although the recording devices were tested in advance.

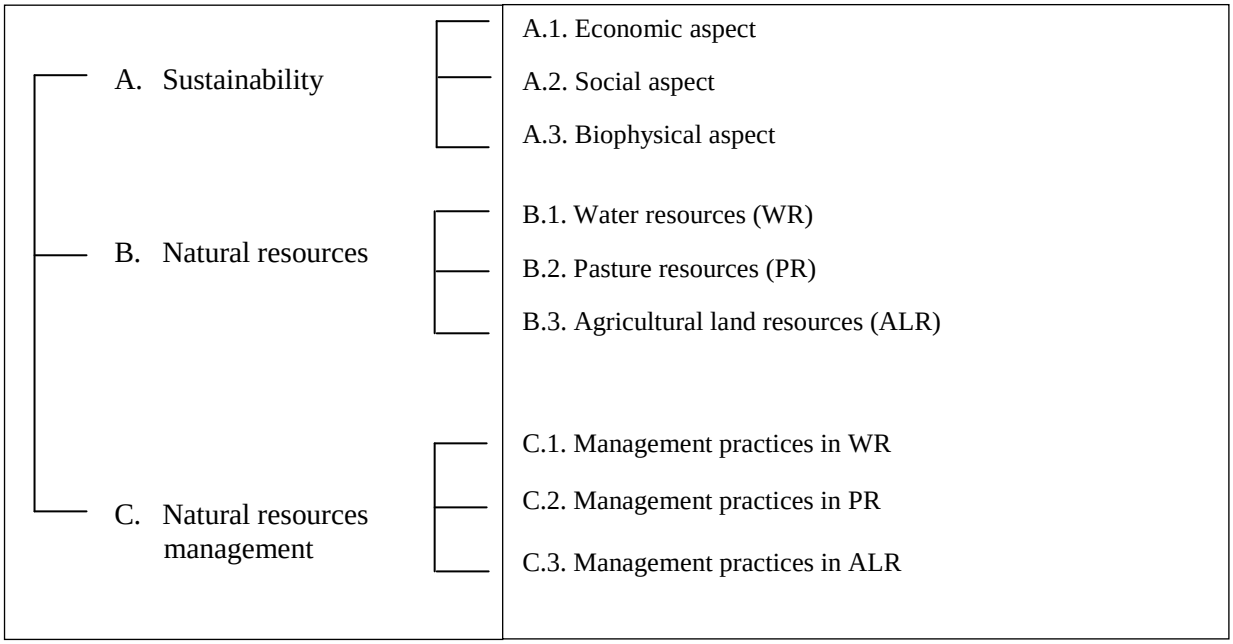
Managing discussion groups constituted something of a challenge to the researcher, as it required a flexible and tolerant approach to be adopted in order to deal with differences of opinion while on the other hand requiring a serious well-focused approach to prevent the attendees from roaming from the initial subject. Dealing with people who are not used to give their opinions to the scientific research was the biggest challenge. The following example highlights this: to meet and interview the Undersecretary of the Ministry of Environment and Climate Affairs took about 5 months of waiting, during them the Director of his office was frequently visited and called, but he asked for postponement, justifying this by the workload of the Undersecretary or his unavailability. This is in spite of the green light for an interview given in a conference meeting.

### 4.3 Data analysis methods

#### 4.3.1 Content analysis of official documents

Among the official document sources were annual reports, reports of conferences and seminars held and organized by these ministries, laws, and strategies of environmental protection. This study examined these resources according to their relevance to the project. In order to achieve this, these documents were assessed in terms of authenticity, credibility, representation, and meaning. Some documents were also subjected to content analysis in order to identify patterns within the texts. Content analysis was used in order to test existing data, such as natural resources management, sustainable development, and environmental protection, in terms of concept occurrences (conceptual analysis). A structured categorization matrix was developed and data were coded according to the categories (Box 4.1). All the data were reviewed for content and coded for correspondence with, or exemplification of, the identified categories. Only aspects that fitted the matrix of analysis were chosen from the texts as references. Content analysis was used here as a complementary method to verify interpretations. The resulting categorization matrix was then analysed using descriptive statistics and the analytical results reported along with the other results of government practices in natural resource management in Oman (Chapter 6).

Box 4.1 An example from a categorization matrix for the purpose of content analysis of themes and concepts related to sustainable natural resources management (SNRM) in some government documents.




### 4.3.2 Quantitative analysis of questionnaires.

As this study employed mixed-methods, the questionnaire analysis involved a search for both quantitative and qualitative data. The quantitative data arose mainly from closed questions that offered one or more of three criteria. (1) Variables could be treated as scales or counts of categorical data, such as ages, income bands, the sizes of the households, or the number of goats. (2) Variables could be treated as ordinal, as their values represented categories offering ranking, including attitude scores representing the degree of agreement or confidence. Preference rating scores, such as the level of local satisfaction about natural resources management service in AAR, ranged from ‘‘strongly agree’’ to ‘‘strongly disagree’’. (3) Variables could be treated as nominal, as their values represented categories with no essential ranking, such as the names of government departments or names of administrative regions. All the answers that represented the previously mentioned variables were numerically coded and incorporated within the Statistical Package for the Social Sciences (SPSS). They were

analysed by descriptive statistics for patterns of response on relationships between the variables, such as those relating to the environmental importance of the AAR. Results obtained by quantitative analysis were classified into descriptive categories to facilitate the process of simplification, summary, comparison and aggregation of data. Frequently the analytical results of these types of questions were used to explain, provide evidence for, and interpret other qualitative results, arising from interviews and focus groups. This contributed to avoiding giving misleading impressions that because the findings were quantitative they were reliable (McGuirk and O'Neill, 2008). In short, the numbers obtained from the quantitative analysis of the questionnaires were used to show the differences or similarities of the data sets. Thus, the quantitative data were used to add a degree of confidence to the interpretive findings, so that cross-referencing of qualitative and quantitative resulted in more robust interpretations.

### 4.3.3 Transcription analysis of interviews and focus group discussions.

The analysis of data derived from interviews and focus group discussions began with the interviews and the discussion sessions. The fact that the researcher considered description as a phase of the analysis is central to this study. It permeates many levels of enquiry and it represents data in forms that can be easily interpreted (Kitchin and Tate, 2000). Thus, the researcher noted and described the situational context in terms of the places of interviews and discussion execution (mostly officials' offices and local people's homes), the social context, and the period within which the data were collected. This step is important, as it provided a detailed account in which to locate and continue to analyze the data, taking into account all the factors that could significantly affect the data collected. Situational context information

also enabled the researcher to compare the data collected in different situations (Kitchin and Tate, 2000; Halcomb and Davidson, 2006).

In addition to notation, the recorded interviews and focus group discussions were transcribed in Arabic and translated to English. For further verification of translation accuracy, translated transcripts were presented to the translation specialist at the Ministry of Education (the researcher's workplace). The amendments proposed by this specialist were followed, and the translated transcripts were categorized. The categorization (Box 4.2) was based on the standards of study objectives, which included (1) the environmental and the socio-economic importance of the AAR, (2) the current status of natural resources (NR) in the AAR, (3) the nature of current government practices in natural resources management (NRM), (4) the traditional environmental knowledge (TEK) systems and practices in managing natural and environmental resources, and (5) the pathways to more sustainable natural and environmental resource management. The selection of this categorization can be justified by the fact that the categories ''should be internally consistent (e.g. the data within each should refer to the same things), be conceptually related to each other (e.g. all categories are variations on a theme), and be analytically useful (e.g. they relate to the aims of the study)'' (Kitchin and Tate, 2000:245). The data were then broken down into basic databits (elements), given a specific code, and placed into similar categories or classes in order to identify commonalities and divergences. This categorization aimed to organize the data, to move beyond description and start effective comparisons between cases to interpret the data and provide further analysis and interpretation. Consequently, these analyses resulted in the documentation of perspectives, practices, and recommendations on aspects related to natural resources management in the AAR. In addition, the perspectives of local people that were categorized

in matrices were used to compare and contrast with their counterparts that resulted from official documents and texts obtained from interviews with government officials.

Box 4.2 An example from a categorization matrix for the purpose of transcription analysis of interviews and focus group discussions.

| | |
|---|---|
| A. The current status of NR | A.1 Status of water resources (WR)<br>A.2 Status of Agricultural land resources (ALR)<br>A.3 Status of pasture resources (PR) |
| B. Government practices (GP) in NRM | B. 1 GP in water resources management<br>B. 2 GP in ALR resources management<br>B. 3 GP in pasture resources management |
| C. TEK systems and practices in NRM | C.1 TEK in water resources<br>C.2 TEK in ALR resources<br>C.3 TEK in pasture resources |
| D. Pathways to more sustainable NRM | D.1 Water resources management<br>D.2 ALR resources management<br>D. 3 Pasture resources management |

## 4.4 Summary

This chapter has outlined the research methods used in data collection and analysis. It has argued that the selection of research methods and their implementation in fieldwork is justified in terms of the research aims and will provide the data necessary to answer the questions posed by the research. To ensure greater credibility for the results obtained from this research, a multi-methods approach was used to triangulate the results, and improve credibility by cross-matching the patterns of responses obtained from various respondents. The chapter has also clarified the procedures followed in implementing the research methods and accessing the prevailing government position. This latter context was helpful and a route to achieve good quality data and perspectives (e.g. via the Undersecretary of the Ministry of Regional Municipalities and Water Resources), but also stressful in terms of bureaucratic lethargy that delayed the implementation schedule of the research.

# Chapter Five

## Status of, and pressures on, natural resources in the AAR

### 5.1 Introduction:

The environment and its NR strongly influence economic activities, and the social fabric and traditions of a population (Simon, 2003; Gylfason, 2007). Environments, however, are vulnerable to environmental and social change and to their inability to adapt (Adger, 2006). This chapter analyses how the AAR perceives the importance of NR, the status of the AAR's NR, and the pressures affecting them. It addresses the first aim of the study to assess the environmental and socio-economic importance of the AAR and the status of its NR.

### 5.2 The environmental importance of natural resources in the AAR

Environmental importance of any region, in general, reflects geography, geology, water resources and the environmental conditions promoting the development of biodiversity (Salvatori, 2004), as these determine the availability of NR (Brata, 2009; Reenberg and Paarup-Larsen, 1997).

Tables 5.1 and 5.2 illustrate government officials' and local people's perspectives on the environmental importance of the AAR. Three dominant aspects emerge: the AAR's representativeness of Oman's nature; the water resources; and the high levels of biodiversity. The perception that the AAR is representative of Oman's nature is clear with 98.3% and 94.2% of officials and local people, respectively, agreeing or strongly agreeing (Tables 5.1 and 5.2).

Table 5.1 Perspectives of government officials regarding the environmental importance of the AAR.

| | Environmental variables Rank order | Mean score | Sum | Distribution | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 5 | 4 | 3 | 2 | 1 |
| 1 | Represents Oman's nature. | 4.52 | 542 | 66 | 52 | 1 | 0 | 1 |
| 2 | Source area of many wadis. | 4.24 | 509 | 52 | 53 | 8 | 6 | 1 |
| 3 | Relatively high levels of biodiversity. | 4.13 | 496 | 42 | 57 | 18 | 1 | 2 |
| 4 | Relatively high level of endemism. | 4.11 | 493 | 38 | 60 | 20 | 1 | 1 |
| 5 | Ecosystems have been converted to another land use. | 3.96 | 475 | 39 | 44 | 32 | 3 | 2 |
| 6 | Relatively high number of rare/endangered species. | 3.92 | 470 | 35 | 49 | 29 | 5 | 2 |
| 7 | Contains good quality soils. | 3.72 | 469 | 31 | 46 | 25 | 14 | 4 |
| 8 | Contains sufficient water resources for human needs. | 2.40 | 288 | 3 | 21 | 18 | 57 | 21 |
| Total respondents = 120 | | | | | | | | |
| 1 = strongly disagree, 2 = disagree, 3 = not sure, 4= agree, and 5= strongly agree. | | | | | | | | |

Table 5.2 Local peoples' perspectives regarding the environmental importance of the AAR.

| | Environmental variables rank order | Mean score | Sum | Distribution | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 5 | 4 | 3 | 2 | 1 |
| 1 | Represents Oman's nature. | 4.63 | 555 | 83 | 30 | 6 | 1 | 0 |
| 2 | Source area of many wadis. | 4.37 | 524 | 62 | 45 | 10 | 1 | 2 |
| 3 | Relatively high levels of biodiversity. | 4.32 | 518 | 54 | 53 | 11 | 1 | 1 |
| 4 | Contains good quality soils. | 4.18 | 49 | 38 | 49 | 17 | 4 | 1 |
| 5 | Relatively high level of endemism. | 4.14 | 497 | 52 | 41 | 20 | 6 | 1 |
| 6 | Ecosystems have been converted to another land use. | 3.96 | 475 | 39 | 45 | 30 | 4 | 2 |
| 7 | Relatively high number of rare/endangered species. | 3.58 | 429 | 21 | 45 | 41 | 8 | 5 |
| 8 | Contains sufficient water resources human needs. | 2.86 | 343 | 5 | 33 | 32 | 40 | 10 |
| Total respondents = 120 | | | | | | | | |
| 1 = strongly disagree, 2 = disagree, 3 = not sure, 4= agree, and 5= strongly agree. | | | | | | | | |

Table 5.3 Perspectives of regional government officials regarding the importance of the AAR as a representation of Oman's nature.

| Category | Region | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Al-Jabal | | Nizwa | | Muscat | | | |
| | count | % | count | % | count | % | count | % |
| Strongly disagree | 0 | 0% | 0 | 0% | 1 | 1.3% | 1 | .8% |
| Not sure | 0 | 0% | 0 | 0% | 1 | 1.3% | 1 | .8% |
| Agree | 8 | 50.0% | 13 | 46.4% | 31 | 40.8% | 52 | 43.3% |
| Strongly agree | 8 | 50.0% | 15 | 53.6% | 43 | 56.6% | 66 | 55.0% |
| Total | 16 | 100% | 28 | 100% | 76 | 100% | 120 | 100% |

Moreover, Table 5.3 illustrates no statistically significant regional differences in the perceptions of the importance of AAR as a representation of Oman's natural environment. Officials from Al-Jabal. Nizwa and Muscat agreed or strongly agreed with its importance. This part of Oman has vitally important NR because of its exceptional geology, topography, and climate and the high responses clearly indicate that most officials and local people are aware of the AAR's environmental value and of its important contribution to Oman's NR endowment.

Geographically, Oman has three main terrains: rugged mountains in the north and south, the central desert plain, and northern and southern coastal plains. Omanis compare the rugged northern Hajar mountain range to a human backbone. It forms a great arc from the north-west of the country towards the southeast. Jabal Shams, in the Dakhiliyah (interior) region, is its highest peak at 3,000 metres (Figure 3.4) (MOI, 2010). The mountain range, a barrier disrupted only by the outlets of some steeply incised intermittent streambeds (wadis), is a stratigraphic unit of sedimentary limestone providing products used in local architecture and for water supplies. The wadis originate from a large rock basin, rising steeply from the surrounding area surrounded by Hajar cliffs (Luedeling and Buerkert, 2008). These wadis are the primary source of water for seven of the ten administrative provinces that comprise the Sultanate of Oman.

There are several possible reasons for the high level of agreement between government and local people. First, both groups understand Oman's nature well, partly because of in-service training programmes on NR management conducted by relevant national, regional, and local ministries (MRMWR, 2010, 2; MOA, 2010). Each Ministry's human resources department

must implement programmes and training courses according to annual plans and the training needs of various Ministry sections. For example, in 2009, the Ministry of Regional Municipality and Water Resources (MRMWR) conducted 131 internal training programmes, 22 programmes outside the Sultanate, and 6 scientific rehabilitation programmes, inside and outside Oman (Figure 5.1) (MRMWR, 2010, 2).

Figure 5.1 Government employees participating in a water resources conference.

Source: (MRMWR, 2010, 2: 116).

The Ministry of Agriculture and Fisheries implemented 120 training programmes and the Ministry of Environment and Climate Affairs (MOECA), in collaboration with the Secretariat of the Gulf Cooperation Council for the Arab Gulf States (GCC) and the European Union (EU), organized the "Joint Environmental Symposium" between the GCC and the EU. This Ministry also organized the Gulf Eco 2010 Symposium in Muscat, "Sustainability, Climate Change, Water, Renewable Energy and the Future of Communities in the Gulf Region," which discussed the challenges and demands for renewable water resources in the GCC countries (Oman International Trade Company, 2010).

The achievement of objectives and the responses of officials to the current survey confirm the success of these training programmes, which have helped officials acquire awareness of, and sensitivity to, environmental values and the associated problems in Oman, and have involved them in working towards resolutions and awareness campaigns for the benefit of local communities.

Second, awareness also results from the educational programmes of Ministry media and public relations departments. In 2009, the Sultanate of Oman's radio station broadcast 44 weekly radio episodes about water resources and 249 other related activities. Oman television aired 52 environment-related shows and the local press published approximately 2,236 print items on water resources and services (MRMWR, 2010, 2). Ministries publish awareness brochures and posters about the Oman ecosystem, environmental situations, and water availability, annual reports on NR, and periodic reports to relevant international organizations, such as the Food and Agriculture Organization (FAO). Represented by the MOECA, Oman joined the Convention on Biological Diversity (CBD) in 1995, and has since issued four reports regarding its biological diversity to that organization and the International Union for Conservation of Nature (IUCN) (MOA, 2010).

Finally, starting in year one, Oman school curricula establishes environmental awareness, giving special priority to Oman's geography and environment (MOE, 2001; MOE, 2007). Special days, such as World Environment Day (5 June), Omani Environment Day (8 January), and the International Year of Freshwater (2003), help to raise environmental awareness. The municipal administration devotes every October to integrated awareness-raising activities (MRMWR, 2010, 1; MRMWR, 2010, 2). The Ministry of Agriculture has a mentoring programme. All efforts aim at joint awareness-raising campaigns with cooperation

among administrations and governmental institutions. These efforts have achieved remarkable success. The high value given to the importance of the region in the survey stems from the people's knowledge of their native land and its environmental status.

The bond between the region's populace and the land, and their identity and sense of belonging, which they draw from this bond, gives them sensitivity and insights into the issues of the land and a deep concern for its wellbeing. They acknowledge identity with place of origin and belonging, and for them, these lands hold the enduring roots of life and are the fulcrum around which their lives revolve. The region's dwellers have strong family and social ties. Most residents of a village belong to one tribe established in the same area for considerable time. Despite the influence of modernity, their social meetings and communications remain frequent and constant. Bonds and ties increase communication and lead to greater understanding of the region's nature and circumstances, with current topics frequently discussed in meetings and family visits.

Three other major elements of environmental importance were established by the questionnaire: water resources (the source area of many wadis), biodiversity, and endemism, with high levels of strong agreement or agreement from both officials and locals (Tables 5.1 and 5.2). Deep, dissecting wadis flow from the AAR mountain range - the drainage divide of northern Oman - leading surface runoff water to the coastal plains in the north and east, and to the interior plains in the south and west (Dickhofer, 2009). Terrestrial biodiversity is an important component of Oman's overall biodiversity. Rangelands and woodlands in the AAR harbour a range of plant species (FAO, 2003). The region classifies as a local centre of plant endemism. Forests, dense woodlands, and related plant formations are often restricted to the mountainous regions of Oman. Montane flora exhibits a distinct latitudinal zonation. The

zone above 1500 m altitude hosts about 33% of Oman's 1200 species of vascular plants, of which 14 taxa are endemic to Oman. Open, drought-deciduous woodlands and shrub lands often intermix with xeromorphic grasslands, and a Panicum turgidum community dominates the alluvial wadi fans and mountain foothills. In the central range of the western Hajar Mountains, from 2100 m to the summit at 3000 m, isolated populations of Juniperus excelsa polycarpos are found (Figure 5.2), unique to the Arabian Peninsula (Ghazanfar, 2003; Brinkmann et al, 2009; MECA, 2010). Moreover, the scattered oases, which abound with Falaj irrigation systems, exhibit rich biodiversity in both agricultural and natural vegetation including date palms, with several varieties, limes, alfalfa, and vegetables (MECA, 2010).

Figure 5.2 Juniperus excelsa polycarpos in Hail Al-msipt, in the AAR.

Despite the very positive response to the environmental importance of the AAR, there was a less favourable view of the sufficiency of water for human needs. Government officials' and local people's perceptions were similar, as 64.5% of officials and 41.6% of local people disagreed or strongly disagreed with the importance of water sufficiency (Tables 5.4 and 5.5). Moreover, Table 5.4 shows regional agreement, with 75.1% of officials from al-Jabal, 88.6%

from Nizwa, and 57.9% from Muscat disagreeing or strongly disagreeing with water's sufficiency (Table 5.4). The respondents who do not consider the AAR to have much potential as a source of sufficient water appear to contradict their previous opinions that the AAR was highly representative of Oman and the source of many wadis. However, careful consideration of the circumstances of the region and the state of its NR shows that the respondents may have an accurate understanding of the resources of their region.

Table 5.4 Perspectives of regional government officials in the rating of sufficient water resources for human needs in the AAR.

| Category | Region | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Al-Jabal | | Nizwa | | Muscat | | | |
| | count | % | count | % | count | % | count | % |
| Strongly Disagree | 3 | 18.8% | 5 | 17.9% | 13 | 17.1% | 21 | 17.5% |
| Disagree | 9 | 56.3% | 17 | 60.7% | 31 | 40.8% | 57 | 47.5% |
| Not sure | 0 | 0% | 3 | 10.7% | 15 | 19.7% | 18 | 15.0% |
| Agree | 4 | 25.0% | 3 | 10.7% | 14 | 18.4% | 21 | 17.5% |
| Strongly agree | 0 | 0% | 0 | 0% | 3 | 3.9% | 3 | 2.5% |
| Total | 16 | 100% | 28 | 100% | 76 | 100% | 120 | 100% |

Table 5.5 Perspectives of local people in the rating of sufficient water resources for human needs in the AAR.

| Category | the AAR inhabitants | |
|---|---|---|
| | count | % |
| Strongly disagree | 10 | 8.3% |
| disagree | 40 | 33.3% |
| Not sure | 32 | 26.7% |
| Agree | 33 | 27.5% |
| Strongly agree | 5 | 4.2% |
| Total | 120 | 100% |

Despite the fact that it rains in both winter and summer, and that the region receives an annual average rainfall of 300 mm (Table 5.6) (MTC, 2010; Dorvlo et al., 2008), the water resources in the AAR remain insufficient to satisfy demand despite government efforts to build more than 50 surface storage dams, with capacities between 300 and 10000 $m^3$, to harvest rainwater for irrigation and grazing animals in AAR villages (Figure 5.3).

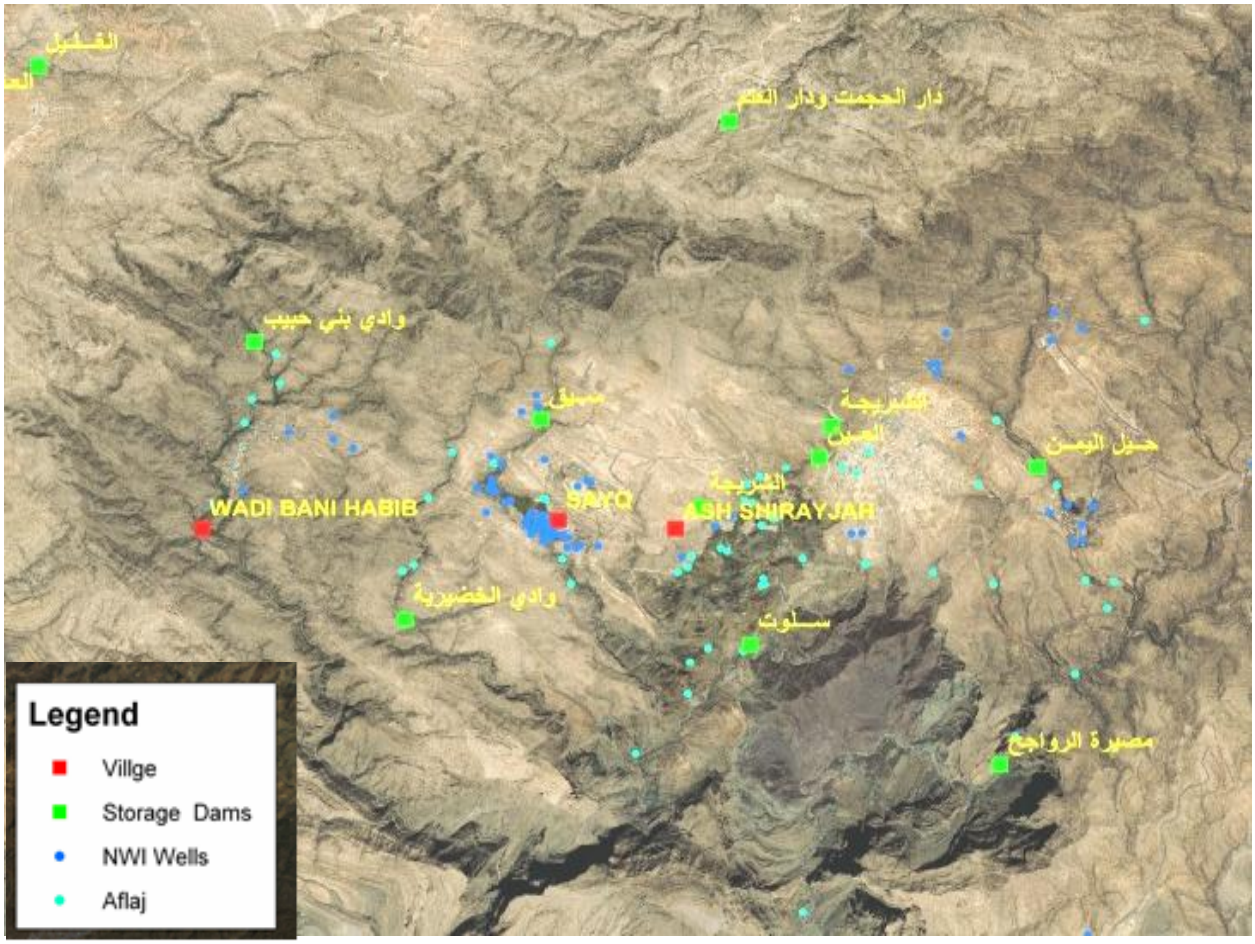



Figure 5.3 Some dams in the AAR. Source: (MRMWR 3, 2010).

Although the AAR has the highest proportion of rainfall in Oman, significant fluctuations in the amounts of rain have occurred during the past ten years (Table 5.6) (MTC, 2010). Local people raised this issue during the interviews. An interview with the Shora Council Representative of the Nizwa district revealed that ‘‘locals emphasize the lack of rain, and the instability of the annual average, which is contrary to what they used to get 10-15 years ago”. Table 5.6 confirms that the annual rainfall has not exceeded 134 mm during each of the last 4 years. The government's response has been to construct more surface storage dams and to start construction of a project to transport water from a desalination station on the coast in Barka. ‘‘The project includes the construction of water tanks with capacity of between 800 (and) 3,000m³ a day, as well as two main water tanks with 5,000m³ and 3,000m³ capacities’’

(MRMWR, 2010, 2). This project will directly benefit the ground water, saving it to only irrigation use.

Table 5.6 Annual rainfall in Saiq from 1990-2009 (Meteorological Station in the AAR)

| Year | Month | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
| 1990 | 21.3 | 169.1 | 1.6 | 32.5 | 70.1 | 3.8 | 25.0 | 73.4 | 7.7 | 0.0 | 36.1 | 0.0 | 440.6 |
| 1991 | 7.1 | 42.9 | 28.8 | 9.0 | 0.0 | 0.1 | 54.2 | 93.3 | 20.3 | 9.8 | 1.0 | 0.7 | 267.2 |
| 1992 | 142.0 | 66.7 | 21.2 | 139.9 | 35.2 | Tr | 11.1 | 61.8 | 1.7 | 17.2 | 0.0 | 0.0 | 496.8 |
| 1993 | 2.0 | 2.0 | 39.3 | 84.3 | 7.2 | 1.0 | 54.7 | 18.5 | 106.6 | 4.0 | **0.0** | Tr | 319.6 |
| 1994 | Tr | 0.0 | 0.0 | 23.4 | 95.0 | Tr | 177.7 | 51.9 | 48.6 | 32.2 | 0.0 | 0.0 | 428.8 |
| 1995 | Tr | 23.3 | 57.0 | 8.2 | 21.8 | 4.2 | 155.2 | 143.3 | 23.9 | 0.0 | 1.3 | 48.6 | 486.8 |
| 1996 | 33.5 | 0.0 | 5.2 | Tr | 53.2 | 85.3 | 35.4 | 125.6 | 0.0 | 0.0 | 0.0 | 20.0 | 358.2 |
| 1997 | 120.2 | Tr | 401.9 | 99.6 | 0.0 | 12.8 | 18.1 | 18.5 | 83.2 | 86.3 | 43.0 | 17.3 | 900.9 |
| 1998 | 107.8 | 56.7 | 5.1 | 16.0 | 2.0 | 18.7 | 7.0 | 72.0 | 34.3 | 5.0 | 0.0 | 11.6 | 336.2 |
| 1999 | 0.0 | 53.1 | 44.4 | Tr | 25.2 | 0.5 | 22.3 | 43.2 | Tr | 0.0 | 0.0 | 0.0 | 188.7 |
| 2000 | 0.0 | 0.0 | 0.0 | 35.4 | 51.8 | 38.4 | 33.6 | 64.7 | 42.5 | 104.4 | 43.1 | 0.0 | 413.9 |
| 2001 | 0.5 | 0.0 | 4.4 | 0.0 | 21.0 | 20.0 | 154.6 | 2.2 | 45.0 | 14.5 | 0.0 | 0.0 | 262.2 |
| 2002 | 0.0 | 2.6 | 15.8 | 14.4 | 26.9 | 46.9 | 10.2 | 17.8 | 1.6 | 0.5 | 0.7 | 1.0 | 138.4 |
| 2003 | 0.3 | 0.6 | 4.6 | 65.2 | 0.2 | 15.9 | 64.9 | 1.6 | 11.6 | 0.2 | - | 0.0 | 165.1 |
| 2004 | 5.0 | 0.0 | 0.0 | 11.0 | 36.8 | 6.2 | 37.4 | 6.6 | 46.0 | 0.4 | 0.0 | 33.4 | 182.8 |
| 2005 | 22.4 | 24.2 | 69.0 | 3.0 | 8.2 | 19.8 | 38.6 | 28.4 | 0.0 | 0.0 | 0.0 | 0.6 | 214.2 |
| 2006 | 0.0 | 94.2 | 1.0 | 0.0 | 0.0 | 0.6 | 0.0 | 0.0 | 0.0 | 2.0 | 2.6 | 33.0 | 133.4 |
| 2007 | 1.0 | 0.0 | 37.2 | 0.0 | 6.8 | 18.0 | 11.6 | 18.0 | 11.2 | 0.0 | 27.0 | 0.6 | 131.4 |
| 2008 | 4.2 | 0.0 | 3.2 | 0.0 | 5.0 | 0.4 | 26.8 | 47.4 | 26.4 | 2.0 | 0.0 | 0.0 | 115.4 |
| 2009 | 10.2 | 0.0 | 9.4 | 14.6 | 0.0 | 2.6 | 18.2 | 0.8 | 27.0 | 0.0 | 0.0 | 38.4 | 121.2 |

Source: (MTC, 2010).

The geographical nature of the region imposes particular constraints on water availability. In this regard, the Engineer Deputy Director General for Management of Water Resources said: ‘‘Al-Jabal Al-Akhdar has no water reservoir like the other regions of the Sultanate. The water is stored in cracks and faults for a short period and can penetrate to the surface whenever access is available’’. Moreover, the Shora Council Representative of Nizwa District supports this, saying: ‘‘although the mountain receives copious amounts of rain … the nature of the mountain does not allow it to retain such amounts for long periods, where they flow to lower areas”. Viktor and Robinson (2009:166) stated that ‘‘rainwater in Al-Jabal Al-Akhdar is

drained by wadis. Natural freshwater resources in these mountains are of three types: groundwater, lotic resources, and lentic resources''. Drilling wells extracts groundwater and facilitates pumping water into the distribution network for domestic purposes. Lotic resources are perennial natural springs that flow downstream as spring-streams; Aflaj (singular Falaj) harness this water mainly for agricultural purposes. Lentic resources are fabricated reservoirs built in the wadi channels as surface storage dams. This water serves agricultural and pastoral purposes (Figure 5.4). (Viktor et al, 2009).

Figure 5.4 Surface storage dam in the AAR as an example of Lentic resources.

Significant expansion of infrastructure projects (e.g., roads) affects the need for water. Victor (2008: 731) asserted that ''at present, Al Jabal Al Akhdar area is open and is easily accessible for four-wheel drive vehicles. Villages and communities are well connected with roads, many of them paved''. Government services, such as schools and health centres are now significantly more available and affordable, encouraging people to stay in their home areas. The role of the private sector, especially in the establishment of hotels and tourist camps, is also expanding, opening the way for home and international tourism. Previously, access to

the AAR was limited to permit holders. The Shora Council Representative of Nizwa district, attributes the increasing pressure on water resources to ‘‘the growing tourism demand following the opening up of the area to tourists without a permit or finance charges’’. The Director General of Natural Conservation explained this further:

> ‘‘... The government has always been planning to diversify the economy of the country, and roads were opened, providing easy access to the mountain. Despite the benefits and facilities provided … great pressure was put on NR due to the development and civil works in AAM aiming to build the infrastructure’’.

Population increases leading to urban expansion in the villages compounded this problem. Victor (2008) asserted that ‘‘development of the area is very rapid and the expansion of the new Seiq (Saih Katnah) in the last five years has been phenomenal. Construction activities are rampant and the increase in vehicular traffic is supported by a new petrol station’’ (Victor, 2008:732). The General Census of Population, Households, and Establishment (1993, 2003, and 2010) confirms population growth. The population of the AAR increased from 6,250 to 7,300 between 2003 and 2010, with an 8% increase in the Nizwa District, the largest district of the Interior Region representing 2.7% of the 332,772 total population of the region. This figure is now 11.4% of the Sultanate population, which has 2,694,094 inhabitants (Table 5.7) (MONE, 2010).

Changing lifestyles and household patterns have increased the consumption of water. Today an increasing shift towards the nuclear/small family has replaced the extended/ large family of 20 years ago. Toilets, showers, and electric washing machines have become commonplace. HE Shora, the Council Representative of Nizwa District, said, ‘‘Population growth, urbanization, the emergence of outposts, which were not previously there and the return of

many of the locals to the region after their displacement, led to insufficient water supply in the region.'' The Deputy Governor and the Director of the Nizwa Branch Municipality in the AAR agreed that population growth and the expansion of construction work were among the main reasons for the inadequacy of water resources. Victor et al. (2009:2) pointed out:

> ''Over the past ten years, the region had undergone enormous changes due to rapid development and the settlements had expanded considerably. As a consequence, the resident and transient populations of this area have increased and their activities exert a severe stress on water resources''.

Table 5.7 Population of some villages in the AAR*

| Villages | Population | households | family size |
|---|---|---|---|
| Saih-qeteneh | 1604 | 138 | 9.2 |
| Sieq | 802 | 69 | 9.1 |
| Alshuraijeh | 214 | 18 | 9.3 |
| Almenacher | 260 | 22 | 9.3 |
| Alain | 119 | 11 | 8.6 |
| Mesierat Arwajeh | 111 | 10 | 8.8 |
| Wadi Beni Hebib | 940 | 81 | 9.2 |
| Alghelail | 142 | 12 | 9.5 |
| Hiel Alyemen | 282 | 24 | 9.3 |
| Total | 4619 | 397 | 9.2 |

*Source: (Al-Azri, 2007: 15)

The Undersecretary of the Ministry of Agriculture describes another issue:

> ''One of the problems facing agriculture in the AAR is that many local people have abandoned their agricultural land and rely on foreign labourers who are inexperienced about local conditions of water resources, and therefore, cannot deal professionally with the requirements of irrigation and other agricultural operations''.

Many expatriate labourers have limited education, no experience in agriculture, and come from regions where water is abundant for immersion irrigation. Many appear to ignore rational water use.

Some respondents attributed water scarcity in some Aflaj and springs to government wells dug to extract water from the source areas to irrigate fruit farms (e.g. Riad Al-Jabal, administered by the Royal Court Affairs, in Hail Lemsipt, the highest point in the AAR). The Deputy Director General for Management of Water Resources commented:

> ‘‘Our aim was to extend the water network to the houses of the inhabitants but two of the wells were far from the residence area. When the concerned officials knew the success of these operations and the presence of water in the wells, the Diwan (Royal Court) decided to establish a farm to plant fruits for the benefit of the Sultan, but this move was not welcomed by me and I decided to withdraw from the project and returned to Muscat. I was sure that the continual water pumping will influence the spring’s flows in the local’s villages’’.

All of the above circumstances have resulted in insufficient water. Hence, the government’s mission was to develop alternatives. It is now implementing a complex and expensive engineering project to transport water from the desalination station in Barka, over 200 km away. In addition, three wastewater treatment/sewage stations will reduce the risk of groundwater contamination and provide safe water to irrigate a public park (MRMWR, 2010, 1; MRMWR, 2010, 2).

Although largely taken for granted, interactions of living organisms with their environments in healthy ecosystems provide “ecosystem services” that sustain human life (Salzman et al, 2001). However, in the questionnaire responses, neither government officials nor local people considered threats to the ecosystem and endangered species as important as the representativeness of Oman’s nature, watershed, and biodiversity. These environmental issues ranked modestly in importance; 69.2% of officials and 70% of local people realized the conversion of ecosystems to other land uses, and 70% of officials and 55% of local

people realized that there was a relatively high number of rare/endangered species (Tables 5.1 and 5.2). A less well-formed understanding of the meaning of the relatively new concepts of ecosystems and endangered species, and a lack of studies associated with these terms in the AAR, may have contributed to the relatively low scores on these elements. Even literature does not agree on a standard definition of an ecosystem service (Boyd and Banzhaf, 2007: Köllner, 2009). Researchers conducted only two comprehensive and multidisciplinary research projects in the region from 2000 to 2008, and the dissemination of their results was limited (Victor, 2009). However, land use changes, rangeland degradation (desertification), and pollution threaten the ecosystem, plant species diversity, and vegetation cover both in the AAR and elsewhere in Oman. The Fourth National Report to The Convention on Biological Diversity in 2010 summarises the threats to vegetation in Oman:

> ‘‘breakdown of traditional land management practices, including livestock management; development of human settlements and other non-agricultural land uses with a substantial footprint; human intrusion and disturbance; climate change; lack of protected areas for plant conservation; lack of species management plans; lack of monitoring of threatened species; lack of restoration programmes’’ (MOECA, 2010:26).

Local people have a much more favourable perception of soils in the region than do government officials. 78.8% of local people (Table 5.2) versus 71.8% of government officials (Table 5.1) agreed or strongly agreed that the AAR contained good quality soils. Apart from Al Wardi’s (2009) and Robinson and Al Nabhani’s (2009) contributions, soil research is limited in Oman’s mountain range, in spite of the AAR being under some of the most extreme grazing pressure. A countrywide soil survey and mapping project in 1990 ‘‘concluded that the main soil orders of the country are Aridiosols, Entisols and Inceptisols, and that soils in the AAR are considered Torriorthents, shallow, young, and undeveloped

soils'' (Robinson and Al Nabhani, 2009:321). Soils in the AAR classify into three groups: red soils with high iron oxide content from limestone decomposition, which provide quite fertile agricultural soil; grey volcanic soils, rich in nutrients with adequate moisture; and brown low-fertility soil, most recently formed and lacking in organic material (Al-Busaidi, 2010). However, historically, people of the AAR transfer thousands of tons of wadi sediments to build agricultural terraces, used extensively for crop farming, and add large amounts of carbon and nutrients, mainly from livestock manure (Bürkert et al, 2007).

The AAR has unique geography, geology, biodiversity, and agriculture and is of high environmental importance, distinguishing it from other surrounding regions. Government officials and local people are likely have similar perspectives about the region's environmental importance because their awareness comes from similar sources. However, the negative perceptions of both groups about the ability of the region to provide sufficient water resources is caused by the current problems of drought, accelerated development activities, and changing life styles.

## 5.3 The socio-economic Importance of NR in the AAR

The socio-economic importance of NR in the AAR addresses part of the first aim of the study. A great deal of literature has discussed a wide range of socio-economic benefits from environment in four primary categories. Firstly, human populations benefit from the environment's capacity to control vital ecological processes and life support systems through bio-geochemical and biological cycles; this regulation function provides clean air, water, soil, and biological control. Secondly, the environment and NR functions to house and protect wild plants and animals, preserving the biological and genetic diversity essential for human

life. Thirdly, the production functions of the living biomass provide environmental goods for human consumption, such as food, raw materials, and energy resources. Finally, a 'reference function' of NR supports human wellbeing and intellectual growth, providing opportunities for cogitation, spiritual improvement, cognitive development, and amenities practices, including recreation and aesthetic appreciation (De Groot et al, 2002; Randall, 1991; Wallace, 2007; Fisher et al., 2009).

Tables 5.8 and 5.9 display the perspectives of government officials and local people on the socio-economic importance of the AAR. The author inferred four categories of socio-economic importance from the results. Firstly, the visitor-related variable (recreational value and aesthetic significance) received the highest rating; 98.3% of officials and 95.8% of local people agreed or strongly agreed on this element's importance (Tables 5.8 and 5.9). Secondly, cultural variables received the second highest value with at least 89.2% of officials and 82.5% of local people in agreement on their importance. Thirdly, at least 81 % of officials and 72.5% of local people agreed or strongly agreed on the importance of the economic variables of ecosystem services and animal species. Finally, in contrast to the previous positive views, local economic opportunities had the lowest value; only 63.3% of officials and 56.6% of local people agreed or strongly agreed that the AAR is a resource for the livelihood of local communities.

Table 5.8 Government officials' perspectives regarding socio-economic importance of NR in the AAR.

| | Socio-economic variables rank order | Mean score | Sum | Distribution | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 5 | 4 | 3 | 2 | 1 |
| 1 | Recreational value and aesthetic significance. | 4.59 | 551 | 73 | 45 | 2 | 0 | 0 |
| 2 | Plant species of social, cultural, or economic importance. | 4.40 | 528 | 56 | 57 | 6 | 1 | 0 |
| 3 | Remarkable features of historical importance. | 4.36 | 523 | 57 | 51 | 10 | 2 | 0 |
| 4 | Educational and/or scientific value. | 4.31 | 517 | 53 | 54 | 10 | 3 | 0 |
| 5 | Contributes ecosystem services and benefits to communities. | 4.08 | 489 | 27 | 79 | 11 | 2 | 1 |
| 6 | Animal species of social, cultural, or economic importance. | 4.03 | 483 | 29 | 69 | 19 | 2 | 1 |
| 7 | Employment source for local communities. | 3.64 | 437 | 22 | 55 | 22 | 20 | 1 |
| 8 | Sustainable resource for communities' development | 3.63 | 435 | 24 | 55 | 22 | 10 | 9 |
| 9 | Resource for local communities' livelihood. | 3.47 | 416 | 9 | 67 | 17 | 25 | 2 |
| Total of respondents= 120 | | | | | | | | |
| 1 = strongly disagree, 2 = disagree, 3 = not sure, 4= agree, and 5= strongly agree. | | | | | | | | |

Table 5.9 Local people' perspectives regarding socio-economic importance of NR in the AAR.

| | Socio-economic variables rank order | Mean score | Sum | Distribution | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 5 | 4 | 3 | 2 | 1 |
| 1 | Recreational value and aesthetic significance. | 4.73 | 567 | 92 | 23 | 5 | 0 | 0 |
| 2 | Plant species of social, cultural, or economic importance. | 4.57 | 548 | 75 | 40 | 4 | 0 | 1 |
| 3 | Remarkable features of historical importance. | 4.53 | 543 | 67 | 49 | 4 | 0 | 0 |
| 4 | Educational and/or scientific value. | 4.17 | 501 | 44 | 55 | 19 | 2 | 0 |
| 5 | Contributes ecosystem services and benefits to communities. | 3.99 | 479 | 30 | 63 | 23 | 4 | 0 |
| 6 | Animal species of social, cultural, or economic importance. | 3.88 | 466 | 26 | 61 | 27 | 5 | 1 |
| 7 | Sustainable resource for communities' development. | 3.66 | 439 | 19 | 56 | 32 | 11 | 2 |
| 8 | Employment source for local communities. | 3.60 | 432 | 22 | 56 | 19 | 18 | 5 |
| 9 | Resource for local communities' livelihood. | 3.42 | 410 | 15 | 53 | 25 | 21 | 6 |
| Total of respondents= 120 | | | | | | | | |
| 1 = strongly disagree, 2 = disagree, 3 = not sure, 4= agree, and 5= strongly agree. | | | | | | | | |

There was a clear difference between government officials' and local people's responses about the recreational value and aesthetic significance of the AAR. For example, 76% of local people, but only 60.8% of government officials, strongly agreed with their importance. Considering the uniqueness of the region, government officials and locals logically should have given high value to its aesthetic and recreational importance. However, the current conditions of the impacts of climate changes, development, modernization, and life style changes may have led both officials and locals to lower their expectation. Generally, the

results were consistent with some of the literature that investigates the socio-economic importance of mountainous regions, especially in arid and semi-arid areas (Messerli and Ives, 1997; Becker and Bugmann, 2001; Beniston, 2003; FAO, 2004; Victor and Robinson, 2009).

A closer consideration of regional government officials' responses to the recreational value and aesthetic significance of the AAR reveals a high degree of recognition, as presented in Table 5.10. A total of 100% of Al-Jabal al-Akhdar and Nizwa officials and 97.4% of Muscat Officials agreed or strongly agreed on its importance in this area.

Table 5.10 Perspectives of regional government officials regarding recreational value and aesthetic significance of the AAR.

| Category | Region | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Al-Jabal | | Nizwa | | Muscat | | | |
| | count | % | count | % | count | % | count | % |
| Strongly disagree | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% |
| Disagree | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% |
| Not sure | 0 | 0% | 0 | 0 | 2 | 2.6% | 2 | 1.7% |
| Agree | 8 | 50% | 15 | 53.6% | 22 | 29% | 45 | 37.5% |
| Strongly agree | 8 | 50% | 13 | 46.4% | 52 | 68.4% | 73 | 60.8% |
| Total | 16 | 100% | 28 | 100% | 76 | 100% | 120 | 100% |

The interesting issue that emerges is the high recognition of the regional importance of recreational and aesthetic contributions contrasted to low recognition of the importance of the AAR in terms of local economic opportunities. Two possibilities provide logical explanations. As referred to in Section 5.2, both officials and local people have a clear awareness of the nature of the region. The perceptions of both groups also reflect their awareness of Oman's tourism vision as an important and sustainable socio-economic sector of Oman, reflecting the Sultanate's heritage, and the ethos of traditional hospitality (Ministry of Tourism, 2010). Another possible explanation for local people's results derives from the trend away from the isolation of the past. Today people of the AAR can communicate via

telephone, mobile phone, and the Internet. They can easily travel between the mountain villages and other regions of the Sultanate, making them more aware of the aesthetic characteristics that distinguish their region and open to compliments about its attractiveness (Figure 5.5). This also encourages a strong affiliation with and pride in their region.

Figure 5.5 Seasonal waterfalls in the AAR.
Source: Department of agriculture development in the AAR.

A closer look at the nature of the region may help clarify these results. Firstly, unlike the surrounding desert area, the high elevation of the AAR (3,000m) gives it a Mediterranean-type climate. Although variable, an annual average rainfall of 300 mm (MTC, 2010) promotes year-round vegetation cover, a feature lacking in the surrounding areas. Dorvlo et al (2009:151) cited that ‘‘the climate parameters at Saiq (the main village of The AAR) are different from the same parameters of the stations surrounding the plateau. These stations are at much lower elevations and are some distance from the plateau. The average temperature at

Saiq is over 10°C lower than surrounding stations''. Moreover, the Deputy Director General for the Development of Water Resources stated that:

> "Due to its green vegetation, pleasant microclimate and availability of fresh water, Al-Jabal Al Akhdar contrasts strikingly with the dry and rough landscape of northern Oman. It is a major tourism attraction in Dakhiliyah Region in the Sultanate, as it locates in a unique position and has an exceptionally moderate climate".

Secondly, the AAR has an attractive topography (Luedeling and Buerkert, 2008; Ministry of Tourism, 2010) (Figure 5.6). The landscape is a mixture of jagged limestone mountains interspersed with high plateaus. Water erosion has created canyons, caves, high peaks and sediment fans in the exposed stratified rocks and uplifted lands (Clarke, 2006). The Director General of Natural Conservation in Oman said:

> "The AAR is more than 2000 m above the sea; a unique area can be seen at very high altitude. The AAR is completely different compared to the low ground levels in the plain, coastal, or mountain areas such as Salaleh or Musendem. It is unique in its topography, biodiversity, and its special plants adaptable with the semi cool weather''.

Figure 5.6 Landscape of the AAR.

Thirdly, thousands of years ago, Omanis built agricultural terraces and associated irrigation systems allowing mountain villages (oases) to develop on the slopes and on the sides of wadis (Nagieb, et al, 2004). Biophysical measurements and archaeological surveys suggest first millennium BC construction of these oases with abundant spring water was the driving force for their development (Nagieb et al, 2005). The terraces cling to cliffs and use boulders from the valley or from quarrying. The oasis creators physically moved the terrace soil from low-lying wadis (Buerkert et al, 2007) and terrace construction required the cooperation and solidarity of all villagers, both men and women. The area/size of these terraces depends on the degree of steepness /inclination - the less steep, the more terrace area. Generally, the areas range from two $m^2$ in steep places to 100 $m^2$ in less steep places (Figure 5.7) (Gebauer et al, 2007). Terrace agricultural and horticultural crops are intensively cultivated in traditional, mainly livelihood-oriented oasis systems (Buerkert et al, 2005; Gebauer et al, 2007) and the human-constructed terraces are one of the attractive features of this area.

Figure 5.7 Terraces in the AAR.

Fourthly, biodiversity, especially in terms of flora, is an important factor in attracting visitors and researchers alike; studies suggest that a quarter of all plant life in the Sultanate is located within the areas of pine trees and wild olives that exist up to 1500 meters. This is one of the most bio-diverse areas in the Arabian Peninsula (Ministry of Tourism, 2010). The AAR massif in the Hajar Mountains of northern Oman classifies as a local centre of plant endemism. Bird diversity includes 129 recorded species, including nine endemic species. Wood Pigeons, for example, breed only in these mountains, and nowhere else in Arabia (Eriksen, 2009). Moreover, Gebauer et al (2007:465) asserted that:

> ‘‘A diverse mosaic of crops was found in this region with area-specific species composition and species richness. The different elevations provide markedly differing agro-climatic conditions. Overall, there are 107 different identified crop species belonging to 39 families. Species number was highest among fruits (33 spp.),

followed by vegetables (24 spp.) (Figure 5.8). Intensive irrigation allows cultivation of a broad range of species at all oases''

In an interview with HE Engineer, the Undersecretary of the Ministry of Agriculture, he described the AAR as the region that:

> ''Al-Jabal Al-Akhdar is known for its significant biodiversity. It is a unique area in the Sultanate where fruit trees could be seen all over the year and the four seasons are reflected in this area not like the other regions of the Sultanate where only summer and winter seasons prevail''.

Figure 5.8 High altitudes' fruit of the AAR.
Source: Department of agriculture development in the AAR.

All of these characteristics in an arid country serve to attract increasing numbers of tourists (Table 5.11 and Figure 5.9), for nature watching or amateur and professional photography (Buerkert, et al, 2010), and for research on characteristics that are rare elsewhere in the world. However, Table 5.11 shows that the number of tourists decreased in 2009. This decrease could have been due to the highest tourism months of 2009 coinciding with Ramadan, during which Muslims fast and limit their travelling. There was also a low yield of pomegranates, the main crop of the area. In spite of the global economic downturn, however, the number of overseas tourists only slightly declined.

Table 5.11 The AAR Visitors Statistics 2009

| Month | Omani | | GCC | | Other Arabs | | Foreigners | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2008 | 2009 | 2008 | 2009 | 2008 | 2009 | 2008 | 2009 | 2008 | 2009 |
| Jan | 1,164 | 937 | 264 | 363 | 88 | 85 | 2,281 | 2,105 | 3,797 | 3,490 |
| Feb | 2,606 | 1,182 | 308 | 252 | 72 | 198 | 2,971 | 2,436 | 5,957 | 4,068 |
| March | 1,565 | 1,896 | 315 | 302 | 113 | 136 | 3,534 | 2,604 | 5,527 | 4,938 |
| April | 1,416 | 1,322 | 210 | 305 | 84 | 194 | 2,510 | 3,621 | 4,220 | 5,442 |
| May | 2,127 | 2,384 | 349 | 397 | 182 | 131 | 2,234 | 1,975 | 4,892 | 4,887 |
| June | 4,673 | 5,375 | 841 | 951 | 139 | 216 | 1,363 | 1,323 | 7,016 | 7,865 |
| July | 13,543 | 21,003 | 2,278 | 4,632 | 201 | 296 | 2,434 | 2,890 | 18,456 | 28,821 |
| Aug | 19,226 | 8,180 | 6,549 | 3,048 | 242 | 211 | 2,180 | 1,152 | 28,197 | 12,591 |
| Sep | 281 | 3,409 | 239 | 1,131 | 50 | 404 | 872 | 5,878 | 1,442 | 10,822 |
| Oct | 7,044 | 2,159 | 2,232 | 629 | 564 | 207 | 7,868 | 2,514 | 17,708 | 5,509 |
| Nov | 2,899 | 1,028 | 216 | 505 | 199 | 268 | 3,111 | 5,580 | 6,425 | 7,381 |
| Dec | 1,832 | 1,721 | 812 | 409 | 421 | 159 | 4,830 | 3,689 | 7,895 | 5,978 |
| Total | 58,376 | 50,596 | 14,613 | 12,924 | 2,355 | 2,505 | 36,188 | 35,767 | 111,532 | 98,302 |

Source: (MOT, 2010)

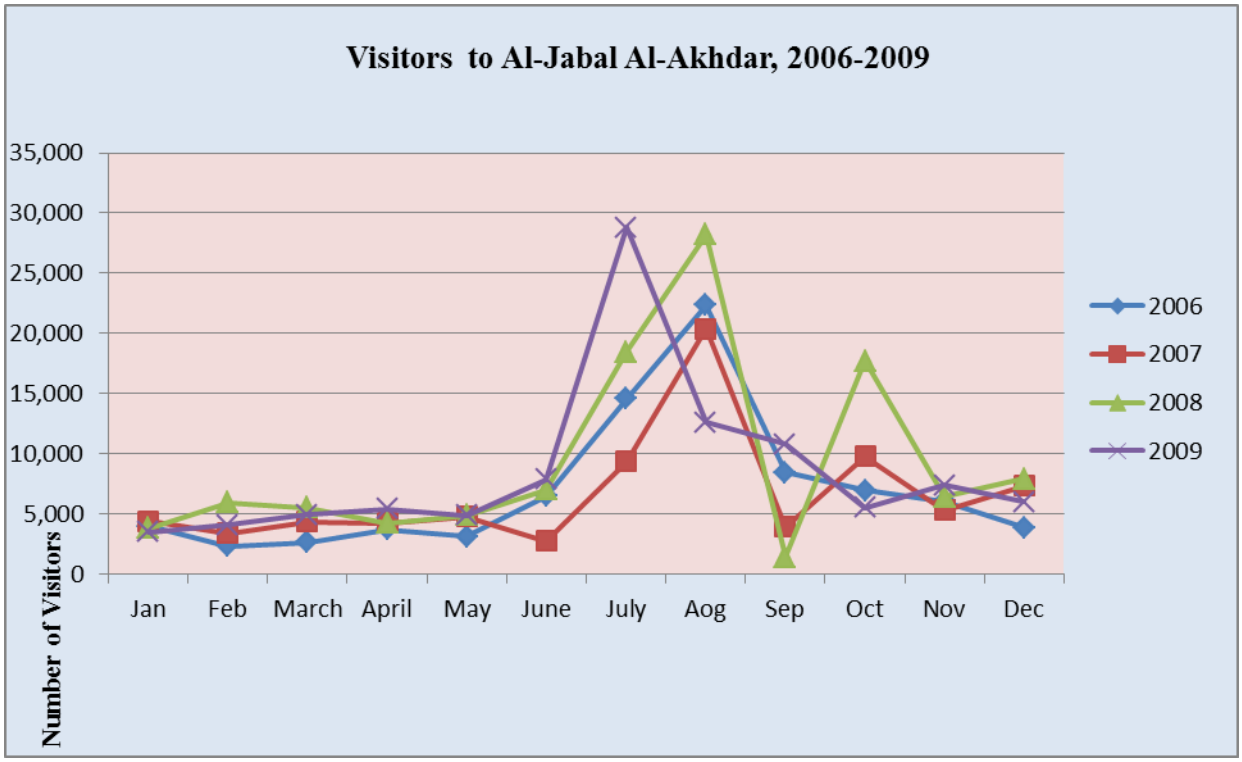



Figure 5.9 Total numbers of visitors to the AAR (2006-2009)
Source: (MOT, 2010)

Surprisingly, the perspectives of both government officials and local people on the variables related to local economic opportunities were identical. These variables ranked at the bottom of the results, as seen in Tables 5.12 and 5.13.

Table 5.12 Perceptions of regional government officials regarding the AAR as a resource for local communities' livelihood.

| Category | Region | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Al-Jabal | | Nizwa | | Muscat | | | |
| | count | % | count | % | count | % | count | % |
| Strongly Disagree | 0 | 0% | 1 | 3.8% | 1 | 1.3% | 2 | 1.7% |
| Disagree | 2 | 12.5% | 2 | 7.1% | 21 | 27% | 25 | 20.8% |
| Not sure | 3 | 18.8% | 3 | 10.7% | 11 | 14.5% | 17 | 14.2% |
| Agree | 10 | 62.5% | 19 | 67.9% | 38 | 50% | 67 | 55.8% |
| Strongly agree | 1 | 6.3% | 3 | 10.7% | 5 | 6.6% | 9 | 7.5% |
| Total | 16 | 100% | 28 | 100% | 76 | 100% | 120 | 100% |

Table 5.13 Local peoples' perceptions regarding the AAR as a resource for local communities' livelihood.

| Category | count | % |
|---|---|---|
| Strongly disagree | 6 | 5.0% |
| disagree | 21 | 17.5% |
| Not sure | 25 | 20.8% |
| Agree | 53 | 44.2% |
| Strongly agree | 15 | 12.5% |
| Total | 120 | 100% |

These perspectives are consistent with perspectives about the environmental importance of the AAR (sufficient water resources for residential and agricultural needs), which also received the lowest ratings in that category. Government officials and locals seem to correlate water abundance to the region's ability to provide livelihood to the dwellers - a logical connection because the ''quality, distribution, seasonality, and abundance of water have been key determinants of livelihood, health, and settlement potentials'' (Hassan, 2010:14). The results in Table 5.12 are surprising; 28.3% of Muscat officials do not agree that the mountain is an important resource for local livelihood compared to 12.5% and 10.9% of the AAR and Nizwa officials. This suggests regional differences among these groups. A Mann Whitney U test showed no statistically significant differences between Al-Jabal and Nizwa officials'

responses, nor between those from Al-Jabal and Muscat; however, the differences between the responses from Nizwa and Muscat officials were statistically significant.

Table 5.14 Man-Whitney Test measuring differences between Al-Jabal and Nizwa on the item "resource for local communities' livelihood".

| **Ranks** | | | | **Test Statistics** | |
|---|---|---|---|---|---|
| Region | N | Mean Rank | Sum of Ranks | Mann-Whitney U | 199.000 |
| Al-Jabal | 16 | 20.94 | 335.00 | Wilcoxon W | 335.000 |
| Nizwa | 28 | 23.39 | 655.00 | Z | -.724 |
| Total | 44 | | | Asymp. Sig. (2-tailed) | .469 |

Table 5.15 Man-Whitney Test measuring differences between Al-Jabal and Muscat on the item "resource for local communities' livelihood".

| **Ranks** | | | | **Test Statistics** | |
|---|---|---|---|---|---|
| Region | N | Mean Rank | Sum of Ranks | Mann-Whitney U | 517.000 |
| Al-Jabal | 16 | 52.19 | 835.00 | Wilcoxon W | 3443.000 |
| Muscat | 76 | 45.30 | 3443.00 | Z | -1.024 |
| Total | 92 | | | Asymp. Sig. (2-tailed) | .306 |

Table 5.16 Man-Whitney Test measuring differences between Nizwa and Muscat on the item "resource for local communities' livelihood".

| **Ranks** | | | | **Test Statistics** | |
|---|---|---|---|---|---|
| Region | N | Mean Rank | Sum of Ranks | Mann-Whitney U | 813.500 |
| Nizwa | 28 | 61.45 | 1720.50 | Wilcoxon W | 3739.500 |
| Muscat | 76 | 49.20 | 3739.50 | Z | -2.025 |
| Total | 104 | | | Asymp. Sig. (2-tailed) | .043 |

The differences may be due to differences in academic backgrounds and in familiarity with the issue. Moreover, the interpretation of ''livelihood'' may determine the response. Recognition of its potential agricultural and pastoral resources has created a unique livelihood production system in the AAR. Nevertheless, more than half of both the officials and the local people agreed with the importance and the capacity of the region to provide life's basic requirements, food for example. This is a logical belief because this region sustained the survival of thousands of people for thousands of years (Nagieb et al, 2005). Few geographical

areas provide all human demands, although many produce the basic requirements of food, clothing, and housing. Other necessities come from trade outside the region. Therefore, the low ranking does not diminish the value of this aspect of the region. Thirty years ago, the responses would have been different. People dealt with resources differently, as described by a member of the women's focus group:

> ''These resources (e.g. trees, water, natural plants, and pastures) were used naturally and rationally without endangering them to extinction. People used to graze goats and sheep in special pastures areas, which were allocated to each village, and they kept cows at houses without having any problem. The people were wise enough to limit their needs for fruits and cereals and to sell what was surplus at the neighboring souks to buy the other requirements of their life''.

Moreover, interviews with residents and focus groups emphasized that the region's products from environmental resources exceeded their needs. They sold surplus products to buy the luxuries of special foods and other life accoutrements. One informant said:

> "We get the basic requirements of living from the production of agricultural land, animal husbandry, and other products of nature around us. We grow cereal … legumes … vegetables … fruits … and nuts …. We benefit from livestock to get meat, milk, and butter … and we got wool to make clothing, carpets, and tents. Moreover, from the natural environment, we get some fruits such as wild olive, and (Boot) … fuel for cooking and heating, timber … and rocks for construction. We consume what we need; the rest is stored as stock for the rest of the year. We sell the surplus to the neighboring markets. From those markets we were buying dates, rice, coffee, sugar, spices, and fish …. We were making our own cement, locally named Omani Sarouj, by burning clay that contains lime".

No other region so rich NR exists in elsewhere in Oman or in the Arabian Peninsula.

However, Oman has now experienced a shift from subsistence to market economy (Looney, 2009; Buerkert, et al, 2007; Buerkert et al, 2010), which has had an impact on the magnitude and efficiency of agricultural and livestock production, hunting, and the utilization of wild plants (Ministry of Housing, 1990; Ministry of Tourism, 2010; Buerkert et al, 2010). The transformation in the AAR toward modernization has negatively affected traditional villages, some of which are becoming urban and suburban units (Buerkert et al, 2010). These modernized villages offer a better standard of living than the traditional settlements. Consequently, many - especially the younger generation - have abandoned the remote villages. Labour shortages caused by poorly paid agricultural work have contributed to the decay of agricultural terraces. Village products cannot compete with cheap imported goods produced with modern irrigation systems elsewhere. Climate change has influenced the productivity of some crops; pomegranate yields in some villages have reportedly declined to a maximum of 50 fruits per tree, from the declining chill hours that fruit trees require (Dorvlo et al, 2009; Luedeling et al, 2009). These shifts have occurred simultaneously with population growth, urban expansion, tourism openness, changes in lifestyles, changes in family patterns, and increased consumption (Buerkert, et al, 2010). Officials and locals are familiar with these conditions, including the status of water and agricultural products, and their knowledge may have influenced their responses to the survey question.

One wonders on what evidence the officials of the three regions based their responses. The AAR and Nizwa are the closest to the mountains, but respondents also included experts from Muscat; all of these officials should be aware of the area's potential as a livelihood resource for local communities. Hence, one might conclude that the contrast in responses is a result of inconsistent knowledge flow among regional officials and the lack of constructive

interactions. The Undersecretary of the Ministry of Agriculture expressed the lack of coordination among concerned ministries:

> ‘‘I would like to suggest that the government initiate a comprehensive programme for the management of NR in Al Jabal Al Akhdar in which all concerned ministries should be involved, a detailed plan should be set to achieve this goal. Experiences and traditional methods of the locals should be included in this plan’’.

The status of NR, threatened by modernization and development, influences government officials’ perspectives about the region's ability to provide good livelihood opportunities for its residents. This situation reflects poor planning. However, the NR status and livelihood opportunities, as reported in oral histories, interviews of officials and experts, and the results of studies in the region, are negative indicators for environmental sustainability. To maintain these resources and their capacity to continue to provide acceptable livelihood for residents, Oman must ensure the following efforts to provide water for human use (domestic and agricultural): surface storage dam construction, Aflaj maintenance, desalinated water delivery, and treated water use for irrigation in public parks.

The third category relating to the importance of the socio-economic results examines economic variables, ecosystem services and important animal species. This element received the second lowest value from both officials and local people whose perspectives were comparable; 88.2% of officials and 77.5% of local people agreed or strongly agreed that services of the AAR ecosystem benefited local communities (Tables 5.17 and 5.18).

Table 5.17 Perspectives of regional government officials regarding the contributions of the AAR to ecosystem services and benefits to communities.

| Category | Region | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Al-Jabal | | Nizwa | | Muscat | | | |
| | count | % | count | % | count | % | count | % |
| Strongly Disagree | 0 | 0% | 1 | 3.6% | 0 | 0% | 1 | .8% |
| Disagree | 0 | % | 0 | 0% | 2 | 2.6% | 2 | 1.7% |
| Not sure | 2 | 12.5% | 3 | 10.7% | 6 | 7.9% | **11** | 9.2% |
| Agree | 8 | 50% | 20 | 71.4% | 51 | 67.1% | **79** | 65.8% |
| Strongly agree | 6 | 37.5% | 4 | 14.3% | 17 | 22.4% | 27 | 22.5% |
| Total | 16 | 100% | 28 | 100% | 76 | 100% | 120 | 100% |

Table 5.18 Perspectives of local people regarding the contributions of the AAR to ecosystem services and benefits to communities.

| Category | Count | Percent | Cumulative Percent |
|---|---|---|---|
| Strongly Disagree | 0 | 0% | 0% |
| Disagree | 4 | 3.3 | 3.3 |
| Not sure | 23 | 19.2 | 22.5 |
| Agree | 63 | 52.5 | 75.0 |
| Strongly agree | 30 | 25.0 | 100.0 |
| Total | 120 | 100.0 | |

The lower numbers of officials and local people who strongly agreed that the AAR contributed ecosystem services and benefits to communities suggests less understanding of the meaning of a relatively new and unfamiliar concept. Ecosystem services are the benefits that nature provides to households, communities, and economies, but beyond that, there is no standardized definition or measurement. The literature reveals multiple, competing meanings of the terms, yet authorities frequently cite these limited definitions (Costanza et al, 1997; Daily, 1997; Wallace, 2007; Millennium Ecosystem Assessment, 2005). The Millennium Ecosystem Assessment (2005) describes ecosystem services as "the benefits people obtain from ecosystems." This description provides a context for discussion, but it is not an operational definition for usage in such areas as accounting (Boyd and Banzhaf, 2007), landscape management (Wallace, 2007), or valuation (Fisher and Turner, 2008) (Fisher et al, 2008). Furthermore, the term conveys an important idea of ecosystem social value that one may not directly perceive or measure (Boyd and Banzhaf, 2003). For example, recreational angling relies on ecological contributions: a body of water and a fish population. However,

many anglers also enjoy its aesthetic values; the water's clarity and the surrounding scenery are also ecosystem services.

Another explanation of the differing responses of both government officials and local people is the lack of research studies related to NR in the AAR and the lack of dissemination of the few available studies. In an interview, one expert from SQU asserted that:

> ‘‘From 2004 – 2008 a study called Al Jabal Al Akhdar Initiative was conducted at SQU, addressing conservation and sustainable development. An inter-ministerial committee was set up to study the recommendations made in this study, but nobody has paid any attention to the results of this research. When meetings are called, nobody shows up’’.

Variables of the socio-economic importance of plant species, history, science, and education values of the AAR (Tables 5.8 and 5.9) received the second highest valuation from both government officials and local people. The results suggest that both perceive that the AAR is important in preserving these values; 90% of the officials and 96.4% of the local people agreed or strongly agreed (Tables 5.19 and 5.20).

Table 5.19 Perspectives of regional government officials about the historical importance of the AAR.

| Category | Region | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Al-Jabal | | Nizwa | | Muscat | | | |
| | count | % | count | % | count | % | count | % |
| Strongly Disagree | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% |
| Disagree | 0 | 0% | 1 | 3.6% | 1 | 1.3% | 2 | 1.7% |
| Not sure | 1 | 6.3% | 3 | 10.7% | 6 | 7.9% | 10 | 8.3% |
| Agree | 7 | 43.8% | 11 | 39.3% | 33 | 43.4% | 51 | 42.5% |
| Strongly agree | 8 | 50% | 13 | 46.4% | 36 | 47.4% | 57 | 47.5% |
| Total | 16 | 100% | 28 | 100% | 76 | 100% | 120 | 100% |

Table 5.20 Perspectives of local people about the historical importance of the AAR.

| Category | Count | Percent | Cumulative Percent |
|---|---|---|---|
| Strongly Disagree | 0 | 0 | 0 |
| Disagree | 0 | 0 | 0 |
| Not sure | 4 | 3.3 | 3.3 |
| Agree | 49 | 40.8 | 44.2 |
| Strongly agree | 67 | 55.8 | 100.0 |
| Total | 120 | 100.0 | |

Once again, government officials and locals were well aware of the cultural, historical, and scientific importance of the region. Their responses were relatively high and consistent with the importance given to the region in books and recent studies, which in turn, provide a rich cultural and scientific heritage worthy of conservation (Phillips, 1911; Al Siyabi, 2001; Buerkert and Schlecht, 2010).

The historical, cultural, and scientific features of the area include the duration of continuous settlement. Despite the rugged terrain, settlement in the region dates back to the first millennium BC (Nagieb et al, 2005). It was an excellent haven for opposition minorities and the last stronghold of the Islamic Imamate controlling the interior of Oman. By the end of The Jebel Akhdar War (1954-1959), the Imam was defeated and his supporters displaced (Phillips, 1911).

The plentiful natural vegetation and agricultural crops also represent a socio-economic value to a wider population. Interviews with local people, for example, show that one kilogram of Boot fruit (Reptonia mascatensis), a wild tree not requiring human intervention to cultivate and manage, is sold for £5, one pomegranate ranges from £2-3, and a 700 ml bottle of rose water is worth £14. Harvesters sell a kilogram of Al-Jabal garlic, exclusive to the mountain area, for £5.

By the beginning of the twentieth century, universities and research institutes from Oman and abroad had begun to draw attention to the region. They conducted multidisciplinary research on vegetation, agriculture, and livestock production, such as the Al Jabal al Akhdar Initiative, and a study of transformation process. The first project addressed (1) climatic data for sustainable development; (2) biodiversity; (3) flora and vegetation ecology; (4) birds, conservation, and ecotourism; (5) assessments of water resources, soil quality, animal industry management, and the environment; and (6) the planning and management of ecotourism resources (Victor, 2008:1). The second project, an interdisciplinary German-Omani project, ran from 1999 to 2007, and focused on the historical processes of economic and ecological transformation in oasis settlements; the origins and development of oasis agriculture; the settlement typology; and the ecological and socio-economic aspects of the land use systems (http://oases-of-oman.org).

### 5.4 Factors threatening NR in the AAR (vulnerability)

This section addresses the vulnerability of NR in the AAR by considering both the human and natural factors that threaten them. These factors have influenced the legal and illegal activities, practices, and events that have had a direct or indirect negative impact on the region's environment by reducing bio-diversity, inhibiting regenerative capacity, and/or impoverishing the region's NR. Ervin (2003) provided examples of pressures and threats that affect the environment in protected areas, from logging to mining, and from waste disposal to invasions of alien species. In some respects, the situation in the AAR resembles the situations described by Ervin. Four main factors threaten NR in the AAR: development activities, climate change, actors such as tourists, pastoralists, and farmers, and malpractices.

### 5.4.1. Pressures and threats on NR from development activities in the AAR

The perceptions of government officials and local people on current pressures and threats to NR from development activities were very similar (Tables 5.21 and 5.22), at least in terms of rank order, although government officials tended to have a consistently stronger view. For example, government officials viewed the rate of pressure acceleration as more severe than did local people (4.57 vs. 4.07, respectively). Indeed, 62.5% of government officials considered the acceleration rate as most severe, while only 40% of local people considered it so. Moreover, government officials' results revealed no statistical regional differences (Al-Jabal, Nizwa and Muscat) (Tables 5.21, 5.22 and 5.23).

Table 5.21 Government officials' perceptions regarding the current pressures and threats from development activities on NR in the AAR.

| Rank order of pressure and threat elements. | | Mean score | Sum | Distribution | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 5 | 4 | 3 | 2 | 1 |
| 1 | Development activities increasing pressure. | 4.57 | 548 | 75 | 42 | 0 | 2 | 1 |
| 2 | Current spatial extent of pressure from development activities. | 3.88 | 466 | 24 | 66 | 24 | 4 | 2 |
| 3 | Current impact of pressure from development activities. | 3.66 | 439 | 17 | 55 | 38 | 10 | 0 |
| 4 | Expected impact of pressure from development activities. | 3.40 | 408 | 10 | 46 | 48 | 14 | 2 |
| Total respondents= 120 | | | | | | | | |
| 1 = None, 2 = Mild, 3 = Moderate, 4= High, and 5= Severe. | | | | | | | | |

Table 5.22 Local peoples' perceptions regarding the current pressures and threats from development activities on NR in the AAR.

| Rank order of pressure and threat elements. | | Mean score | Sum | Distribution | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 5 | 4 | 3 | 2 | 1 |
| 1 | Development activities increasing pressure. | 4.07 | 488 | 48 | 52 | 5 | 10 | 5 |
| 2 | Current spatial extent of pressure from development activities. | 3.54 | 425 | 30 | 28 | 44 | 11 | 7 |
| 3 | Expected impact of pressure from development activities. | 3.50 | 420 | 23 | 32 | 49 | 14 | 2 |
| 4 | Current impact of pressure from development activities. | 3.43 | 411 | 14 | 40 | 51 | 13 | 2 |
| Total respondents= 120 | | | | | | | | |
| 1 = None, 2 = Mild, 3 = Moderate, 4= High, and 5= Severe. | | | | | | | | |

Table 5.23 Perceptions of regional government officials regarding development activities increasing pressure on NR in the AAR.

| Category | Region | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Al-Jabal | | Nizwa | | Muscat | | | |
| | count | % | count | % | count | % | count | % |
| Decreased sharply | 1 | 6.3% | 0 | 0% | 0 | 0% | 1 | .8% |
| Decreased slightly | 1 | 6.3% | 0 | 0% | 1 | 1.3% | 2 | 1.7% |
| Remained constant | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% |
| Increased slightly | 6 | 37.5% | 12 | 42.9% | 24 | 31.6% | 42 | 35% |
| Increased sharply | 8 | 50% | 16 | 57.1% | 51 | 67.1% | 75 | 62.5% |
| Total | 16 | 100% | 28 | 100% | 76 | 100% | 120 | 100% |

These results indicate that both groups have a clear understanding of the status of development in the AAR, regardless of their proximity to the region, and their recognition of the seriousness of the pressure on NR posed by development acceleration is apparent.

However, many development activities today result from the implementation phase of a 1980's developmental plan designed by the Consultancy within Engineering, Environmental Science, and Economics (COWI) on behalf of the Ministry of Housing. The plan objectives were:

> "To promote the development of a more diversified economic base that will provide productive employment opportunities; to respect traditions and to conserve the ecology, natural environment and historical heritage; and to provide access to services such as health, education and other facilities to those who are currently deprived in comparison to the nation as a whole'' (COWI consult, 1990:3).

The plan aimed to help the region become more attractive by creating more job opportunities and reducing emigration out of the region. While planners may not have ignored the conservation of NR, the implementation probably encountered various obstacles such as limited flat spaces to establish projects. Thus, the projects were located in areas rich in plant and animal life resulting in the loss of important elements in the region's ecosystem. Second, the development project implementers (companies, for example) did not abide by environmental standards, a result of poor follow-up by government officials and the lack of

penalties for violators. Figure 5.10 shows an example of an uncovered sewage hole near a small public park, posing the risk of contamination of the underground water. Finally, development projects' environmental misuse also resulted in irreversible resource and environmental disruptions. Off-road vehicle driving devastates the natural vegetation and animal species, resulting in environmental degradation (Brown, 2001; Priskin, 2003; Schlacher and Thompson, 2007), as illustrated in Figure 5.11.

Figure 5.10 Uncovered sewage hole near one of the small public parks in the AAR.

Figure 5.11 Results of off-road vehicle driving in one area (Alghlail) of the AAR.

The mistakes that accompanied the implementation of the plan led to damage that was similar to what Costa (1983:273) described in his study on the loss of architectural heritage in the Gulf States. He said,

> "The bureaucratic machinery was unfortunately (and not surprisingly) slow in the practical implementation of the principles of conservation. Hit by waves of 'modernisation' and 'development', the architectural heritage paid the highest toll: not only were single historic monuments destroyed but also sometimes, the built environment of entire areas was obliterated''.

Officials and researchers in Oman who asserted that increasing development activities, such as the transfer of specific ecosystems to other land use types, threatened both heritage and NR echoed this view. Most AAR- related studies have referred to the region's sensitivity and the need for cooperation and solidarity in protecting its beauty and preserving its NR during rapid development (Costa, 1983; COWI consult, 1990; Burkert, 2007; Siebert and Nagieb, 2007; Victor, 2008; Patzelt, 2009; Erikson, 2009; Brinkmann et al, 2007; Brinkmann et al, 2011). Nevertheless, the COWI report for the Ministry of Housing in 1990 predicted that activities such as intensive grazing, population growth, and regional development, would severely affect the region's environment, and proposed the establishment of four national nature reserves in the region. This recommendation was ignored.

Interestingly, the expected duration of pressure from development activities received the lowest response from government officials and the second lowest response among local people. However, 60% of officials and 46% of local people agreed on the seriousness, and the underestimation, of long term and permanent pressures and threats (Tables 5.21 and 5.22). To be accurate in their responses, officials and locals need more knowledge from, and access to,

research results and official reports, which are not widely available. Secrecy often shrouds the planning and implementation of development projects in Oman.

### 5.4.2. Impact of climate change on NR in the AAR

It would seem that local people have a stronger concern about the impact of climate change in the AAR than government officials (Tables 5.24 and 5.25), with over 63% of local people, but only 50% of officials considering the impact of climate change severe. Officials in al-Jabal and in the regional centre of Nizwa had stronger views of severity (62.5% and 64.3% seeing sever or high pressure, respectively) compared to fewer in Muscat (42.1%) (Table 5.26).

Table 5.24 Government officials' perceptions regarding perceived impact of climate change on NR in the AAR.

| Impact elements | | Mean score | Sum | Distribution | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 5 | 4 | 3 | 2 | 1 |
| 1 | Recent impact of climate changes. | 3.45 | 414 | 10 | 50 | 46 | 12 | 2 |
| Total respondents= 120 | | | | 8.3% | 41.7% | 38.3% | 10% | 1.7% |
| 1 = None, 2 = Mild, 3 = Moderate, 4= High, and 5= Severe. | | | | | | | | |

Table 5.25 Local people's perceptions regarding perceived impact of climate change on NR in the AAR.

| Impact elements | | Mean score | Sum | Distribution | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 5 | 4 | 3 | 2 | 1 |
| 1 | Recent impact of climate changes. | 3.72 | 446 | 27 | 49 | 30 | 11 | 3 |
| Total respondents= 120 | | | | 22.5% | 40.8% | 25.0% | 9.2% | 2.5% |
| 1 = None, 2 = Mild, 3 = Moderate, 4= High, and 5= Severe. | | | | | | | | |

Table 5.26 Perceptions of regional government officials regarding climate change impact on NR in the AAR.

| Category | Region | | | | | |
|---|---|---|---|---|---|---|
| | Al-Jabal | | Nizwa | | Muscat | |
| | count | % | count | % | count | % |
| Severe | 4 | 25% | 1 | 3.6% | 5 | 6.6% |
| High | 6 | 37.5% | 17 | 60.7% | 27 | 35.5% |
| Moderate | 4 | 25% | 8 | 28.6% | 34 | 44.7% |
| Mild | 2 | 12.5% | 2 | 7.1% | 8 | 10.5% |
| Non | 0 | 0% | 0 | 0% | 2 | 2.6% |
| Total | 16 | 100% | 28 | 100% | 76 | 100% |

The conservatism of the officials' responses, especially officials from Muscat, may explain their two preferences (41.7% for high impact and 38.3% for moderate) (Table 5.24). Some see climate change in the region as an unproven fact, consistent with some worldwide perspectives (Parmesan, 2006; Tietjen, 2007; Parry et al, 2007; Ziervogel et al, 2008; Lioubimtseva and Henebry, 2009; Ziervogel and Ericksen, 2010).

Currently, most consider climate change a fact that has the potential to damage NR irreversibly. Parry et al (2007:8) commented,

> "Physical and biological systems on all continents and in most oceans are already being affected by recent climate changes, particularly regional temperature increases (very high confidence) … More evidence from a wider range of species and communities in terrestrial ecosystems and substantial new evidence in marine and freshwater systems show that recent warming is strongly affecting natural biological systems (very high confidence)''.

They added that:

> "during the course of this century the resilience of many ecosystems (their ability to adapt naturally) is likely to be exceeded by an unprecedented combination of change in climate, associated disturbances (e.g., flooding, drought, wildfire, insects, ocean acidification) and in other global change drivers (especially land-use change, pollution and over-exploitation of resources), if greenhouse gas emissions and other changes continue at or above current rates (high confidence)… Substantial changes in structure and functioning of terrestrial ecosystems are very likely to occur with a global warming of more than 2 to 3°C above pre-industrial levels (high confidence)'' (Parry et al, 2007:213).

The situation in Oman is no different. Successive cyclones and long periods of drought depict unusual climatic changes. Cyclone Gunu in 2007 (Figure 5.12) and cyclone Phet in 2010 occurred at frequent intervals, and caused mass destruction in the AAR. The storm, the

torrential rains, and the flash floods resulted in uprooted trees (Figure 5.13), the loss of green/unripe fruit and other agricultural yields, and demolished terraces.

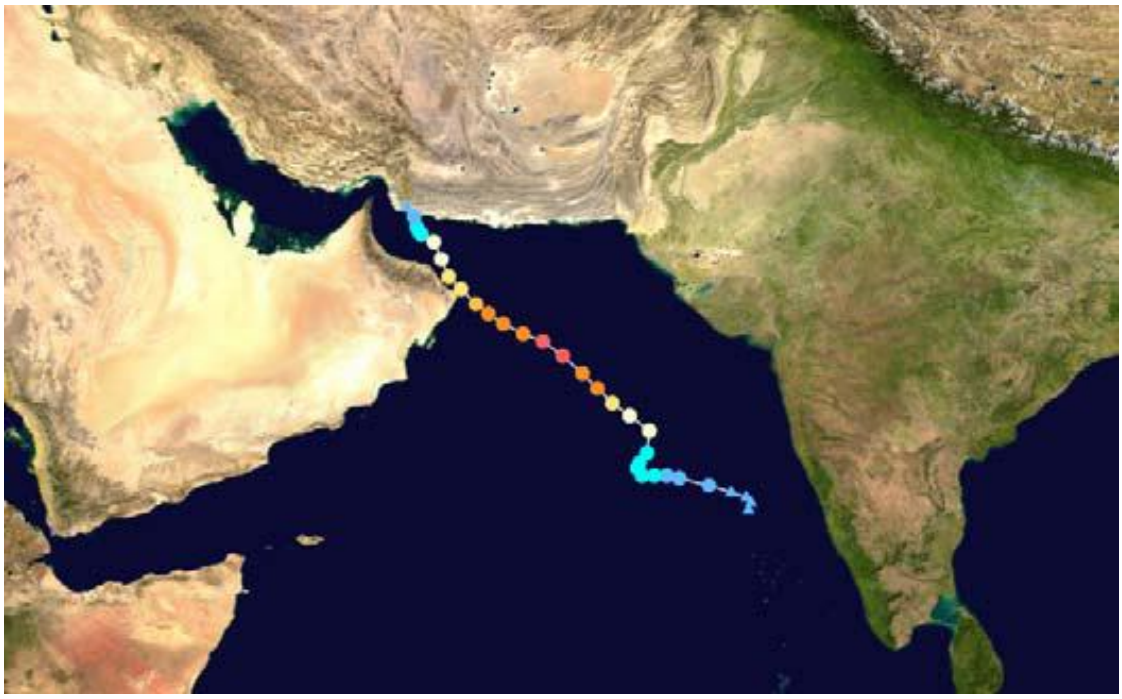


Figure 5.12 Cyclone Gunu hit Oman in June 2007. Its route is shown.
Source: MOTC, 2009.

Figure 5.13 The effect of cyclone Phet 2010 on agriculture in the AAR.

Oral history, climate records, and specialised studies, such as Luedeling et al (2009), suggest that climate change has already affected the AAR. Bürkert et al (2007: 8) said,

> "According to the oases' inhabitants, in the past decade a third of the original area of terraces has been gradually abandoned, as a result of the increasing shortage of water. The farmers blame this on the steady decline in precipitation that has taken place over the past few decades'.

In their study of the high-altitude fruit production systems of the AAR, Luedeling et al. (2009) concluded that "cultivation of temperate crops in the oases of the region represents an increasing risk for farmers, because the annual chilling hours are not always sufficient to ensure fructification'' (Luedeling et al, 2009:91-92). Their conclusions used correlated temperatures at the oases and hourly temperatures recorded at the nearby weather station in Saiq to estimate the chilling hours at each oasis. The rate of decline in chilling hours was significant, with the annual total decreasing, on average, 17.4 hours per year - a 66% reduction. Furthermore, they warned that:

> "Horticultural systems that are based on such crops might not be able to survive, as trends over the past 24 years suggest that in the long run, the temperature niche for the cultivation of temperate crops and subtropical crops with chilling requirements is getting smaller in the Oman Mountains'' (Luedeling et al, 2009:106).

Further evidence suggests that yields were low in all oases in 2007, and again in 2010, because of hailstorms during the tree blossom seasons, tropical cyclone Gunu in June 2007 and cyclone Phet in 2010 (Figure 5.13) (Luedeling et al, 2009). The strength and frequency of these storms was uncommon in the region.

### 5.4.3. The negative impact of various actors in NR in the AAR

Participants in the study expressed issues in terms of the main human causes of environmental impacts in the AAR. Firstly, both government officials and local people (Table 5.27 and Table 5.28) saw two main culprits: tourists and pastoralists. The environmental impact of tourists was the most significant with 57.5% of officials and 72.5% of local people agreed on their negative impact on the NR of the region (Tables 5.27 and 5.28).

Table 5.27 Negative impact on NR from various actors in the AAR. Views of government officials.

| | rank order | Mean score | Sum | Distribution | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 5 | 4 | 3 | 2 | 1 |
| 1 | Tourists. | 3.54 | 425 | 26 | 43 | 27 | 18 | 6 |
| 2 | Pastoralists. | 3.43 | 411 | 16 | 53 | 23 | 22 | 6 |
| 3 | Farmers. | 2.92 | 350 | 11 | 35 | 22 | 37 | 15 |
| 4 | Non-governmental organizations. | 2.79 | 335 | 4 | 52 | 50 | 24 | 17 |
| 5 | Tribes. | 2.60 | 312 | 3 | 14 | 54 | 30 | 19 |
| 6 | Government departments. | 2.27 | 272 | 1 | 17 | 22 | 53 | 27 |
| total respondents= 120 | | | | | | | | |
| 1 = strongly disagree, 2 = disagree, 3 = not sure, 4= agree, and 5= strongly agree. | | | | | | | | |

Table 5.28 Negative impact on NR from various actors in the AAR. Views of local people.

| | rank order | Mean score | Sum | Distribution | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 5 | 4 | 3 | 2 | 1 |
| 1 | Tourists. | 3.92 | 470 | 42 | 45 | 18 | 11 | 4 |
| 2 | Pastoralists. | 3.34 | 401 | 23 | 43 | 19 | 22 | 13 |
| 3 | Non-governmental organizations. | 3.32 | 398 | 21 | 28 | 50 | 10 | 11 |
| 4 | Government departments. | 2.86 | 343 | 14 | 24 | 36 | 23 | 23 |
| 5 | Tribes. | 2.76 | 331 | 11 | 16 | 41 | 37 | 15 |
| 6 | Farmers. | 2.48 | 297 | 5 | 32 | 16 | 29 | 38 |
| total respondents= 120 | | | | | | | | |
| 1 = strongly disagree, 2 = disagree, 3 = not sure, 4= agree, and 5= strongly agree. | | | | | | | | |

Secondly, both government officials and local people accused each other and distanced themselves from having an impact (Tables 5.27 and 5.28). Officials ranked farmers third and locals ranked government departments fourth, while both ranked the tribes' impact as fifth, indicating the declining role of the tribe over the last two decades because of government control over the land and NR (Siegfried, 2000). The Basic Statute of the State (constitution) in 1996, stipulated that:

‘‘All NR are the property of the State, which safeguards them and ensures that they are properly utilised while taking into account the requirements of State security and the interests of the national economy, no concession may be granted, nor may any of the country’s public resources be exploited, except in accordance with the Law and for a limited period of time, and in such a manner as to preserve national interests’’ (Ministry of Legal Affairs, 1996:2).

Finally, the results also reflected some indecisiveness in officials’ responses; more than 42.5% (Table 5.27) were not sure or disagreed on the negative impact of these actors. This indecisiveness is attributable to the overlap effects in each group and to the lack of formal monitoring and studies.

Table 5.29 Negative impact on NR from tourism in the AAR. Views of government officials.

| Category | Region | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Al-Jabal | | Nizwa | | Muscat | | | |
| | count | % | count | % | count | % | count | % |
| Strongly Disagree | 1 | 6.3% | 3 | 10.7% | 2 | 2.6% | 6 | 5.0% |
| Disagree | 1 | 6.3% | 7 | 25.0% | 10 | 13.2% | 18 | 15.0% |
| Not sure | 3 | 18.8% | 6 | 21.4% | **18** | 23.7% | 27 | 22.5% |
| Agree | 9 | 56.3% | 6 | 21.4% | 28 | 36.8% | 43 | 35.8% |
| Strongly agree | 2 | 12.5% | 6 | 21.4% | 18 | 23.7% | 26 | 21.7% |
| Total | 16 | 100% | 28 | 100% | 76 | 100% | 120 | 100% |

Regionally, 69% of Al-Jabal officials and just over 60% of Muscat officials agreed on the negative impact of tourists, but this contrasted with the 43% of Nizwa officials who agreed (Table 5.29). Al-Jabal officials clearly recognized the tourists’ impact in relation to the readiness of the region for growing tourism demands - an issue that Nizwa officials might have overlooked. These results correlate to the highly recognized recreational value and aesthetic significance of the AAR discussed in Section 5.2. The officials who supported and encouraged tourism, recognising its importance as a source of revenue, did not want to criticize tourism and accuse it of having a negative impact on the region and its NR.

Therefore, they may have underestimated the negative impact of tourists on the NR of the region.

Those government officials and local people who believed that tourists were having a negative impact on NR justified this by their answers to questions raised in the interviews. They felt that differences in tourist qualities and environmental awareness, degrees of indifference to preserving the environment, the absence of formal monitoring and follow-up, and the absence of penalties for all violators contribute to the negative impact of tourists on NR (Table 5.30). Despite the large number (101,879) of tourists who visit the region, there is no visitor centre to provide effective, high quality natural and cultural information.

Table 5.30 Government officials and local people' perceptions of reasons for tourists' impact on NR in the AAR.

| No | Categories | Official responses | | Local people responses | |
|---|---|---|---|---|---|
| | | Count | Percent | Count | Percent |
| 1 | Tourists' quality* and their environmental awareness | 22 | 73.3% | 16 | 80% |
| 2 | Careless about preserving the environment | 19 | 63.3% | 13 | 65% |
| 3 | The absence of formal monitoring | 15 | 50% | 15 | 75% |
| 4 | The absence of penalties for violators | 15 | 50% | 16 | 80% |
| Total of respondents are 40 of government officials and 30 of local people.<br>* Tourists' quality: excellence of the tourist in terms of their age and level of education, as well as their cultural and environmental awareness. | | | | | |

The negative effects of tourists include cutting trees for cooking and barbecuing, burning herbs and trees during camping, and destroying rare herbs and shrubs under the wheels of cars. They also include hunting birds and some rare wild animals, plucking fruit from wild fruit trees and fruit groves before it is ripe, and disposing of waste inappropriately. This waste causes pollution, harms sheep and goats when they eat it, and encourages the proliferation of harmful insects. More disturbingly, some officials in the Ministry of Environment and Climate Affairs not only recognized the severity of the negative effects of tourists, but also

suggested that overgrazing and feral donkeys exacerbated the impact. Those officials recognized that there could be no regeneration of existing trees, and that efforts to promote strict conservation were limited, yet the natural recovery progress needs intensive governmental intervention and cooperation from local people.

These results clearly agree with many international study results regarding the impact of tourism on the environment (UNEP, 2007; Kotios et al, 2009). For example, UNEP (2007) stated that the tourism industry commonly overuses water resources for hotels, golf courses and personal use of water by tourists. This can result in water shortages and degradation of water supplies, as well as generating a greater volume of wastewater. Despite the declining rate of international tourism in 2009, the United Nations World Tourism Organization (UNWTO) forecasts international tourism to grow between 3% and 4% in 2011 (UNWTO, 2010). Domestic tourism is even greater in numbers (Ministry of Tourism, 2010). Over time, increasing numbers of tourists have magnified the pressures on the environment and caused severe negative impacts on its NR, which many researchers have exposed. These negative environmental impacts are likely to increase in the future.

Table 5.31 Negative impact on NR from government departments in the AAR; views of government officials.

| Category | Region | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Al-Jabal | | Nizwa | | Muscat | | | |
| | count | % | count | % | count | % | count | % |
| Strongly Disagree | 7 | 43.8% | 5 | 17.9% | 15 | 19.7% | 27 | 22.5% |
| Disagree | 6 | 37.5% | 15 | 53.6% | 32 | 42.1% | 53 | 44.2% |
| Not sure | 3 | 18.8% | 4 | 14.3% | 15 | 19.7% | 22 | 18.3% |
| Agree | 0 | 0% | 4 | 14.3% | 13 | 17.1% | 17 | 14.2% |
| Strongly agree | 0 | 0% | 0 | 0% | 1 | 1.3% | 1 | .8% |
| Total | 16 | 100% | 28 | 100% | 76 | 100% | 120 | 100% |

Table 5.32 Negative impact on NR from government departments in the AAR; views of local people.

| Category | Count | Percent | Cumulative Percent |
|---|---|---|---|
| Strongly Disagree | 23 | 19.2 | 19.2 |
| Disagree | 23 | 19.2 | 38.3 |
| Not sure | 36 | 30.0 | 68.3 |
| Agree | 24 | 20.0 | 88.3 |
| Strongly agree | 14 | 11.7 | 100.0 |
| Total | 120 | 100.0 | |

Officials largely reject the idea of any negative impact to NR caused by them or their regimes (Table 5.31). They believe that they play a favourable role in protecting these resources and they see themselves as being in charge of NR management. However, not all ministries responsible for NR management observe this role consistently. Government officials do not consider ignored duties, such as monitoring and implementing regulations, to be an indirect cause of damage to NR. However, Oman does have a high level of regulation - a mix of environmental laws that contain primary legislation (Sultani Decrees), secondary legislation (Ministerial Decisions), international treaties, conventions, and protocols. These legislations make Oman one of the few countries in the Gulf region with a high-level of nationally integrated environmental policies (Eldridge and Rudd, 2009).

However, the weakness lies in the application of these laws. Some officials seem to condone environmental violations by authorizing projects without environmental assessments, flaunting nepotism and corruption, and adhering to a bureaucracy that has unrealistic requirements to protect the environment. Three scenarios demonstrate these positions. First, the results of the local peoples' survey revealed widely dispersed responses to government departments having a negative impact on NR in the AAR (19.2% strongly disagreed, 19.2% disagreed, 30% were not sure, 20% agreed, and 11.7% strongly agreed) (Table 5.32). These erratic views of residents suggest deficiencies in government department regimes. If the schemes results were consistent with their declared "theoretical" plans, there would be no dispute about impact.

Secondly, during the interviews, one local person related a case of how government deals with some projects in the region. He said:

> ‘‘Despite dwellers’ opposition, the government permitted an investor to establish productive poultry projects… this because the investor is well known for his tribe and wealth; the government gave many facilities for the project to be constructed, among these constructing a road to the project area. The government also ignored the negative environmental impacts that could result from the project such as stench that may be emitted from the barns, and groundwater contamination as a result of leakage of contaminated water by chickens’ dung especially at the rainfall times’’.

Thirdly, the normally peaceful Sultanate of Oman experienced popular protests in March 2011, demanding an end to corruption, among other demands for political and social reforms, higher wages, more jobs, and the removal of some government ministers. In response, Sultan Qaboos fired a number of cabinet ministers and assigned ten new faces, amongst whom were three ministers in charge of NR management (Oman Daily Observer, 2011; Future Directions International, 2011). Similarly, local people, who are mainly farmers, largely reject any negative impact caused by them to NR in their area (Table 5.33).

Table 5.33 Local people’ perceptions regarding negative impact of farmers on NR in the AAR.

| Category | Count | Percent | Cumulative Percent |
|---|---|---|---|
| Strongly Disagree | 38 | 31.7 | 31.7 |
| Disagree | 29 | 24.2 | 55.8 |
| Not sure | 16 | 13.3 | 69.2 |
| Agree | 32 | 26.7 | 95.8 |
| Strongly agree | 5 | 4.2 | 100.0 |
| Total | 120 | 100.0 | |

It seems that all parties retreat from taking responsibility for any negative impact on the environment and NR. This raises the question of responsibility. Despite being in an arid region, the AAR offers land, water, and climate conducive to temperate regions’ plant growth and rich yielding husbandry. However, the largest proportion of the sustainability of this regions’ agriculture is the responsibility of farmers. Farmers must be accountable for their agricultural practices. Irrigation systems, which reduce water consumption, controlled

methods for agricultural pests that do not pollute or harm the environment, fertilizers that will not contribute to water contamination, and non-erosive cultivating practices can achieve sustainability. These conditions and practices were available three decades ago in traditional farming systems that relied on organic materials and established continuous productivity of agricultural land as the main priority. However, 30.9 % of local people either agree or strongly agree that they do have a negative impact. This can be justified as the region's farms, as in most of Oman, are now gradually depend on expatriate workers who may be not at same level of caution about their agricultural activity as the locals do. Moreover, at present, rapid development, life style changes, and modernization shroud agricultural sustainability in ambiguity. If the current agriculture conditions in the AAR persist, agricultural sustainability will be in jeopardy.

### 5.4.4 Malpractices: reasons for pressures and threats on NR in the AAR

The third underlying reason for the vulnerability of NR in the AAR is malpractice. Tables 5.34 and 5.35 illustrate examples. Government officials and local people agreed on the top two malpractices: the influence of market value and the influence market demand. However, beyond that, there is disagreement. Firstly, government officials did not recognize the association between vulnerability of NR and corruption; slightly less than half (48.3%) disagreed on this association (Table 5.34). This contrasted with the 47.5% of local people who agreed with this association (Table 5.35). Secondly, government officials (46.6%) perceived the conflict with local cultural practices as the third malpractice that could threaten NR in the AAR, while 42.5% of local people perceived this as the fifth malpractice (Tables 5.34 and 5.35).

Table 5.34 Government officials' perceptions regarding threat and pressure of malpractices on NR in the AAR.

| Rank order | | Mean score | Sum | Distribution | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 5 | 4 | 3 | 2 | 1 |
| 1 | The influence of high market value for resources. | 3.94 | 473 | 37 | 59 | 10 | 8 | 6 |
| 2 | The influence of high demand for resources. | 3.68 | 442 | 24 | 51 | 34 | 5 | 6 |
| 3 | Conflict with local cultural practices. | 3.31 | 397 | 12 | 44 | 35 | 27 | 2 |
| 4 | Difficulties in monitoring illegal activities. | 2.88 | 345 | 6 | 38 | 28 | 31 | 17 |
| 5 | Low rates of law enforcement. | 2.86 | 343 | 5 | 37 | 25 | 42 | 11 |
| 6 | Bribery and corruption. | 2.42 | 290 | 6 | 7 | 49 | 27 | 31 |
| Total respondents= 120 | | | | | | | | |
| 1 = strongly disagree, 2 = disagree, 3 = not sure, 4= agree, and 5= strongly agree. | | | | | | | | |

Table 5.35 Local peoples' perceptions regarding threat and pressure of malpractices on NR in the AAR.

| Rank order | | Mean score | Sum | Distribution | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 5 | 4 | 3 | 2 | 1 |
| 1 | High market value for resources. | 3.93 | 472 | 54 | 34 | 12 | 10 | 10 |
| 2 | High demand for resources. | 3.61 | 469 | 37 | 51 | 21 | 6 | 5 |
| 3 | Low rates of law enforcement. | 3.48 | 418 | 27 | 40 | 26 | 18 | 9 |
| 4 | Bribery and corruption. | 3.39 | 407 | 22 | 35 | 39 | 16 | 8 |
| 5 | Conflict with local cultural practices. | 3.20 | 384 | 14 | 37 | 38 | 21 | 10 |
| 6 | Difficulties in monitoring illegal activities. | 3.00 | 360 | 12 | 37 | 30 | 21 | 20 |
| Total respondents= 120 | | | | | | | | |
| 1 = strongly disagree, 2 = disagree, 3 = not sure, 4= agree, and 5= strongly agree. | | | | | | | | |

Apart from the first and second variables, the likely explanation for this result lies in officials' unfamiliarity with transparency and disclosure; these practices do not happen as a matter of course in government departments. Some officials consider issues such as bribery and corruption, monitoring difficulties, and inadequate law enforcement unapproachable red lines that maintain the secrets, confidentialities, and credibility of government work. Clearly, officials want to protect themselves by not revealing government ''secrets''.

Regionally, there is virtually no difference among government officials' with regard to the high market value of NR products, as almost 80% of each group agreed on this issue (Table 5.36).

Table 5.36 The high market value of AAR resources as seen by government officials.

| Category | Region | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Al-Jabal | | Al-Jabal | | Muscat | | | |
| | count | % | count | % | count | % | count | % |
| Strongly Disagree | 0 | 0% | 1 | 3.6% | 5 | 6.6% | 6 | 5% |
| Disagree | 3 | 18.8% | 2 | 7.1% | 3 | 3.9% | 8 | 6.7% |
| Not sure | 0 | 0% | 2 | 7.1% | 8 | 10.5% | 10 | 8.3% |
| Agree | 8 | 50% | 17 | 60.7% | 34 | 44.7% | 59 | 49.2% |
| Strongly agree | 5 | 31.2% | 6 | 21.4% | 26 | 34.2% | 37 | 30.8% |
| Total | 16 | 100% | 28 | 100% | 76 | 100% | 120 | 100% |

These results, concerned with the influence of strong demands for vulnerable AAR resources, revealed that government officials and local people acknowledge the basic controls of supply and demand. They also revealed the extent of interdependence between supply and demand that determines the market price. The most important reason for high market value is excess demand (Arestis and Sawyer, 2005). Both groups of responses suggest an excess demand for products for human consumption and for amenities in the region. As stated in Part 5.2, the high quality and flavour of some organically produced AAR products create a high market value. Problems arise when farmers or pastoralists try to increase production, use new methods of production, or at least attempt to maintain production to ensure a reasonable profit margin. For example, one government official in an interview stated that ‘‘an inexperienced farmer may use pesticides or chemical fertilizers that may lead to reduced yields, lessen the groundwater quality, and threaten the living creatures that are important for maintaining the ecological balance’’. Indeed, this happened when farmers used pesticides in the 1990s to eradicate the pomegranate butterfly. It led to a decrease in the pomegranate yield when the insects developed anti-resistance to parasite. Officials and experts in the Department of Agricultural Development made an urgent and necessary intervention, using Biological Control methods in all villages of Al- Jabal Al-Akhdar (MOA, 2009).

The high market value of the pomegranate fruit also provided stability for many farmers who preferred the cultivation of this fruit to any other fruit, abandoning crops cultivated in past generations. However, the agricultural status of the region has changed, the great diversity of plants is gradually diminishing, and the area is losing its traditional crops and one of its unique features (Buerkert and Schlecht, 2010). The research from January to August 2010 confirms the changes and many local people described situations in which their previous harvests no longer exist. Today, the scene in the region's farms, as it appears in Figure 5.14, is limited to pomegranate trees; Al-Jabal roses; garlic winter crop; and what remains of walnut trees. Other fruit trees are no longer grown and farmers are replacing those that are dead, or uprooted by wind, with pomegranate trees or roses.

Figure 5.14 Al-Jabal's terraces now are limited to pomegranate trees, Al-Jabal roses, garlic winter crop. Resource: (Buerkert and Schlecht, 2010).

These changes do not bode well for the survival of traditional pastoral scenery and its related livestock. Because of the high market value of Al-Jabal goats, shepherds increase numbers in order to obtain greater profits; thus, overgrazing, exacerbated by drought, negatively affects

pastoral resources. Wild olive trees, despite their ability to resist drought, are not resilient enough to resist the pastoralists' practice of cutting their branches to feed increasing numbers of grazing animals. These practices, along with the inability to regenerate and unstable climatic conditions, have decreased the numbers of wild olive trees and reduced their ability to grow. In addition to the pressures from tourists, altering productivity to meet increasing demands and gain higher financial income has also directly threatened NR in the AAR region.

The lowest ranked variable in the officials' results was corruption, although local people's views were different. Officials' results (Table 5.37) show their conflicting views, as the majority (40.8%) opted for the "Not Sure" preference. Despite the fact that 48.4% of the study sample did not believe corruption existed in the region, a minority of 10.8% did concede this might be an issue.

Table 5.37 Government officials' perceptions regarding the existence of corruption throughout the AAR.

| Category | Region | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Al-Jabal | | Nizwa | | Muscat | | | |
| | count | % | count | % | count | % | count | % |
| Strongly Disagree | 3 | 18.8% | 8 | 28.7% | 20 | 26.3% | 31 | 25.8% |
| Disagree | 4 | 25% | 9 | 32.1% | 14 | 18.4% | 27 | 22.6% |
| Not sure | 5 | 31.2% | 9 | 32.1% | 35 | 46.1% | 49 | 40.8% |
| Agree | 2 | 12.5% | 2 | 7.1% | 3 | 3.9% | 7 | 5.8% |
| Strongly agree | 2 | 12.5% | 0 | 0% | 4 | 5.3% | 6 | 5% |
| Total | 16 | 100% | 28 | 100% | 76 | 100% | 120 | 100% |

Table 5.38 Local people's perceptions regarding the existence of corruption throughout the AAR.

| Category | Count | Percent | Cumulative Percent |
|---|---|---|---|
| Strongly Disagree | 8 | 6.7 | 6.7 |
| Disagree | 16 | 13.3 | 20.0 |
| Not sure | 39 | 32.5 | 52.5 |
| Agree | 35 | 29.2 | 81.7 |
| Strongly agree | 22 | 18.3 | 100.0 |
| Total | 120 | 100.0 | |

Local people's opinions disagreed with officials' views and they identified corruption as an issue; the majority of them (47.5%) agreed and strongly agreed (Table 5.38). With the government committing much of its budget to tackling Oman's most pressing challenges, from the instability of financial markets to achieving social welfare, corruption (the hidden disease) remains an obstacle to achieving much needed progress. The 2010 Corruption Perceptions Index shows Oman among the three quarters of the 178 countries in the index whose score below five, on a scale from 10 (very clean) to 0 (highly corrupt). Despite its advanced regional position (4$^{th}$ in Middle East and North Africa) in transparency, and its moderate ranking of 41$^{st}$ of 178 states internationally (Transparency International, 2010), these results indicate a serious corruption problem in Oman.

Although the Sultan has repeatedly made clear that abuse of power will not be tolerated, there are persistent accusations and suspicions of bribery, misuse of public office, and breach of trust. The combination of governmental and private positions in the management of NR may not be in the interest of these resources. ''Conflict of interests among the ruling elite is common practice. Many cabinet members and senior office holders were involved (either personally or through their relatives) in businesses that benefit from public contracts. Four of Oman's largest holding companies are controlled by two special advisers to the Sultan (the previous minister of agriculture and the previous minister of commerce and industry) either directly or via their children'' (Bertelsmann Stiftung, 2009:7). Undoubtedly, these practices are against Article (53) of the Basic Statute of the State that forbids Members of the Council of Ministers from combining their position with Board membership on any joint stock company, and from dealing with any entity in which they have an interest, whether direct or indirect (Ministry of Legal Affairs, 1996).

Faced with undesirable situations about state NR utilization, among other corrupt practices, March 2011 witnessed a demonstration of hundreds of people, demanding reform and accountability from government. Seven thousand activists from all over the Sultanate signed a bill of indictment seeking trials for corrupt ministers (including those in charge of NR) and submitted it to the Attorney General of Oman. Based on Article 11 of the Basic Statute of the State, the bill is about the economic principles that restrict the utilization of NR of the Sultanate of Oman, taking into consideration the requirements of the State's security and the interests of national economy (Ministry of legal affairs, 1996). To address corruption challenges, Oman's government needs to sign and act on the United Nations Convention against Corruption and promote integrity and combat corruption. This action would help to integrate anti-corruption measures with international commitments to eradicate financial and social problems, since this is the only global initiative that provides a framework for putting an end to corruption.

## 5.5 Summary

Appraisal of the environmental and socio-economic importance of the AAR and the audit of the status of the environment and NR in the area suggests the following summary.

The region's environment and its NR are unstable, with many threatening natural and human factors. Human factors have a severe impact on these resources. According to the views of government officials and locals, the region suffers from pressures and threats from a significant escalation in development and tourism activities, activities that could cause a wide range of negative influences. Studies conducted in the region have highlighted these threats

and pressures. For example, threat to the environment from the development expansion (Costa, 1983), overgrazing (COWI consult, 1991; Victor, 2008) and the long-term destruction of the vegetation of pastures (Buerkert and Schiecht, 2010). Climate change has also had a negative impact on the environment of the region. Most of the officials and locals declared this manifest in rising temperatures and decreasing rainfall resulting in unusual extensions of the duration of droughts. Studies of Bürkert et al. (2007), Luedeling et al, (2009) and Dorvlo et al (2009) support the accuracy of those declarations.

Government officials and locals indicated actors whose negative impacts affect the region's environment and its NR. Firstly, the irresponsible behaviours and activities of some tourists threaten the ecosystem and the associated pollution harms the environment. Secondly, pastoralists' overgrazing causes floral degradation. There has been a shift away from traditional grazing systems that allowed pasture regeneration and recovery. Finally, locals and officials classified the high market value of the regions' products and the increasing demand for these products as the most significant malpractices that harm the environment of the region and adversely affect the NR.

Ironically, whilst the local people noted that the region suffers from corruption, officials did not recognise this problem. However, any type of corruption can put pressure on the region's environment and its NR, the results of which may not be visible in the short term.

The results of this study revealed that the AAR had significant environmental importance in the Arabian Peninsula. Its unique geographical, geological, and agricultural characteristics represent a wide array of Oman's nature and landscape (mountains and interior desert plains).

The region is the source of the many wadies that descend in all directions towards the surrounding areas. Despite this, the region suffers from a water shortage, sometimes severe, because of the disruption of rainfall periods, population growth, the acceleration of development activities, and increasing consumption patterns linked to changes in life patterns influenced by modernization and globalization. Recognised for its biological diversity and its environmental significance, the region is unique and distinguished from other regions of the Arabian Peninsula. Its rangeland and shrub land harbours diverse flora and fauna. It is also a local centre for endemic plants. Moreover, as the climate varies with altitude, its agricultural crops also vary from the crops of the warm desert region (mostly dates and Alfalfa) to the crops of the cold summit regions (pomegranates, apricots and walnuts).

The AAR stands out as an exception to the harsh desert nature of Oman and delivers many advantages and attractions for tourism. Thus, officials and locals see the region characterized by substantial aesthetic and recreational value. Properly utilized, this value for tourism could ensure a good financial income for local communities and the State. This, in turn, could lead to socio-economic prosperity in the region. However, thus far, inefficient and corrupt officialdom has poorly handled the impacts of tourism - a situation that is unsustainable in its present form. Products of the region such as natural medicinal vegetation, agricultural crops, and handcrafts are important. Historically and culturally rooted in the region, the importance of these products is a result of their infrequent availability, quality, and originality, all of which ensure competitive prices. Many officials and locals agreed on the scientific and educational importance of the region, an issue echoed by researchers and scientists.

Despite the agreement of officials and locals on the biodiversity of Oman's natural oases, and on the quality and competitive prices of its products, most do not believe in the region's ability to continue to provide local communities with economic opportunities and livelihood because of economic, social, and developmental changes that impact on the potential of the region. The maintenance of sustainability is a major present and future challenge for this region and sustainable control of the NR of the AAR will not only become more difficult but also more critical to the lives of the people living in the region.

# Chapter Six

## Government practices and effectiveness in NRM in the AAR.

### 6.1 Introduction:

Management systems are normally characterised by planning, implementation and evaluation and are generally part of an iterative process (Hockings et al, 2000). Based on this, an evaluation of the management cycle could focus on questions and information about these phases, as presented in Figure 6.1. Such an examination would include: a) the goals and the objectives to be achieved and the vision set to define them; b) an environmental assessment, which would include and clarify the current status of natural resources (NR) and the pressures and threats that affect the ability to achieve the objectives; c) the environmental management plan; d) the implemented plan, evaluating the management inputs mapped against objectives e) the management outputs, and success in achieving the objectives; and f) the management system, identifying the weaknesses and the strengths to support changes to the plan as appropriate (Hockings et al, 2000; Ervin, 2003).

This chapter presents an analysis of government practices in natural resource management (NRM) in the AAR. These practices are purported to be based on SEK. As such, their analysis addresses the second aim of the study, to determine the nature of current government practices in NRM.

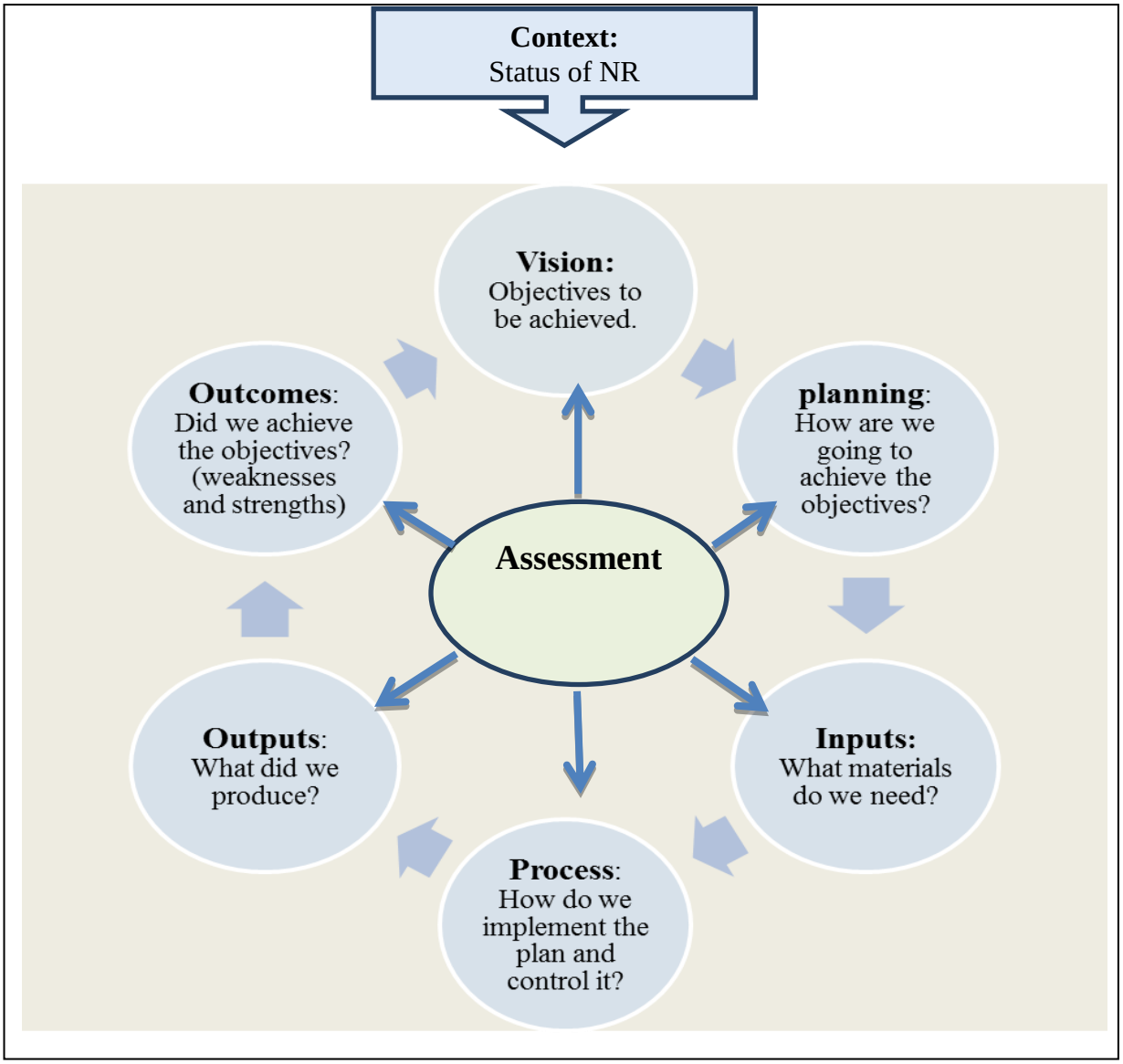



Figure 6.1 The management cycle and assessment.
Source: adapted from Hockings et al, 2000.

## 6.2 The government officials' responses regarding the natural resources management plan and objectives

Three categories can be identified in Table 6.1. Firstly, government officials saw that sustainability, local knowledge and local community support were the most prominent features of the plan's objectives, as these elements were ranked highly. A total of 60.8% of officials agreed or strongly agreed that sustainability was a key issue in the NRM plan for the region, 56.6% of them saw that local knowledge was incorporated in NR plans, and 58.3% of

them agreed that the support of local communities to protect NR was among the plan's objectives (Table 6.1). Moreover, although 18.4% of Muscat officials did not feel that sustainability was a key issue in the NRM plan only 6.3% of al-Jabal officials and 10.7% of Nizwa officials agreed that it was (Table 6.2). This did not indicate statistically significant regional differences (Table 6.3).

Table 6.1 Management Plan and Objectives: Views of Government Officials.

| | Management plan and related objectives Rank order | Mean score | Sum | Distribution | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 5 | 4 | 3 | 2 | 1 |
| 1 | Sustainability is a key issue in the NRM plan. | 3.58 | 429 | 14 | 59 | 29 | 18 | 0 |
| 2 | Local knowledge is incorporated in NR plans. | 3.43 | 411 | 12 | 56 | 25 | 25 | 2 |
| 3 | Local communities support NR protection objectives. | 3.40 | 408 | 9 | 61 | 28 | 13 | 9 |
| 4 | Management plans contain specific NR-related objectives. | 3.25 | 390 | 9 | 49 | 35 | 17 | 10 |
| 5 | Conflicts over NR are planned to be solved by local customs. | 3.22 | 386 | 6 | 47 | 42 | 17 | 8 |
| 6 | NR-related regulations are considered in project plans. | 3.21 | 385 | 9 | 50 | 31 | 17 | 13 |
| 7 | An obligatory legal protection is available. | 3.21 | 385 | 11 | 45 | 33 | 20 | 11 |
| 8 | NR protection is considered in land use plans. | 3.08 | 370 | 8 | 38 | 33 | 38 | 3 |
| 9 | The NRM plan is based on adequate policy. | 2.89 | 347 | 2 | 36 | 40 | 31 | 11 |
| Total of respondents = 120 | | | | | | | | |
| 1 = strongly disagree, 2 = disagree, 3 = not sure, 4= agree, and 5= strongly agree. | | | | | | | | |

Table 6.2 Sustainability as a Key Issue in the NRM Plan: Views of Regional Government Officials.

| Category | Region | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Al-Jabal | | Nizwa | | Muscat | | | |
| | Count | % | Count | % | Count | % | Count | % |
| Strongly disagree | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% |
| Disagree | 1 | 6.3% | 3 | 10.7% | 14 | 18.4% | 18 | 15.0% |
| Not sure | 6 | 37.5% | 5 | 17.9% | 18 | 23.7% | 29 | 24.2% |
| Agree | 8 | 50.0% | 16 | 57.1% | 35 | 46.1% | 59 | 49.2% |
| Strongly agree | 1 | 6.3% | 4 | 14.3% | 9 | 11.8% | 14 | 11.7% |
| Total | 16 | 100.0% | 28 | 100.0% | 76 | 100.0% | 120 | 100.0% |

Table 6.3 Chi-Square Tests Measuring Differences between Al-Jabal, Nizwa, and Muscat on the Item "sustainability is a key issue in NRM plan''.

| | Value | df | Asymp. Sig. (2-sided) | Exact Sig. (2-sided) | Exact Sig. (1-sided) | Point Probability |
|---|---|---|---|---|---|---|
| Pearson Chi-Square | 4.482[a] | 6 | .612 | .627 | | |
| N of Valid Cases | 120 | | | | | |
| a. 5 cells (41.7%) have expected count less than 5. The minimum expected count is 1.87. | | | | | | |
| b. The standardized statistic is -.645. | | | | | | |

Secondly, 48.3% of government officials agreed or strongly agreed that the management plan contained specific NR-related objectives: 43.3% that the plan would solve conflicts over NR by local customs; 49.2% that regulations related to NR are considered in project plans; and 46.6% that an obligatory legal protection is available for NR (Table 6.1). Finally, the majority of government officials agreed or strongly agreed NR protection was not considered in the land use plans and that the NRM plan was not based on adequate policy, as more than 50% of them disagreed or were not sure about these features (Table 6.1).

The higher scores of the officials who agreed that sustainability was a key issue in the NRM plan suggest a higher understanding of the importance of sustainability. These perceptions coincide with the current worldwide trend toward sustainability, the concept that dominates environmental discourse (Goodland, 1995; McMichael et al, 2003; Vlek and Steg, 2007). The discrepancy lies in the fact that, whilst government officials perceived sustainability as a key issue in the NRM plan, 35% of them disagreed and 33.3% of them were not sure (Table 6.1) that the NRM plan was based on adequate policy. These results suggest that the policies of NRM do not stipulate and support sustainability as far as they might. This was confirmed by the 34.2% of officials who perceived that NR protection was not considered in land use plans, and by the surprising uncertainty demonstrated by the 27.5% who were not sure if it was (Table 6.1). The Principles of Sustainable Development should guide any such plan and environmental protection should comprise an integral part of the development process, and should not be isolated from it. In addition, in order to protect NR, effective environmental laws should be enacted to penalise those who inflict environmental damage and compensate victims of environmental damage (Lafferty and Hovden, 2003; Lafferty et al, 2004). However, although the Sultanate of Oman has many environmental laws in place, including one Royal Decree on the conservation of the environment and the prevention of pollution,

and although Ministerial decisions have been made to regulate the management of natural resources, monitoring and evaluation of the environmental impact of proposed activities that are likely to have a significant adverse impact on the environment are uncommon (FAO, 2003; Victor, 2009).

It is axiomatic that plans of NRM and associated programmes are based on policies and legislation adopted (in force) to maintain the sustainability of these resources. To verify to what extent the policies and legislation include the concept of sustainability, the researcher conducted a content analysis of the Law on Conservation of the Environment and Prevention of Pollution issued by the Royal Decree No 114/2001. Table 6.4 illustrates the results of this analysis. As indicated in that table, sustainability was not mentioned directly as a concept, nor were sustainable natural resources management (SNRM) and NRM, but reference was made to sustainable development. In fairness, the Law issued by Royal Decree considered many aspects of the environment and environmental preservation such as natural resources, ecosystems, exploration, exploitation of natural resources, and nature conservation areas. This might justify the perspectives of the drafters of the law, as they cited synonyms or implications of sustainability. However, this does take away the importance of emphasizing the necessity of embedding the specific concept of sustainability into important environmental laws.

Table 6.4 Content analysis of themes and concepts related to SNRM in the Law on Conservation of the Environment and Prevention of Pollution, Oman

| Themes and concepts related to SNRM | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sustainability | | NR | | NRM | | SNRM | | Sustainable development | |
| Count | % | Count | % | Count | % | Count | % | Count | % |
| 0 | 0% | 6 | .15% | 0 | 0% | 0 | 0% | 2 | .05% |
| % is the result of number of times a phrase is mentioned out of all of the words number. | | | | | | | | | |

Interestingly, whilst 56.6% of government officials saw the issue of local knowledge incorporated in NR plans to be important, 22.5% of them contradicted this perception (Table 6.1). This rather contradictory result is difficult to explain, but it might be explained either by the fact that the officials of al-Jabal and Nizwa (Table 6.5) considered the current extent of local knowledge integration into the NRM plan sufficient or that the officials from Muscat underestimated this issue.

Table 6.5 Local knowledge integration into the NRM Plan: .Views of regional government officials.

| Category | Region | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Al-Jabal | | Nizwa | | Muscat | | | |
| | Count | % | Count | % | Count | % | Count | % |
| Strongly disagree | 1 | 6.3% | 0 | 0% | 1 | 1.3% | 2 | 1.7% |
| Disagree | 1 | 6.3% | 4 | 14.3% | 20 | 26.3% | 25 | 20.8% |
| Not sure | 4 | 25.0% | 5 | 17.9% | 16 | 21.1% | 25 | 20.8% |
| Agree | 9 | 56.3% | 15 | 53.6% | 32 | 42.1% | 56 | 46.7% |
| Strongly agree | 1 | 6.3% | 4 | 14.3% | 7 | 9.2% | 12 | 10.0% |
| Total | 16 | 100.0% | 28 | 100.0% | 76 | 100.0% | 120 | 100.0% |

An examination of the published plans of Omani ministries in charge of natural resources, such as the Ministry of Regional Municipalities and Water Resources, shows that this planning adopts two parallel approaches. First, the declared plan of the Ministry relies on the application of methods in the preparation of proposals for the five years development plans and the investment programmes that cover municipal and water projects and other activities. Second, explicit attention is given to traditional knowledge related to the systems providing irrigation water that are locally known as Aflaj. This is evidenced by the attention given to the maintenance of these Aflaj and by the provision of the necessary financial and technical support, in consultation with the local Wakil (agent) of al-Falaj, to ensure the continued flow of water through the Aflaj. It is also evidenced by the interest in documenting the knowledge of the Aflaj system and related management methods: for example the adoption of five Omani Aflaj in UNESCO's World Heritage List and the publication of many books on the subject (MRMWR, 2008).

The Ministry of Agriculture, conversely, has a poor documentation record of its efforts to maintain the agricultural and livestock legacy despite its efforts to maintain an acceptable record of production in these areas. For example, the present study revealed that sections of the agricultural and livestock inheritance were not activated at the local, regional or national levels. When officials were asked about the reasons for this, they attributed it to the lack of qualified personnel in these areas. One wonders, with the Ministry having a history dating back to the date of the Omani renaissance (1970), why it did not have qualified employees to work in the department of agricultural and livestock inheritance, or why the Ministry continued to have this section in its administrative structure when little importance seems to be placed on it. However, the real situation on the ground suggests that the tradition, heritage and traditional knowledge in agricultural and livestock in the Sultanate of Oman are under threat, and need urgent intervention to sustain it (Dickhöfer, 2009). Responding to this, the Ministry does not oppose the use of conventional practices by farmers regarding agro-pastoral activities. However, this may be more due to the inability of the Ministry to control the farmers or to force them to adopt modern methods in agriculture, as well as to the inappropriate surface conditions and the land ownership system (small holdings of agricultural land).

The third category of officials' perspectives regarding the management plan and objectives is the NR policies that are incorporated in the NRM plan. A closer look at the different regional officials' perceptions (Table 6.6) reveals a clear distinction between Nizwa officials and both al-Jabal and Muscat officials in this regard. Only 25% of both al-Jabal and Muscat officials perceived that NRM in the AAR was based on an adequate policy, yet 53.6% of Nizwa officials agreed with this perception (Table 6.6).

Table 6.6 Perspectives of regional government officials regarding the adequate policy for NRM.

| Category | Region | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Al-Jabal | | Nizwa | | Muscat | | | |
| | Count | % | Count | % | Count | % | Count | % |
| Strongly disagree | 2 | 12.5% | 0 | 0% | 9 | 11.8% | 11 | 9.2% |
| Disagree | 6 | 37.5% | 5 | 17.9% | 20 | 26.3% | 31 | 25.8% |
| Not sure | 4 | 25.0% | 8 | 36.8% | 28 | 36.8% | 40 | 33.3% |
| Agree | 4 | 25.0% | 15 | 53.6% | 17 | 22.4% | 36 | 30.0% |
| Strongly agree | 0 | 0% | 0 | 0% | 2 | 2.6% | 2 | 1.7% |
| Total | 16 | 100.0% | 28 | 100.0% | 76 | 100.0% | 120 | 100.0% |

A chi-square test was performed but no significant association was found between regional officials and their perceptions about adequate policies for NRM, X2 (8, N = 120) = 13.65, p =.091 (Table 6.7).

Table 6.7 Chi-Square Tests between regional officials and their perception about the adequate policy for NRM.

| | Value | df | Asymp. Sig. (2-sided) | Exact Sig. (2-sided) |
|---|---|---|---|---|
| Pearson Chi-Square | 13.650a | 8 | .091 | .090 |
| N of Valid Cases | 120 | | | |
| a. 7 cells (46.7%) have expected count less than 5. The minimum expected count is .27. | | | | |
| b. The standardized statistic is -.575. | | | | |

This difference is probably explained by the observation that officials of al-Jabal are directly responsible for the practical application of a management plan that has been formulated centrally in Muscat and are thus aware of the terms and directions contained in the plan. At the same time, the presence of Ministry experts and academics from Sultan Qaboos University in Muscat may also influence this result, as they are involved in evaluating the plans and conducting the necessary research; they must be critically informed of these plans. Nizwa officials, despite their supervisory professional tasks, may be aware of only the more major plans and many interviewees referred to this as a weakness in the management system of the region.

However, as depicted in the preceding chapter, Oman already has a high level of regulation, with a mix of environmental laws that contain primary legislation (Sultani Decrees),

secondary legislation (Ministerial Decisions), international treaties, conventions, and protocols (Table 6.8). These legislations make Oman one of the few countries in the Gulf region that has a high-level of nationally integrated environmental policies, supposedly to organize institutional work and protect the environment simultaneously. It is clear that the problem lies in the application of these environmental policies (Solomon and Burt, 1999; Silecchia, 2004).

Table 6.8 Examples of environmental laws and legislations in Oman.

| No | Regulation title | Year of issue |
|---|---|---|
| 1 | Water Resources Development Law. | 1977 |
| 2 | Regulation for the management of solid non-hazardous waste | 1993 |
| 3 | Regulation for the Management of Hazardous Waste | 1993 |
| 4 | Issuing the Law of Handling and Use of Chemicals | 1995 |
| 5 | Amendment of some conditions of the Law of Establishment of National Parks and Natural Protected Areas | 1995 |
| 6 | Ministerial Resolution No. 5 of 17 May 1986 issuing the Regulation of the wastewater reuse and discharge, | 1986 |
| 7 | Water Wealth Protection Law, and The Two Executive<br>- Regulations on Wells And Aflaj<br>- The Use of Desalination Units on Wells | 2000 |
| 8 | Environmental protection and pollution control | 2001 |
| 9 | The law of nature reserves and wildlife conservation | 2003 |
| 10 | National strategy to preserve Omani environment. | 1986 |
| 11 | National biodiversity strategy and action plan | 2000 |

Only 8.3% of the government officials (Table 6.1) perceived that protection of NR is considered in the land use plans. An interviewee in charge of the development of agriculture in the AAR said:

> ‘‘The increase in population and in construction works in al-Jabal al-Akhdar is inevitable, since each citizen has the right to possess his own house, as stipulated by the constitution of the Sultanate of Oman. In time where there is no adequate space for this expansion, the threat to the natural resources of al-Jabal al-Akhdar is always expected, and we have to choose between these two issues and to handle them in a smart/wise way’’.

This identifies the weakest link of land use and NRM plans. How can those officials avoid threats to the pastures and woodlands, with a lack of available space for development

expansion at a time where they face an increasing demand for residential, commercial, industrial and tourism land? In such a situation, in order to overcome the problem of lack of suitable space for housing and projects and to ensure sustainable development, laws concerning property ownership must be reviewed. For example, residents may have to accept the vertical expansion of housing (building multi-storey buildings).

In summary, as shown in Table 6.1, the contradictory perspectives of government officials about the general practices in NRM occur at a time when sustainability should be viewed as the strongest part of NRM practices. Policy implementation was perceived as the feeblest part suggesting that there is a real gap between the two situations, and this puts the achievement of sustainability in doubt. The following results of the government survey about the details of the NRM plan reveals more in this regard.

### 6.3 The government official responses regarding management inputs

According to the survey, the input scores (Table 6.9) from the government officials' perspectives, were below the median level (less than 50% of officials agreed on the adequacy of these elements), especially those relating to staffing, information adequacy and budget reliability. It appears that these basic inputs for the NRM plan were missing, and that there was often little security perceived for the future. Transportation infrastructure and field equipment scored better than other inputs.

Table 6.9 Infrastructure, equipment and funding are sufficient in NRM plan: Views of government officials.

| | Management inputs Rank order | Mean score | Sum | Distribution | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 5 | 4 | 3 | 2 | 1 |
| 1 | Adequacy of transportation infrastructure. | 3.58 | 430 | 17 | 65 | 12 | 23 | 3 |
| 2 | Adequacy of field equipment. | 3.28 | 393 | 3 | 53 | 42 | 18 | 4 |
| 3 | Effectiveness of communication with local communities. | 3.23 | 388 | 8 | 53 | 28 | 21 | 10 |
| 4 | Adequacy of current funding | 3.16 | 379 | 4 | 32 | 66 | 15 | 3 |
| 5 | Adequacy communication between field and office staff. | 3.08 | 396 | 0 | 53 | 35 | 20 | 12 |
| 6 | Suitability of tourism infrastructure. | 3.02 | 362 | 6 | 35 | 42 | 29 | 8 |
| 7 | Suitability of expenditures allocation. | 3.00 | 360 | 5 | 31 | 46 | 29 | 6 |
| 8 | Adequacy of relevant information for management. | 2.95 | 354 | 1 | 36 | 46 | 30 | 7 |
| 9 | Reliability of funding. | 2.88 | 346 | 4 | 21 | 57 | 33 | 5 |
| 10 | Sufficient staff. | 2.45 | 294 | 3 | 9 | 51 | 33 | 24 |
| Total of respondents = 120 | | | | | | | | |
| 1 = strongly disagree, 2 = disagree, 3 = not sure, 4= agree, and 5= strongly agree. | | | | | | | | |

Generally, the government officials' perceptions of the sufficiency of management inputs can be subdivided into three dominant inputs, four inputs that are deemed relatively less available in the plan, and three inputs that were regarded as hardly available in the plan. A total of 68.4% of the government officials (Table 6.9) agreed or strongly agreed that transportation infrastructure as the most adequate part of the management plan.

Given the relatively high values that were given to the transportation infrastructure and field equipment, one might question the reasons for this result, whilst responses to the elements of staffing and financial management were relatively low. However, the responses are compatible with the current state of transportation infrastructure. There is an appropriate road network covering the region that links villages to each other and a trunk road linking the region to surrounding areas. The state's interest in the development of transportation infrastructure suggests a recognition of the basic requirements to operate effectively, and to achieve a clear management presence for natural resources. Indeed, transport infrastructure development is well recognised as a framework for developing a sustainable outcome. However, some bottom line requirements to promote the benefit from transport infrastructure are:

> ‘‘1) support economic vitality while developing infrastructure in a cost-efficient manner. Costs of infrastructure must be within a society’s ability and willingness to pay; 2) meet social needs by making transportation accessible, safe, and secure; include provision of mobility choices for all people (including people with economic disadvantages); and 3) develop infrastructure that is an asset to communities; and create solutions that are compatible with the natural environment, reduce emissions and pollution from the transportation system, and reduce the material resources required to support transportation’’ (Center for Environmental Excellence by AASHTO, 2009:2).

This interest corresponds with commonly recognized beliefs about the strong relation between the adequacy of management inputs and general effective management (Leverington et al, 2010).

Government officials put the adequacy of field equipment in second place (Table 6.9), as 68.3% of the officials agreed or strongly agreed that the equipment was sufficient to achieve its purpose within the management of the plan. But 21.6% of the officials disagreed. This may be explained by the fact that officials who think field equipment to be adequate may have considered that if the equipment was available then there was no issue, whereas other officials considered both the availability of equipment and how efficiently it was used. This is referred to by one interviewee, when he said:

> ‘‘The problem of the NRM in the Sultanate of Oman, in particular, in this region is not the availability of field equipment as it is the effectiveness of the use of equipment to ensure the achievement of management objectives. This ineffectiveness is attributed to the lack of skilled staff who can effectively use of these equipment’’.

This issue is returned to in the following paragraphs.

Nearly half (47.5%) of Government officials agreed or strongly agreed that the level of staffing was insufficient to manage natural resources in AAR effectively (Table 6.9). Staff provide the direct line of professional responsibility in NRM as they do all the tasks and carry

the responsibilities. Any shortfall in staff numbers or in their levels of skill, will negatively affect performance quality, and thus negatively affect the other components of the NRM effort. However, the perspectives of the officials can be justified by the fact that the departments responsible for natural resources lack both the capability and the potential for sound management of natural resources. Two scenarios can demonstrate this situation. First, the deteriorating situation of some natural resources like water and pasture (see Chapter 5), which did not elicit the required attention from government officials, suggests a defective administrative structure of departments responsible for the management of these resources. This defect appears to be perceived by the government officials themselves as a lack of staff. Second, a closer look at the government officials' responses to the interview questions reveals a general consensus by officials that staff are under-trained, particularly training that draw on issues about SEK and TEK. In his explanation of the main obstacles facing the management of natural resources in the region, the Director of Nizwa Municipality at al-Jabal al Akhdar' Branch said:

> ''The main problem is the staff number, as we need a greater number of trained workers more than ever before…. Now we face challenges of declining water for human use, increasing pastoral activities, and increasing tourism demand. All of these challenges need to be dealt with in a prudent and responsible ways''.

In the same context, the Acting Director of the Environment and Climate Affairs Department in the Dakhiliyah Region said:

> ''In order to operate an appropriate monitoring for natural habitats, and to control activities that violate the environmental laws and regulations, we need a sufficient number of staff who can engage in such tasks, this sufficient number is not available to us now''.

The survey results suggest that there are four inputs deemed relatively less available in the management plan of the departments responsible for natural resources. These four inputs are the adequacy of current funding; communication between field and office staff; the suitability

of tourism infrastructure; and expenditure allocations (Table 6.9). It is interesting to note that only 30% of the government officials agreed that funding was adequate to carry out a sound NRM plan in the region whereas 55% of those officials were not sure (Table 6.9). A similar proportion of officials did not see that expenditures were suitably allocated, suggesting the susceptibility of the financial situation, and the extent of financial system deficiencies should be regarded as an important constraint on the NRM. Careful consideration of the completed and uncompleted projects in the field of environment, agriculture and water resources (Table 6.10) highlights the low amount of spend in those areas. This can explain the low value given by the officials to the financial aspects of the management plan. Furthermore, Table 6.10 does not illustrate any project implemented by the Ministry of Environment and Climate Affairs, which causes some confusion about the planning role of this ministry in this vital area. Although some officials, in the interviews, pointed to some protection projects such as the protected area, which had not received permission at that time, no reference can be found to these projects in the documents and publications issued by this Ministry.

Table 6.10 Some of the NR-related projects in Al-Jabal Al-Akhdar.

| N | Projects | Executing agency | Budget O Real | From To |
|---|---|---|---|---|
| 1 | Olive oil extraction. | MAF* | 73.500 | 2008 2012 |
| 2 | Production of rose water. | MAF | 12.385 | 2008 2011 |
| 3 | Construct genetic complex of deciduous trees. | MAF | 100.000 | 2009 2010 |
| 4 | Integrated management of pomegranate pests (Phase II) | MAF | 90.821 | 2008 2009 |
| 5 | Development of animal husbandry systems in the mountain villages and nomadic communities and Shuwwan** of the Interior Region. | MAF | 20.6250 | 2007 2008 |
| 6 | Establishing two surface storage dams in Wadi Alqunfor and Wadi Alsogereh | MRMWR*** | 244.425 | 2009 2010 |
| 7 | Establishing a surface storage dam in Wadi Qetm and raise the dam's wall in Wadi Saiq and Wadi Bani Habib. | MRMWR | 194.570 | 2009 2010 |

* Ministry of Agriculture and Fisheries (MAF)
**Shuwwan is a form of nomadism where shepherds seasonally transfer grazing animals (mainly goats) between the mountains and its piedmonts away from the desert areas.
*** Ministry of Regional Municipalities and Water Resources (MRMWR).
Source: http://maf-oman.faorne.net and http://www.mrmwr.gov.om

Regionalism was evident in the ratings and comments of the government officials. Table 6.11 shows that some of officials of Muscat were more likely to challenge the adequacy of the funding for the NRM plan, as only 21% of them agreed that funding was adequate, in contrast to 42.8% of the officials of Nizwa and 50% of the officials of al-Jabal who agreed that it was. The annual budget of NRM is identified centrally in Muscat and officials of Muscat may be more informed about expenditure allocations, and can better judge whether the funding of NRM in AAR is adequate or not. The Director General of Natural Conservation in the Ministry of Environment and Climatic Affairs quantified financial restrictions among several difficulties that prevent good management. He said,

> ‘‘Despite the several challenges encountered, such as the lack of availability of well-qualified persons from the same area, financial restrictions are another problem, which we have to adopt and cope with. Accordingly, these results show the extent of the assessment that is needed to develop the status of the NRM plan in the region, and that an appropriate proposal of adequacy amount of funding should be decided to enable effective management of these resources taking into account the fragile environment of the region’’.

Table 6.11 Perspectives of regional government officials regarding the funding adequacy in the NRM plan.

| Category | Region | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Al-Jabal | | Nizwa | | Muscat | | | |
| | Count | % | Count | % | Count | % | Count | % |
| Strongly disagree | 1 | 6.3% | 1 | 3.6% | 1 | 1.3% | 3 | 2.5% |
| Disagree | 1 | 6.3% | 3 | 10.7% | 11 | 14.5% | 15 | 12.5% |
| Not sure | 6 | 37.5% | 12 | 42.9% | 48 | 63.2% | 66 | 55.0% |
| Agree | 8 | 50% | 10 | 35.7% | 14 | 18.4% | 32 | 26.7% |
| Strongly agree | 0 | 0% | 2 | 7.1% | 2 | 2.6% | 4 | 3.3% |
| Total | 16 | 100.0% | 28 | 100.0% | 76 | 100.0% | 120 | 100.0% |

Communication between field and office staff was seen, by government officials, as a relatively weak input in the NRM plan, as only 44.2% of them agreed or strongly agreed that this communication was adequate whereas 29.2% of them were not sure (Table 6.9). This result is very interesting and may help explain the many perspectives that are present here. Vertical communication between actors at different levels of governance is very important for

both accountability and for planning differential policy responses and it also increases the trust between actors that helps facilitate cooperation (Andersson, 2004). Such cooperation is considered necessary for effective outcomes. This relationship can explain the negative perspectives adopted by the government officials about communication between field and office staff. Either side may not see the benefit from the communication and so do not communicate effectively.

Tourism infrastructure is another input seen by the government officials as relatively weak in the NRM plan. Only 34.2% of those officials agreed that the NRM plan relied on a suitable tourism infrastructure to facilitate the growing tourism activities, whereas 65.2% of them disagreed or were not sure about this. This negative perception reflected the poor status of tourism infrastructure and facilities in the region. The situation was clearly recognised by those officials and they negatively responded to this aspect. As depicted in the preceding chapter, although the region is one of the most prominent tourist destinations in the Arabian Peninsula, it is deficient in tourism infrastructure. Many officials and residents expressed this deficiency through the interviews. For example, HE Engineer, the Undersecretary of the Ministry of Agriculture, described the poor management of tourism in the region:

> ‘‘The second main problem is the growing tourism demand. This growth in tourism demand may not recognized as problem by some officials rather than a benefit for the region. However, if tourist demand is combined with the weak structure of tourist facilities that are available in the region, then one will realize the magnitude of the problem caused by the increasing number of tourists to the region. Furthermore, the region lacks for integration government efforts to manage this tourism demand in a manner that does not damage the natural resources in the region’’.

The Director of the Department of Irrigation and Agriculture lands expressed the same problem when he said:

> ‘‘Human factors represented in population increase and the increasing number of tourists to the region form a major threat to the natural resources in the region. Both factors require more food and more water supplies, thus this is impacting on natural resources as there is a real problem in the management plan that is pursued by the concerned department’’.

Nevertheless, the Assistant Director General of Agriculture and Animal Wealth in Dakhiliyah Region made the problem more specific. He said:

> ‘‘The main factors that threaten the sustainability of the natural resources in the region are the weak enforcement of legislation to protect these resources, and the management systems that lack the most appropriate inputs to ensure the quality of the NRM plan, and thus to obtain the required output. Poor infrastructure and facilities that serve the tourism growth is one of management challenges which if not dealt with in a serious way can lead to undesirable consequences for the future of the natural resources in the region’’.

Although there were optimistic perspectives from government officials about the inputs into the NRM plans, pessimistic perspectives seemed more dominant. This conclusion is supported by the low percentage (not exceeding 4.2%) of officials who strongly agreed on the adequacy of the expenditures allocation and 0% for the adequacy of communication between field and office staff (Table 6.9). The next paragraphs will outline the perspectives of government officials about the processes of the NRM plan.

Table 6.12 Sufficiency management processes: views of government officials.

| | Management processes<br>Rank order | Mean score | Sum | Distribution | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 5 | 4 | 3 | 2 | 1 |
| 1 | Specialized governmental management services for natural resource based in AAR. | 3.33 | 399 | 2 | 70 | 20 | 21 | 7 |
| 2 | Collaboration between different departments' officials in AAR. | 3.22 | 386 | 6 | 55 | 31 | 15 | 13 |
| 3 | Projects and programmes are periodically evaluated. | 3.06 | 367 | 5 | 39 | 44 | 22 | 10 |
| 4 | Strategy for addressing threats and pressures that face natural resources in AAR | 3.01 | 361 | 4 | 35 | 45 | 30 | 6 |
| 5 | Accurate monitoring legal and illegal uses of the natural resources in AAR. | 2.96 | 355 | 5 | 36 | 46 | 15 | 18 |
| 6 | Participation of local communities in decisions that affect them. | 2.93 | 352 | 3 | 39 | 41 | 21 | 16 |
| 7 | Research on key issues related to natural resources in AAR is frequently carried out | 2.92 | 350 | 4 | 28 | 48 | 34 | 6 |
| 8 | Inclusive relatively recent written NRM plan. | 2.87 | 344 | 2 | 29 | 54 | 21 | 14 |
| 9 | Comprehensive inventory of natural resources. | 2.83 | 339 | 2 | 33 | 45 | 22 | 18 |
| Total of respondents = 120 | | | | | | | | |
| 1 = strongly disagree, 2 = disagree, 3 = not sure, 4= agree, and 5= strongly agree. | | | | | | | | |

As presented in Table 6.12, government officials negatively responded to the management processes included in the NRM plan. Their negative perspectives about management inputs in the NRM plan continued in a more pessimistic manner. Although the best response was for the item "specialized governmental management services to natural resource management based on AAR", the 40% of officials who disagreed or were not sure (Table 6.12) raises doubts. These conflicting results can be explained by two factors. First, the presence of government management services for natural resources, based in the Nizwa Municipality Branch, the Department of Agriculture Development and the Office of Water Services provide basic management services for NR. Second, the lack of satisfaction with the provided services, and their lack of quality and comprehensiveness, supports the negative perspectives of those officials. Given the perspectives of regional government officials regarding this aspect, although the Chi-Square test (Table 6.14) shows no statistically significant differences, Table 6.13 highlights that 75% of officials from both Al-Jabal and Nizwa agreed on the existence of these services in the region, opposed to 55% of officials from Muscat who disagreed or were not sure about these services.

Table 6.13 Perspectives of regional government officials regarding the specialized governmental services for NRM based in AAR.

| Category | Region | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Al-Jabal | | Nizwa | | Muscat | | | |
| | Count | % | Count | % | Count | % | Count | % |
| Strongly disagree | 1 | 6.3% | 2 | 7.1% | 4 | 5.3% | 7 | 5.8% |
| Disagree | 1 | 6.3% | 3 | 10.7% | 17 | 22.4% | 21 | 17.5% |
| Not sure | 2 | 12.5% | 2 | 7.1% | 16 | 21.1% | 20 | 16.7% |
| Agree | 12 | 75% | 21 | 75% | 37 | 48.7% | 70 | 58.3% |
| Strongly agree | 0 | 0% | 0 | 0% | 2 | 2.6% | 2 | 1.7% |
| Total | 16 | 100.0% | 28 | 100.0% | 76 | 100.0% | 120 | 100.0% |

Table 6.14 Chi-Square Tests measuring regional differences (Al-Jabal, Nizwa and Muscat) on the item ‘‘specialized governmental services for NRM that based in AAR’’.

| | Value | df | Asymp. Sig. (2-sided) | Exact Sig. (2-sided) | Exact Sig. (1-sided) | Point Probability |
|---|---|---|---|---|---|---|
| Pearson Chi-Square | 10.086a | 8 | .259 | .248 | | |
| N of Valid Cases | 120 | | | | | |

a. 10 cells (66.7%) have expected count less than 5. The minimum expected count is .27.
b. The standardized statistic is -1.620.

The likely explanation for this result may lie in the fact that the persuasions of most Al-Jabal and Nizwa officials about the services provided to the region's natural resources derive from the fact that they are themselves working to provide those services, and thus they know the extent and the adequacy of the services, and the mechanisms in place to run them. In contrast, Muscat officials, knowing the services provided to NR in other parts of Oman, were not persuaded by the extent and the adequacy of services provided to NR in AAR. Indeed, there exists a desire, expressed by some officials in Muscat, to further improve the quality and comprehensiveness of services provided to the NR in the region. In this regard, HE Engineer, the Undersecretary of Ministry of Agriculture and Fisheries said:

> ‘‘We have an ambitious programme in cooperation with the Arab Centre for the Studies of Arid Zones and Dry Land (ACSAD) to draw maps for pastoral areas in the Sultanate of Oman including Al Jabal Al Akhdar, and this programme will allow us to perform a reliable management for pastoral resources in Al Jabal Al Akhdar’’.

Furthermore, the Director of the Agricultural Quarantine Department recommended an improvement for the NRM plan. He said:

‘‘More services that provide protection for natural resources and ensure its sustainability are strongly recommended. For example, the services provided by the Ministry of Environment and Climate Affairs in the field of scrutiny and controls of offenders are inadequate and must be improved’’.

The second most positive response was for ‘‘collaboration between different department executives and staff in AAR’’; 50.8% of government officials (Table 6.12) agreed or strongly agreed that collaboration effectively occurred between executives and staff of the departments in charge of NR of the region. Again, differing perspectives consistently appeared between officials in both Al-Jabal and Nizwa, as 59.9% and 64.3% respectively agreed or strongly agreed on the existence of such cooperation, while 43.4% of Muscat officials did so (Table 6.15).

Table 6.15 Collaboration between officials of NRM based in AAR: views of regional government officials

| Category | Region | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Al-Jabal | | Nizwa | | Muscat | | | |
| | Count | % | Count | % | Count | % | Count | % |
| Strongly disagree | 0 | 0% | 0 | 0% | 13 | 17.1% | 13 | 10.8% |
| Disagree | 3 | 18.8% | 3 | 10.7% | 9 | 11.9% | 15 | 12.5% |
| Not sure | 3 | 18.8% | 7 | 27.6% | 21 | 27.6% | 31 | 25.8% |
| Agree | 9 | 53.6% | 15 | 53.6% | 31 | 40.8% | 55 | 45.8% |
| Strongly agree | 1 | 6.3% | 3 | 10.7% | 2 | 2.6% | 6 | 5.0% |
| Total | 16 | 100.0% | 28 | 100.0% | 76 | 100.0% | 120 | 100.0% |

These results are consistent both locally and nationally. Locally there is horizontal communication between executives and staff of the departments that are in charge of NR of the region. There is the local committee of cooperation and coordination, headed by the Vice-governor (Naib Al-Wali) with a membership of directors of government departments in Al-Jabal. This committee specialises in consultations and discussions about the government projects to be established in the region. Vertical communication happens through the formal meetings between the officials of Al-Jabal and the officials of Nizwa. These meetings are frequently conducted and they discuss various issues of NR in the region. This horizontal and

vertical cooperation can explain the positive perspectives of the officials of Al-Jabal and Nizwa. At the national level, horizontal and vertical communication between executives and staff of the ministries in charge of NR of Oman was negatively perceived by the officials of Muscat. This negative perception may spring from a lack of effective procedures or committees that require communication and coordination of efforts among these ministries. This was demonstrated through interviews with some officials who saw the need for enhancing communication and coordination between the various ministries involved in the NRM in the region. In this regard, HE Engineer the Undersecretary of Ministry of Agriculture and Fisheries expressed the need for government cooperation for prudent management of NR in the region. He said:

> ‘‘I would like to suggest that the government initiate a comprehensive programme or committee for the management of natural resources in Al Jabal Al Akhdar in which all concerned ministries should be involved, a detailed plan should be set to achieve this goal. Such programme will facilitate and communicate all efforts of these ministries and will yield in a better management plan’’.

In a similar manner, the Director of Pastoral Resources in the Ministry of Agriculture and Fisheries commented on the absence of government cooperation in the development of projects and on how this could influence NR in the region. He said, ‘‘impacts of development can negatively contribute in damaging the natural resources if no coordination and cooperation are made with the concerned ministries’’.

The weakest processes in the NRM plan, presented in Table 6.12, were a ‘‘comprehensive inventory of natural resources’’ and ‘‘recent written NRM plan’’ as these were ranked lowest at the bottom of the table with more than 60% of the government officials not sure or disagreeing on the existence of these processes. These negative perspectives emphasized the imbalance and general incompleteness of the NRM plan, which also appeared in the

objectives and input aspects of the NRM plan. Again, these perspectives are consistent with what was observed during fieldwork. When asked for written plans pursued by the ministries responsible for NRM in AAR, some officials said that the NRM plan is modified from the general one that could apply to all of Oman's regions. Such a situation suggests an administrative oversight, and indicates a chronic disconnection between accurate scientific methodology and management implementation. This in turn negatively reflects on the general situation of resources in the region, which has only a limited capacity to absorb additional human error. Officials should be aware that the AAR is fragile and its natural resources require special management (Matwani, 2011; Berkes, 2004).

Considering the perspectives of government officials in al-Jabal, Nizwa and Muscat, Table 6.16 illustrates the perspectives of those regional government officials regarding the ''comprehensive inventory of natural resources'', which is supposed to be a main process in the NRM plan in AAR. However, portions of 50.2% of Al-Jabal officials and 35.6% of Muscat officials disagreed on the availability of this process and suggested some doubt about its practicability. Moreover, these results emphasized the previous results that indicated imbalance and general incompleteness in the NRM plan.

Table 6.16 Perspectives of regional government officials regarding the comprehensive inventory of NR as a process in the NRM Plan in AAR.

| Category | Region | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Al-Jabal | | Nizwa | | Muscat | | | |
| | Count | % | Count | % | Count | % | Count | % |
| Strongly disagree | 1 | 6.3% | 0 | 0% | 17 | 22.4% | 18 | 15.0% |
| Disagree | 7 | 43.8% | 5 | 17.9% | 10 | 13.2% | 22 | 18.3% |
| Not sure | 1 | 6.3% | 13 | 46.4% | 31 | 40.8% | 45 | 37.5% |
| Agree | 7 | 43.8% | 8 | 28.6% | 18 | 23.7% | 33 | 27.5% |
| Strongly agree | 0 | 0% | 2 | 7.1% | 0 | 0% | 2 | 1.7% |
| Total | 16 | 100.0% | 28 | 100.0% | 76 | 100.0% | 120 | 100.0% |

To investigate whether the differences in the results of regional government officials, regarding the ''comprehensive inventory of natural resources'', were statistically significant,

the Chi-Square Test (Table 6.17) was applied, and its results indicated that there were significant statistical regional differences regarding this item.

Table 6.17 Chi-Square Tests measuring regional differences (Al-Jabal, Nizwa and Muscat) on the Item ‘‘comprehensive inventory of natural resources’’ as a process in the NRM Plan in AAR.

| | Value | df | Asymp. Sig. (2-sided) | Exact Sig. (2-sided) |
|---|---|---|---|---|
| Pearson Chi-Square | 28.022a | 8 | .000 | .001 |
| N of Valid Cases | 120 | | | |
| a. 7 cells (46.7%) have expected count less than 5. The minimum expected count is .27.<br>b. The standardized statistic is -1.632. | | | | |

It is appropriate to consider the opposing viewpoints between the officials of both Al-Jabal and Nizwa (43.8% and 35.7%, respectively) who agreed or strongly agreed on the availability of this process and, on the other hand, the officials of Muscat, where only 23.7% agreed on the existence of this process. These inconsistent perspectives may indicate a misunderstanding of the concept of inventory and the way it applies to the region's natural resources. Positive perspectives may be explained by an understanding of the inventory as a census, since there was an agricultural census in 2005. However, this census was not specified for Al-Jabal only and was a census of all regions of Oman and included agricultural crops, livestock and all pastoral resources including water resources. As such, it was not the comprehensive and accurate inventory required for NRM. Such a natural resource inventory (NRI) has become an important tool for the gathering, synthesis, depiction and explanation of natural resources data relating to a geographic area, and maps that result from NRI are useful to inform better decisions that may impact on those resources (Kane and Ingraham, 2009).

For example, water resources are attended to by wells in the region to monitor groundwater levels and to judge the adequacy and duration of the water supply. However, the nature of the mountainous region prevents the availability of the large underground reservoirs that occur in the plains areas. It is therefore difficult to predict the quantities of existing groundwater

through these wells because they are less extensive and the data less accurate than those in the plains areas. This was confirmed by the Assistant Director General of the Directorate General for Water Resources Management in the Ministry of Regional Municipalities and Water Resources. Thus, the negative perspectives of the officials about the availability of inventory as a process in the NRM plan may be explained by the lack of a comprehensive inventory that shows the status of all natural resources in the region. In addition, this census was taken in 2005 and it has not been repeated or updated recently. It seems that these negative perspectives stem from the inadequacy of the inventory as a process in the NRM plan for the region. Indeed, there is no evidence from the government documents about the existence of a comprehensive inventory of resources that can refute these negative perspectives.

In light of the prevalence of "not sure" responses about some processes in the NRM plan, the ''strategy for addressing threats and pressures that face natural resources in AAR'' as a process in the NRM plan showed that 37.5% of the officials were not sure what is really happening in terms of this strategy, and that only 29.2% knew of its existence. This contradiction can be explained by the fact that water is the resource that attracts the most formal attention and it has a proposed strategy (not yet approved), while no strategy yet exists for the agricultural land and pastoral resources (MRMWR, 2005). However, even the proposed water resources strategy is in reality a general strategy for water in all regions of Oman, and does not include specific activities and procedures for dealing with water resources in the AAR. Not all officials who were respondents in this study were aware of the strategy and so their answers were contradictory.

Similarly, ‘‘accurate monitoring of legal and illegal uses of the natural resources in AAR’’ was ranked in the middle of the table. This proposed process in the NRM plan was perceived by government officials, as 34.2% agreed on the existence of this monitoring process, while 27.5% of them felt it was not available (Table 6.12). Given the results from officials in the regions, a contrast in views appears between officials of both Al-Jabal and Nizwa and officials of Muscat, since 43.8% of the officials of Al-Jabal and 50% of the officials of Nizwa agreed on the existence of this monitoring process, contradicted by 32.9% of Muscat’s officials who did not see the existence of this process at all (Table 6.18).

Table 6.18 Perspectives of regional government officials regarding the comprehensive inventory of NR as a Process in the NRM Plan in AAR.

| Category | Region | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Al-Jabal | | Nizwa | | Muscat | | | |
| | Count | % | Count | % | Count | % | Count | % |
| Strongly disagree | 1 | 6.3% | 1 | 3.6% | 16 | 21.1% | 18 | 15.0% |
| Disagree | 1 | 6.3% | 5 | 17.9% | 9 | 11.8% | 15 | 12.5% |
| Not sure | 7 | 43.8% | 8 | 28.6% | 31 | 40.8% | 46 | 38.3% |
| Agree | 7 | 43.8% | 12 | 42.9% | 17 | 22.4% | 36 | 30.0% |
| Strongly agree | 0 | 0% | 2 | 7.1% | 3 | 3.9% | 5 | 4.2% |
| Total | 16 | 100.0% | 28 | 100.0% | 76 | 100.0% | 120 | 100.0% |

Uncertainty was dominant, as more than 40% of both Al-Jabal and Muscat officials, and 28.6% of Nizwa officials were not sure about this process (Table 6.18). Uncertainty and conflicting perspectives indicated the unclear vision about the existence and the effectiveness of the monitoring program and its procedures. The positive perspectives of officials suggest the existence of a monitoring programme as a process within the Management Plan, while the negative perspectives do not deny the existence of a monitoring programme as suggested, but suggest a lack of effectiveness and adequacy. The latter was addressed by more than one government official through the interviews. In an indirect reference to this problem, the Director of the Department of Agriculture Development in Al-Jabal al-Akhdar said, ‘‘The biggest problem is the absence of the role of the concerned government agencies to combat these problems and regulate such activities”. However, the Director of Nizwa Municipality at

Al-Jabal al-Akhdar Branch directly described the staff shortage problem in the region. He said:

> ‘‘The main problem is the staff number, as we need a greater number of trained workers more than ever before. For example, we have a programme of environmental monitoring aimed at controlling the illegal use of environmental resources, and reducing the impact of environmental violations. Unfortunately, in the presence of only two observers or environmentalists, the objectives of the programme are out of reach now’’.

Moreover, among several difficulties that prevent good management in the region, the Director General of Natural Conservation in the Ministry of Environment and Climatic Affairs specified qualified staff as a problem. He said:

> ‘‘Our policy focuses on creating and managing protected areas and to seek the funds required to run these protected areas including employment and recruitment of conservation officers and technical personnel specialized in environmental, social, statistics issues and researchers specifically for biodiversity. In addition to that, we seek to ensure that our staff have the needed skills to implement the management plans, despite the several challenges encountered such as un availability of well qualified persons from the same area. The financial restrictions is a another problem which we have to adopt and cope with’’.

A further layer of complexity can occur when it comes to circumventing the law via social norms. If an activity is performed by women then it requires the presence of a female environmental observer. In this regard, the Deputy Director of Environment and Climate Affairs in Al-Dakhiliyah region explained such situations:

> ‘‘Locals resort to circumvent the law of logging prevent, where the women are the actors who cut off trees branches to feed their goats, so that the women would not be subjected by environmental observers, who are all men. This is because of the terms of customary law that prevent men from interacting with women in any way. Such a

situation requires handling with care, the best solution is to appoint females as environmental observers, and this is not available now''.

As previously depicted, it clearly appears that the official bodies responsible for NRM in the region have ambitious goals in their management plan. But at the same, these plans lack some of the necessary inputs that support the management processes, achieving the targeted management outputs. These outputs and the related government officials' perspectives are detailed in the following paragraphs.

## 6.4 Perspectives of government officials and locals regarding management outputs: issues related to water resources

As this study shows, weaknesses in management inputs have negatively influenced the effectiveness of management outputs. These weaknesses contribute to an exacerbation of the problems facing water resources, as shown in Tables 6.19 and 6.20, where evidence indicates a lack of effectiveness in the management outputs regarding water resources. Firstly, 75.8% of officials and 61.6% of locals agreed, or strongly agreed, that the water department faces difficulties in supplying the required water for developmental expansion in the AAR. These difficulties can be attributed to short-term planning and a lack of a holistic long-term vision for the future. Despite the existence of five-year plans that Oman relies upon for future development requirements, some of the requirements and requests of citizens remain unfulfilled, primarily due to a lack of budget to ensure implementation. In this context, in an interview, the Undersecretary of the Ministry of Regional Municipalities and Water Resources said:

''We receive a lot of demands and claims for implementation of projects, such as building dams, maintenance of Aflaj or building flood protection walls, and we

implement these projects according to the available budget, which is often limited, and (must be) distributed to all Oman's regions''.

Table 6.19 Perspectives of government officials regarding the management outputs (issues related to water resources).

| | Management plan outputs Rank order | Mean score | Sum | Distribution | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 5 | 4 | 3 | 2 | 1 |
| 1 | Adequacy of social protection from water hazards. | 3.79 | 455 | 18 | 73 | 16 | 12 | 1 |
| 2 | Difficulties in supplying required water for developmental expansion in AAR. | 3.76 | 451 | 23 | 61 | 23 | 10 | 3 |
| 3 | Appropriate resolutions for water resource difficulties in AAR. | 3.48 | 418 | 18 | 50 | 33 | 10 | 9 |
| 4 | Adequacy of physical protection from water hazards. | 3.39 | 407 | 7 | 66 | 20 | 21 | 6 |
| 5 | Incorporation of water resource protection in developmental plans. | 3.23 | 387 | 7 | 56 | 25 | 21 | 11 |
| 6 | Suitable awareness of traditional knowledge relating to water resource management in AAR. | 3.23 | 387 | 4 | 59 | 28 | 18 | 11 |
| 7 | Appropriate application of sanctions against offenders against water resource conservation regulations. | 3.20 | 384 | 11 | 40 | 36 | 28 | 5 |
| 8 | Availability of socio-economic data to plan for water resource management. | 2.99 | 359 | 5 | 34 | 43 | 31 | 7 |
| 9 | Effective monitoring of locals' obligation to observe water resources conservation policy. | 2.88 | 346 | 6 | 24 | 51 | 28 | 11 |
| 10 | Availability of skilled staff. | 2.83 | 340 | 3 | 23 | 53 | 33 | 8 |
| Total of respondents = 120 | | | | | | | | |
| 1 = strongly disagree, 2 = disagree, 3 = not sure, 4= agree, and 5= strongly agree. | | | | | | | | |

Secondly, although most of the officials and locals showed some satisfaction with the social and physical protection provided by the government to prevent risks and problems from water, they resented the failure to apply sanctions against offenders who failed to observe water resource conservation regulations. They also complained of a lack of socio-economic data for water resource management planning, poor monitoring of locals' obligations to observe the water resources conservation policy and an unavailability of skilled staff.

Table 6.20 Perspectives of locals regarding the management outputs (issues related to water resources).

| | Management plan outputs Rank order | Mean score | Sum | Distribution | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 5* | 4 | 3 | 2 | 1 |
| 1 | Difficulties in supplying required water for the developmental expansion in AAR. | 3.70 | 444 | 36 | 38 | 28 | 10 | 8 |
| 2 | Adequacy of social protection from water hazards. | 3.33 | 399 | 16 | 45 | 27 | 26 | 6 |
| 3 | Adequacy of physical protection from water hazards. | 3.28 | 394 | 15 | 53 | 14 | 27 | 11 |
| 4 | Incorporation of water resources protection into development plans. | 3.26 | 391 | 18 | 35 | 36 | 22 | 9 |
| 5 | Appropriate resolutions for water resource difficulties in the AAR. | 3.19 | 383 | 17 | 33 | 40 | 16 | 14 |
| 6 | Suitable awareness of traditional knowledge relating to water resource management in the AAR. | 3.218 | 382 | 11 | 39 | 37 | 27 | 6 |
| 7 | Appropriate application of sanctions against offenders against water resource conservation regulations. | 3.08 | 369 | 19 | 24 | 39 | 23 | 15 |
| 8 | Availability of socio-economic data to plan for water resource management. | 3.05 | 366 | 10 | 30 | 42 | 32 | 6 |
| 9 | Effective monitoring of locals' obligation to observe water resources conservation policy. | 2.80 | 336 | 11 | 27 | 27 | 37 | 18 |
| 10 | Availability of skilled staff. | 2.74 | 329 | 7 | 20 | 39 | 43 | 11 |
| Total of respondents = 120 | | | | | | | | |
| 1 = strongly disagree, 2 = disagree, 3 = not sure, 4= agree, and 5= strongly agree. | | | | | | | | |

There were some positive aspects regarding the social and physical protections for water related to government attempts to maintain an acceptable level of water security in the region. Since the 1980s, the government has explored new sources of water that can be extracted, stored and pipe to residents at subsidized prices. In addition, the government has constructed water storage tanks in remote areas that are unsuited to an extension of the pipeline network. The government also provides mobile water tanks for areas where there is neither a water network nor water storage tanks. All of these efforts have been strengthened by the construction of more than 36 surface storage dams and the building of many protection walls to reduce flooding and soil erosion in agricultural terraces.

The negative perspectives of both officials and locals on the unavailability of skilled staff, lack of socio-economic data for planning of water resources management and limited

policing of locals' obligation to observe the water resources conservation policy, are an extension and confirmation of official disquiet about these aspects of the NRM plan. One of the locals described in interview the official monitoring of locals' obligation to respect the water resources conservation policy, saying:

> ''It has been said that the government monitors the commitment of the people to the policy of water resources protection, but we did not experience any type of monitoring, and we have not heard about any person who has been punished as a result of violation of this legislation which is the subject of prejudice constantly. This lenient approach with offenders leads to their persistence and thus to the depletion of these resources''.

As regards the incorporation of the protection of water resources into development plans, fewer locals agreed with this position than officials, with 52.5% of the officials (Table 6.19) believing that this principle is taken into account in development plans, but a larger percentage (55.8%) of locals (Table 6.20) did not agree with this opinion, or were not sure about it. This raises some questions about the real state of the supposed protection of water resources. The likely explanation lies in the fact that government documents, codes and regulations clearly indicate the mandatory protection of water resources which should be taken into account in development plans for housing, industrial and tourism. This explains the positive perceptions expressed by both officials and locals. However, the lack of application of this legislation is reflected in the negative perceptions of both officials and locals. These negative perceptions are supported by three pieces of evidence. First is the problem of water pollution in Falaj Al-Azizi in Sieq (the largest and most famous village in the AAR). The problem first occurred in 1997 when locals realized that their Falaj's water was mixed with oil and it smelled of diesel. Research and investigation showed that the cause of the problem lay in a diesel spill from corroded underground military diesel tanks close to the source of

Falaj Al-Azizi. Legislation prohibits the construction of any type of building within one kilometre of any Falaj (MRMWR, 2000). Secondly, personal observation of non-compliance with legislation in relation to the protection of water resources in housing plans, not only in AAR but in the interior region in general. The construction and drilling of government wells near the headwaters of the Aflaj have either contaminated, as happened in Falaj Al-Azizi, or threatened its flow, leading to reduced agricultural production. Thirdly, the views of officials and locals on this matter more than once referred to the construction and drilling of wells near the headwaters of the Aflaj. Most prominent among these openly and boldly expressed perspectives was that of the Assistant Director-General of Water Resource Management in the Ministry of Regional Municipalities and Water Resources, who said:

> ‘‘During my working period (1988-1995) in the water exploration project in the AAR, our aim was to extend the water network to the houses of the inhabitants but two of the wells were far from the residential area. When the concerned officials knew the success of these operations and the presence of water in the wells, the Diwan [Royal Court] decided to establish a farm to plant fruit for the benefit of the Sultan, but this move was not welcomed by me and [I] decided to withdraw from the project and returned to Muscat. The reasons for my withdrawal from the project can be attributed to: first, my conviction about the damage that may result from the establishment of the farm, where plants need large amounts of water and this could drain the groundwater that feeds [the] region’s Aflaj. This is what is happening now with the decreasing levels of water flow of the Aflaj, exacerbated by continuous drought. Second: I noticed that the housing plans prepared by some government departments were not based on scientific thoughtful planning in terms of taking into account the aquifers that are the primary source of the Aflaj’s water’’.

TEK relating to water resource management was ranked sixth in both sets of results. However, there are clear distinctions between the official and locals, as 52.5% of officials (Table 6.19) agreed or strongly agreed that there is ‘‘suitable awareness of traditional knowledge relating to water resources management in AAR’’, whereas only 41.6% of locals

(Table 6.20) agreed with this perspective. This difference may reflect the personal views held by the government officials and locals. This might mean that TEK is not seen as an output in the formal NRM plan.

To be fair, government documents do reflect the effort and the management practices implemented by the Ministry of Regional Municipalities and Water Resources in maintaining the heritage of traditional water resources and how to access and use them, particularly with respect to the traditional Aflaj irrigation system. Examples of these efforts and practices can be seen in the maintenance works carried out according to the traditional methods used since ancient times, as well as the ‘‘Pilot Project to Document the Properties, Customs, Traditions and Data of Aflaj’’, a 2009 government project to document some of the traditional customs and practices relating to the Aflaj system in the north of Oman (MRMWR, 2009). Despite these efforts, it appears that locals want greater government effort and grants to include all Aflaj not covered by previous projects.

## 6.5 Perspectives of government officials and locals regarding the management of plant and pasture resources

Despite differences in perspective from government officials regarding certain outcomes in water resource management and pasture resources management (Table 6.21), all agreed that pasture resource management was less effective than water resource management. Less than 50% of the officials thought pasture resource management to be effective, suggesting limited success for the pasture management programmes and management plans adopted by the Ministry of Agriculture. This was not denied by officials during the interviews, and it was confirmed by the ‘‘Symposium on Sustainable Development of the Agricultural Sector and Regulation of its Labour Market’’ held by the Ministry of Agriculture in February 2007. This

symposium emphasized the need to reduce overgrazing by implementing the National Strategy for the Advancement of Natural Pastures and Sustainable Development of Livestock. Direct observation in this study identified an on-going deterioration of pasture resources in the region as a result of overgrazing. Clearly, an appropriate solution has not yet been found to control overgrazing by herds of feral donkeys, problems compounded by extended periods of drought. The Ministry of Agriculture is trying to manage the problem of pasture resources by establishing projects, such as the replanting of wild plants in locations affected by desertification. However, this project needs time and continued effort to yield clear results. ‘‘Identifying and Mapping the Pastoral Areas in Oman’’ is among the more recent responses initiated by the Ministry of Agriculture in 2010. This project aims at saving what remains of the natural pasture and protecting it against the risk of urban and development expansion, but how it will do this remains unclear.

Table 6.21 Perspectives of government officials regarding the management outputs (Issues related to plant and pasture resource).

| | Management plan outputs Rank order | Mean score | Sum | Distribution | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 5 | 4 | 3 | 2 | 1 |
| 1 | Difficulties in conserving plant and pasture resources because of developmental expansion in AAR. | 3.47 | 416 | 13 | 43 | 53 | 9 | 2 |
| 2 | Incorporation of pasture resources protection into development plan. | 3.18 | 382 | 4 | 50 | 34 | 28 | 4 |
| 3 | Suitable awareness of traditional knowledge relating to pasture resource management in AAR. | 3.18 | 382 | 1 | 52 | 39 | 24 | 4 |
| 4 | Encouraging locals to manage plant and pasture resources according to their traditional knowledge. | 3.18 | 381 | 5 | 43 | 46 | 20 | 6 |
| 5 | Appropriate resolutions for pasture resources difficulties in AAR. | 3.08 | 370 | 3 | 39 | 48 | 25 | 5 |
| 6 | Implementation of projects to ensure the safety and sustainability of plant and pasture resources | 3.08 | 369 | 4 | 38 | 45 | 29 | 4 |
| 7 | Availability of socio-economic data to plan for pasture resources management. | 2.95 | 354 | 0 | 36 | 50 | 26 | 8 |
| 8 | Appropriate application of sanctions on offenders against pasture resource conservation regulations. | 2.84 | 341 | 6 | 27 | 34 | 48 | 5 |
| 9 | Effective monitoring of locals’ obligation to observe water resources conservation policy. | 2.67 | 320 | 2 | 16 | 54 | 36 | 12 |
| 10 | Availability of skilled staff. | 2.60 | 312 | 0 | 11 | 62 | 35 | 12 |
| Total respondents = 120. | | | | | | | | |
| 1 = strongly disagree, 2 = disagree, 3 = not sure, 4= agree, and 5= strongly agree. | | | | | | | | |

Table 6.22 Perspectives of locals regarding the management outputs (Issues related to plant and pasture resource).

| | Management plan outputs Rank order | Mean score | Sum | Distribution | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 5* | 4 | 3 | 2 | 1 |
| 1 | Difficulties in conserving plant and pasture resources because of developmental expansion in AAR. | 3.47 | 413 | 13 | 56 | 29 | 19 | 3 |
| 2 | Suitable awareness of traditional knowledge relating to pasture resource management in AAR. | 3.35 | 402 | 12 | 51 | 28 | 25 | 4 |
| 3 | Encouraging locals to manage plant and pasture resources according to their traditional knowledge. | 3.27 | 392 | 18 | 39 | 27 | 29 | 7 |
| 4 | Incorporation of pasture resources protection into development plan. | 3.11 | 373 | 12 | 41 | 29 | 24 | 14 |
| 5 | Appropriate resolutions for pasture resources difficulties in AAR. | 3.08 | 370 | 11 | 38 | 36 | 20 | 15 |
| 6 | Implementation of projects to ensure the safety and sustainability of plant and pasture resources | 2.98 | 358 | 15 | 29 | 33 | 25 | 18 |
| 7 | Availability of socio-economic data to plan for pasture resources management. | 2.83 | 340 | 2 | 24 | 57 | 26 | 11 |
| 8 | Appropriate application of sanctions on offenders against pasture resource conservation regulations. | 2.83 | 339 | 7 | 28 | 34 | 39 | 12 |
| 9 | Effective monitoring of locals' obligation to observe water resources conservation policy. | 2.80 | 336 | 10 | 30 | 25 | 36 | 19 |
| 10 | Availability of skilled staff. | 2.67 | 320 | 4 | 20 | 43 | 38 | 15 |
| Total respondents = 120. | | | | | | | | |
| 1 = strongly disagree, 2 = disagree, 3 = not sure, 4= agree, and 5= strongly agree. | | | | | | | | |

The official and local views regarding the management outputs of plant and pasture resources are identical (Tables 6.21 and 6.22). The only difference is in the rank order of ‘‘Encouraging locals to manage plant and pasture resources according to their traditional knowledge’’ and ‘‘Incorporation of pasture resources protection into the development plan’’. However, perspectives that were discussed in the section on water resources management outputs are repeated here, with 46.6% of the officials and 57.5% of locals perceiving that the Ministry is facing difficulties in protecting the pasture resources from development expansion, a sign of the ineffectiveness of the management plan for pasture resources. One of the interviewees responded that pasture resources management ‘‘lacks the comprehensive planning that takes into account the different aspects required for management plans such as the necessary

budget, availability of trained manpower and availability of data and information which the plans depend on'', a perspective echoed by officials and locals (Tables 6.21 and 6.22).

Although the output ''suitable awareness of traditional knowledge relating to pasture resources management in AAR'' is rated third by officials and second by locals, the 44.2% of officials (Table 6.21) and 52.5% of locals (Table 6.22) who agreed, or strongly agreed, on this item, raises some questions about the extent of the officials' awareness of and attention to traditional knowledge in this sector. It would seem that TEK awareness is declining, as evidenced by the lack of attention paid to it by the officials (for example, animal inheritance issues have no staff working on it), and also by the abandonment of traditional methods of grazing that controlled the allocation of grazing by villages, seasons and environmental conditions. Consequently, the TEK that might control this system will be forgotten once the elderly are no longer there to pass it on.

## 6.6 Perspectives of government officials and locals regarding the management outputs of agricultural resources

The perspectives of government officials and local people on the management of agricultural land resources in AAR are illustrated in Tables 6.23 and 6.24. It seems that the agreement in opinions that characterised the water and pasture resources issues above are restricted to the last two items ''availability of socio-economic data to plan for agriculture land resources management'' and ''availability of skilled staff'' which rank low in the tables.

Table 6.23 Perspectives of government officials regarding the management outputs (Issues related to agriculture land resources).

| | Management plan outputs Rank order | Mean score | Sum | Distribution | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 5 | 4 | 3 | 2 | 1 |
| 1 | Appropriate solutions for agricultural land difficulties in AAR. | 3.41 | 409 | 14 | 49 | 30 | 21 | 6 |
| 2 | Incorporation of agricultural land protection into development plan. | 3.38 | 405 | 19 | 42 | 33 | 15 | 11 |
| 3 | Difficulties in conserving agricultural land because of developmental and building expansion in AAR. | 3.36 | 403 | 13 | 52 | 22 | 25 | 8 |
| 4 | Comprehensive inventory of agricultural land and its uses. | 3.31 | 397 | 13 | 52 | 24 | 20 | 11 |
| 5 | Government policies help to reduce dependence on unsafe livelihoods or agricultural practices in local communities. | 3.31 | 397 | 16 | 38 | 38 | 19 | 9 |
| 6 | Implementation of projects to ensure the safety and sustainability of agricultural land resources. | 3.22 | 386 | 15 | 39 | 31 | 24 | 11 |
| 7 | Suitable awareness of traditional knowledge relating to agricultural land resources management in AAR. | 3.19 | 383 | 12 | 36 | 33 | 25 | 14 |
| 8 | Encouraging locals to manage agricultural land according to their traditional knowledge. | 3.16 | 379 | 12 | 42 | 19 | 34 | 13 |
| 9 | Availability of socio-economic data to plan for agricultural land resource management in AAR. | 2.98 | 357 | 15 | 21 | 44 | 30 | 10 |
| 10 | Availability of skilled staff. | 2.84 | 341 | 9 | 27 | 47 | 29 | 8 |
| Total of respondents = 120 | | | | | | | | |
| 1 = strongly disagree, 2 = disagree, 3 = not sure, 4= agree, and 5= strongly agree. | | | | | | | | |

Table 6.24 Perspectives of locals regarding the management outputs (Issues related to agriculture land resources).

| | Management plan outputs Rank order | Mean score | Sum | Distribution | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 5 | 4 | 3 | 2 | 1 |
| 1 | Suitable awareness of traditional knowledge relating to agricultural land resources management in AAR. | 3.41 | 409 | 6 | 57 | 41 | 12 | 4 |
| 2 | Comprehensive inventory of agricultural land and its uses. | 3.38 | 405 | 7 | 53 | 42 | 14 | 4 |
| 3 | Encouraging locals to manage agricultural land according to their traditional knowledge. | 3.36 | 403 | 11 | 45 | 43 | 18 | 3 |
| 4 | Incorporation of agricultural land protection in development plan. | 3.31 | 397 | 4 | 51 | 44 | 20 | 1 |
| 5 | Implementation of projects to ensure the safety and sustainability of agricultural land resources. | 3.31 | 397 | 7 | 50 | 41 | 17 | 5 |
| 6 | Difficulties in conserving agricultural land because of developmental and building expansion in AAR. | 3.22 | 386 | 1 | 54 | 39 | 22 | 4 |
| 7 | Appropriate resolutions for agricultural land difficulties in AAR. | 3.19 | 383 | 1 | 56 | 40 | 11 | 12 |
| 8 | Government policies help to reduce dependence on unsafe livelihoods or agricultural practices in local communities. | 3.16 | 379 | 1 | 48 | 43 | 25 | 3 |
| 9 | Availability of skilled staff. | 2.98 | 357 | 0 | 37 | 49 | 28 | 6 |
| 10 | Availability of socio-economic data to plan for agricultural land resources management in AAR. | 2.84 | 341 | 1 | 21 | 61 | 32 | 5 |
| Total of respondents = 120 | | | | | | | | |
| 1 = strongly disagree, 2 = disagree, 3 = not sure, 4= agree, and 5= strongly agree. | | | | | | | | |

A total of 52.5% of officials agreed or strongly agreed on the availability of appropriate solutions for difficulties faced by agricultural land (Table 6.23). In comparison, 47.5% of locals agreed with this point of view (Table 6.24). Despite the position of this item at the top of the table of officials' results, 22.5% disagreed and 25% who were unsure (Table 6.23) suggest doubts regarding the adequacy of these solutions to reduce the difficulties facing agricultural land. These doubts are supported by officials' revelations about their concerns regarding these difficulties, especially those relating to the protection of agricultural land from development and construction expansion (54.2% of officials agreed or strongly agreed on the existence of these difficulties) (Table 6.23). Officials who agreed may be influenced by the availability of solutions offered by government reports and yearbooks that document projects and programmes already implemented, or still to be implemented, to reduce these difficulties, whereas opponents may reflect the low success rate of these programmes in

reducing the difficulties. The Department of Agricultural Development makes a great effort to preserve agricultural production and farmers' access to attractive returns from production, by providing free extension services, fertilizers, seeds, small tillers and biological controls. The Department also maintains many agricultural terraces and builds flood protection walls whilst striving to apply laws preventing construction on agricultural land. However, the lack of effectiveness and comprehensiveness of these solutions is reflected in the negative opinion of locals.

Surprisingly, differences occur between the perspectives of officials and locals regarding the extent of awareness of traditional knowledge and the extent to which locals are encouraged to manage their NR according to this knowledge. 52.5% of locals agree that there is an appropriate awareness about traditional knowledge, placing this item top of the locals' results table (Table 6.24), whereas 40% of officials agreed on such awareness, placing it in seventh position (Table 6.23). This also applied to the statement ''encouraging locals to manage agriculture land by their traditional knowledge'', ranked third by locals (46.6%) and eighth in by officials (45%). It seems that the level of current awareness is below the level required to ensure that this knowledge is appropriately placed within formal managerial practices, and ensure the conservation of this knowledge. However, 47.5% of locals disagreed or were not sure about the existence of this awareness in officials. It may be that the high rank of this item has impacted on the rest of the items in the table, with locals adopting an even more negative perspective. There appear to be few government achievements in this regard. Despite the fact that Oman strives to preserve cultural heritage and indigenous knowledge in various fields, this aspect (traditional knowledge in agriculture) has not yet been given enough attention to guarantee the protection of this knowledge into the future.

## 6.4 Summary

The results presented in this chapter about government practices in regard to the NRM in AAR indicate weaknesses and inadequacies which need to be addressed in order to achieve the required efficiency to manage the natural resources in such a sensitive area. This is especially the case as natural resources become more vulnerable to pressure with the increasing impacts of climate change, overgrazing and unregulated tourism. In spite of efforts made by the Government on the provision of laws and environmental policy to govern the use and management of natural resources in Oman, the application of these policies, laws and plans are practically and procedurally fraught with difficulties. These difficulties can be summarised as follows: (1) the management of developmental programmes relating to natural resources still depends on a classical approach where perceived problems are identified by external agents (national government officers). This is an obsolete approach that experience has shown to be ineffective for modern resources management (Pelesikoti, 2003); (2) in terms of planning and objectives, although officials consider sustainability to be a key focus when developing objectives and plans for NRM, the defects in the other objectives of NRM plan make one question the possibility of achieving the required sustainability of these resources; (3) weaknesses in the management system in general, particularly where management is fundamentally based on skilled staff, appropriate funding and the availability of data and information for planning. Deficiencies in any of these important elements negatively influence the outputs of the whole system and many officials perceived these elements as inadequate or inappropriate; and (4) unsatisfactory management processes that are weak in addressing the pressures and illegal practices. Government officials acknowledge the existence of difficulties in meeting the required supply of water for human use. In addition, there are difficulties relating to pastoral resources management, such as weak enforcement of

environmental legislation, weak punishment of violators and limitations in skilled/ trained staff.

These difficulties are reinforced by the fact that local people have been stripped of their role in traditional governance with respect to access to resources and the regulation of their use being replaced by an inadequate state system. The declining role of traditional governance in the management of the resources of the region, as well as the lack of efficiency of the modern governance system, is a national issue. It is clear that there is an urgent need for a new system to manage these resources which not only addresses the lack of efficient governance but also embraces traditional governance systems. This resonates with calls by Pelesikoti (2003) who concludes the need for new integrated sustainable resource and environmental management for Tonga in the Pacific, with Mfune (2011) in Zambia, and with the FAO et al (2011) for high land in the World's drylands.

From the above, it is clear that the management processes adopted by stakeholders in natural resources in AAR lack many of the pillars needed to ensure its effectiveness. In general, the results of this study correspond with some of the findings of Hockings et al (2006) and Leverington et al (2010), which report case studies from many countries about the management effectiveness and management evaluation of protected areas. These studies show clearly inadequate management where basic needs are not being met, for example the management of protected areas in Spain. Hockings et al (2006) recommend a planning system to be supported by national strategies addressing invasive climate change. In addition, site planning for management was observed to be falling behind schedule; strategic objectives and indicators were recommended to update this process. Periodical risk assessment was suggested to help to emphasise planning on key sites in need of action.

# Chapter 7

# Traditional environmental knowledge and natural resource management practices in the AAR

## 7.1. Introduction:

This chapter presents an analysis of traditional environmental knowledge (TEK) and practices in NRM in the AAR. The knowledge and practices are inherent to the community and handed down through generations to community members. Traditional knowledge includes wisdom, teachings, expertise, skills and practices that govern all life-related matters, including the management and use of natural resources. This analysis addresses the third objective of the study, to determine the nature of current local practices and traditional knowledge in NRM.

The practical dimension, which encompasses a system of NRM that includes the traditional practices, tools and techniques of TEK (Berkes, 1999; Berkes et al, 2000) is an essential approach to evaluate current practices and land uses in the communities of the AAR. This chapter focuses on the practical matters of water and land use, including the applied technology and the TEK perceptions of community members. Because matters such as accessing, sharing, and benefiting from resources connect to and influence social systems, the chapter addresses their impact on the practical dimension from an evaluative perspective. The study addresses the environmental effects of farming-related activities, such as harvesting and grazing, through description, analysis and comments on the survey results, which reflected responses from local people and NRM government officials.

## 7.2 Natural resources management and traditional environmental knowledge: water resources.

Tables 7.1 and 7.2 display the perspectives of government officials and the local people regarding TEK and practices related to water resources management in the AAR. Four elements dominate the results of both groups: the management of the Aflaj properties, including selling and buying within the framework of Islamic law (Sharia); pursuing the Omani traditional irrigation system known as Aflaj (singular Falaj); using local knowledge to manage and exploit water resources; and retaining useful TEK.

Table 7.1 Perspectives of Government Officials regarding the TEK and management practices of water resources in the AAR.

| | TEK and management practices. | Mean score | Sum | Distribution | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 5 | 4 | 3 | 2 | 1 |
| 1 | Water properties are managed in an Islamic way. | 4.13 | 495 | 35 | 67 | 17 | 0 | 1 |
| 2 | Local people are operating the Omani conventional irrigation system (Aflaj). | 4.12 | 494 | 27 | 81 | 11 | 1 | 0 |
| 3 | Local people still use local knowledge to manage and exploit their water resources | 3.93 | 471 | 12 | 92 | 11 | 5 | 0 |
| 4 | People in AAR have useful traditional environmental knowledge. | 3.86 | 463 | 16 | 81 | 13 | 10 | 0 |
| 5 | Using traditional methods of water harvesting. | 3.60 | 432 | 12 | 64 | 31 | 10 | 3 |
| 6 | Maintenance of water resources is funded through its endowments and leasing. | 3.58 | 430 | 10 | 62 | 38 | 8 | 2 |
| 7 | Using traditional tools for the maintenance of water resources. | 3.54 | 425 | 4 | 74 | 28 | 11 | 3 |
| 8 | Local knowledge is integrated into government natural resource management programmes. | 3.17 | 380 | 5 | 40 | 55 | 10 | 10 |
| 9 | Local people still use wells to extract groundwater. | 2.78 | 333 | 4 | 39 | 25 | 30 | 22 |
| Total of respondents = 120 | | | | | | | | |
| 1 = strongly disagree, 2 = disagree, 3 = not sure, 4= agree, and 5= strongly agree | | | | | | | | |

Table 7.2 Perspectives of local people regarding the TEK and management practices of water resources in the AAR.

| | TEK and management practices. | Mean score | Sum | Distribution | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 5 | 4 | 3 | 2 | 1 |
| 1 | Operating the Omani conventional irrigation system (Aflaj). | 4.43 | 532 | 65 | 46 | 6 | 2 | 1 |
| 2 | Water properties are managed in an Islamic way. | 4.25 | 510 | 56 | 43 | 17 | 3 | 1 |
| 3 | People in AAR have useful traditional environmental knowledge. | 4.13 | 496 | 33 | 74 | 10 | 2 | 1 |
| 4 | Local people still use local knowledge to manage and exploit their water resources. | 4.06 | 483 | 31 | 68 | 18 | 3 | 0 |
| 5 | Using traditional methods of water harvesting. | 3.89 | 467 | 26 | 63 | 24 | 6 | 1 |
| 6 | Using traditional tools for the maintenance of water resources. | 3.89 | 467 | 26 | 68 | 13 | 13 | 0 |
| 7 | Maintenance of water resources is funded through its endowments and leasing. | 3.85 | 462 | 33 | 55 | 16 | 13 | 3 |
| 8 | Local knowledge is integrated into government natural resource management programmes. | 3.26 | 391 | 12 | 28 | 64 | 11 | 5 |
| 9 | Local people still use wells to extract groundwater. | 3.20 | 384 | 22 | 37 | 19 | 27 | 12 |
| Total of respondents = 120 | | | | | | | | |
| 1 = strongly disagree, 2 = disagree, 3 = not sure, 4= agree, and 5= strongly agree | | | | | | | | |

According to Table 7.1, 85% of the officials agreed or strongly agreed that the inhabitants of the AAR operated the Aflaj properties, including their inheritance, sale, purchase, and donation, within the context of Islamic Sharia Law, while 89.7% of the local people agreed (Table 7.2). These results reflect both governmental and local awareness of the prevailing practices in water properties management. They were also closely linked to opinions about the Omani traditional irrigation system known as Aflaj, where 90% of the government officials and 92.5% of the local people agreed or strongly agreed that local people still maintaining this system, and with ‘using local knowledge to manage and exploit water resources,’ where 86.7% and 82.5% of officials and locals agreed or strongly agreed, respectively.

Overall, the figures in Tables 7.1 and 7.2 show a strong connection between having knowledge and applying it to exploit the available water resources, especially in this rugged semi-arid environment. The field situation, as observed by the researcher and as evidenced in

interviews and focus groups, confirmed the richness of the region's TEK and its use in managing water resources.

### 7.2.1 The systems of water harvesting: spatial and temporal patterns of water harvesting

People in the region recognised long ago that the climatic nature of the area required them to develop systems to provide sufficient reliable water supplies to survive. They have developed a number of water harvesting and irrigation systems, organically related to agriculture. Two systems are critical: spatial and temporal patterns of water harvesting; and water flow harvesting.

Spatial and temporal patterns of water harvesting exploit the sporadic and low rainfall; water basins or cisterns collect rainwater or runoff water from adjacent catchments for everyday use - generally not for agriculture. Shepherds, in particular, use this technique. The following quotation explains rainwater basin construction.

> ''I once remember asking my father about an artificial water basin that used to be in front of our house. He said, 'Your grandfather and his father were the ones who built that rain water basin. I was very young, but I used to help them bring the stones needed for the building work….' My grandfather chose the position for the rainwater basin because it was sloping and would allow rainwater to enter easily. They mainly used stones and Omani cement to build it… the stored water was for our daily needs. This water was only renewed in the rain season''.

Omanis have adapted to their surroundings and improved their living conditions by exploiting different aspects of TEK: topographic and climatic knowledge, the ability to gauge the estimated water needs for human and animal use; and knowledge of the necessary building tools and materials, such as stones, digging tools and Omani cement (al-Sarooj). Unfortunately, no-one documented or photographed these rainwater basins and most of them now exist only in the memories of older people. However, local people are trying to restore them and adapting TEK to a modern style by digging underground water tanks below houses and lining them with concrete and non-porous tiles. Water irrigates sufficiently profitable plants grown in house yards, such as pomegranates and flowers (Figure 7.1).

Figure 7.1 Rainwater basins in a house in Wadi Beni Habib in the AAR

There are many positive benefits for this method of rainwater harvesting. The technique is a low cost, highly devolved method of individual water management providing access to water and sanitation in remote areas, and therefore attracting further settlement in the summit area of the region. According to field observations, local interviews and the Oman General Census of Population, Housing, and Establishments 2010, the smallest of these demographic

settlements did not exceed five houses, as in Al-Ssafah, and the biggest barely reached twenty houses, as in Al-Gholail (Figure 7.2).

Figure 7.2 One of the dispersed demographic settlements in the AAR.

### 7.2.2 The systems of water harvesting: the systems of water resources exploitation and irrigation (Aflaj)

The people of the region exploit water flowing from springs, water in the wadi-beds, which they call "al-Gheel", and water from underground. These systems are Aflaj (singular Falaj), which are common in most of the northern regions of the Sultanate of Oman. This kind of system is also familiar to other arid zone countries, such as Iran, central Asia, and Latin America (Al Sulaimani et al, 2007).

The word Falaj derives directly from the Arabic word for division. Hence, Falaj means the division of property into shares or the system of dividing water among stakeholders

(Wilkinson, 1977). In fact, the Falaj is a directed irrigation system of main and subsidiary tunnels or canals, designed, dug and built to divide available water and distribute it to those who have the right to use it (Ibrahim, 2006).

There are three types of Aflaj in the AAR. Dawudi Falaj, or Adi Falaj, is the first type, which is a deep underground canal, dug manually to exploit and collect the reserves of ground water from the piedmont. One local informant said:

> ‘‘These forms of Aflaj are attributed to the prophet Sulaiman (peace upon him PUH) according to the myth, which says that they were established by the miraculous work of Sulaiman bin Dawud (PUH) during the period of his reign. However, this is only legend with no evidence to prove it, because there is documented evidence to indicate that one of our Aflaj, which is al-Khotmain, was built in the al-Ya’arebah period (1624-1744)’’.

The high stability of the level of its flow means that periods of drought only slightly affect these types of Aflaj. This, however, depends on the length of the drought and the location of the Falaj. An example of this is the Al-Khutmain Falaj in Burkat Al Mooz that is located on the south piedmont of Al-Jabal al-Akhdar (Figures 7.3 and 7.4). These types of Aflaj originate from underground and they draw from underground sources of water through a very sophisticated geometrical design that can reach 17 km in length. Most parts of this system are covered (Al-Hagri, 1998), as explained in detail later.

Figure 7.3 Falaj al-Khotmain, Berkat al-Monz, an example of Dawudi Falaj.

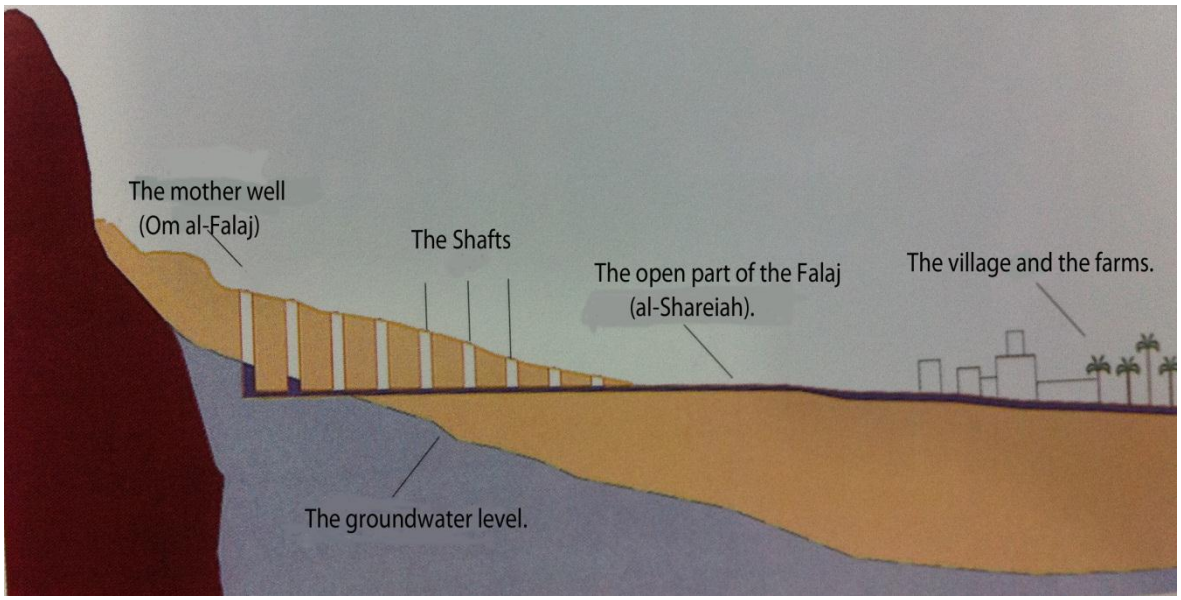



Figure 7.4 Diagram of a Dawudi Falaj. Source: adapted from MRMWR, 2005.

In the Ainy Falaj, the second type of Aflaj in the AAR, water originates as a surface spring that waters the agricultural villages via canals – the local meaning of al Ain is spring. A well-known example is the Al-Ain Falaj, named Al-Kobiari, in the village of Alain (Figures 7.5

and 7.6). These types of Aflaj are common in other regions of Oman. Their importance varies according to the quality of their water, which can range from hot to cold or alkaline to fresh, the latter being suitable for drinking. The alkaline water that occurs in some wadis is suitable for agriculture. Other types of springs, rich with mineral salts, are suitable for treatments and cures (Ibrahim, 2006). In the AAR, the water is usually of normal temperature and suitable for drinking. The lengths of these Aflaj vary between 200 to 1,500 metres.

Figure 7.5 Al-Ain Falaj in the village of Alain in AAR.

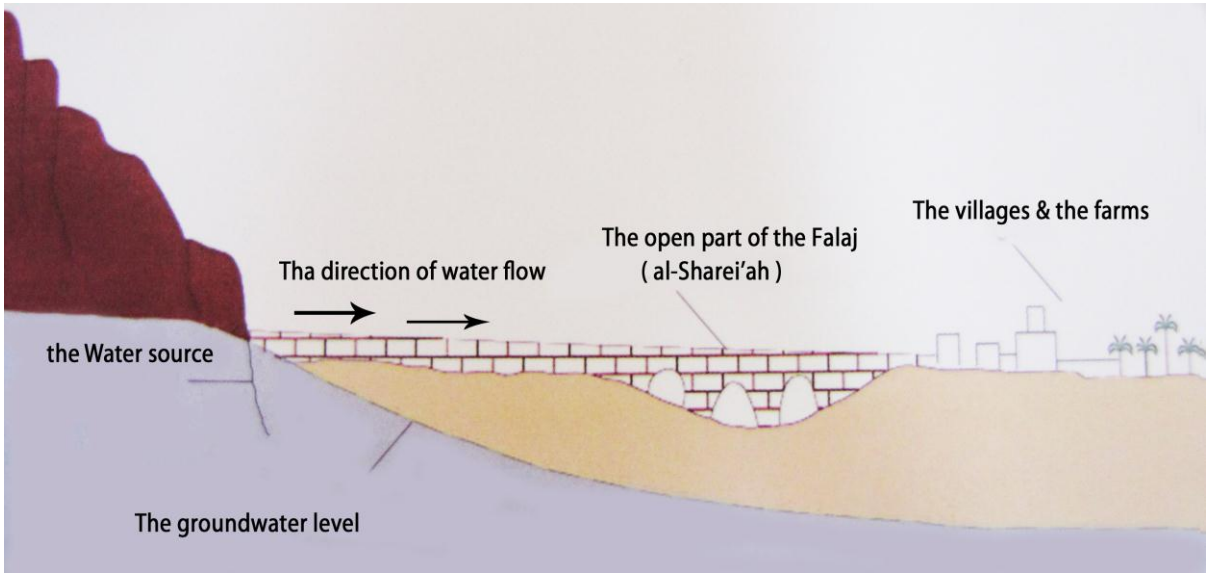



Figure 7.6 Diagram of an Ainy Falaj. Source: adapted from MRMWR, 2005.

Ghaily Falaj is the third type of Aflaj in the AAR. Fed entirely by wadi water (Ibrahim, 2006), which the local people traditionally call “al-Ghail”, Ghaily Aflaj are superficial, exposed and seasonal. A gravel layer feeds the streams, which flow briefly after rainfall in the mountains. People use these widespread systems for agriculture through split canals from 500 to 2,000 metres in length. The Aflaj hold water between wadis, on the sides of wadis, or between stones, and farmers can easily construct them, directing the water flow by putting up stones as barricades. An example of this type is Falaj Tawi Sudah in Wadi Al-Moaiden (Figure 7.7). These Aflaj resemble the exposed Ainy Falaj but their sources are different; the Ghaily Falaj relies on surface flows or upper ground water, whereas the Ainy Falaj relies on the constant flow of spring water.

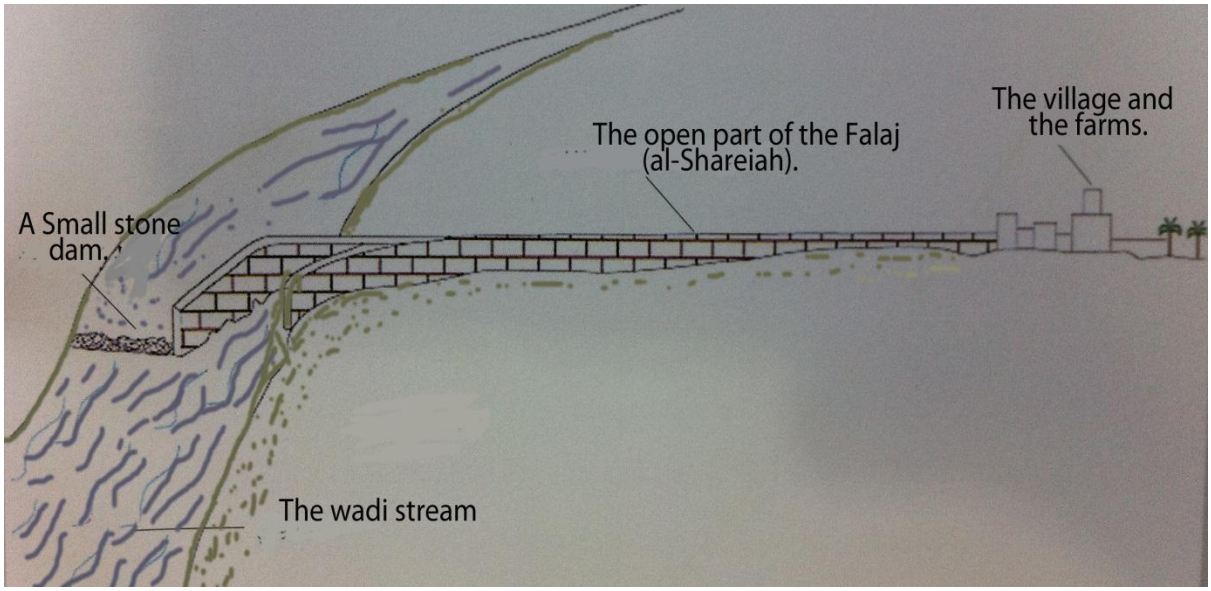



Figure 7.7 Diagram of a Ghaily Falaj. Source: adapted from MRMWR, 2005.

### 7.2.3 The engineering of a Falaj:

The people in the region have developed a working engineering knowledge to support their exploitation of water resources. Historically, they were interested in this knowledge for basic

geographical reasons. First, huge layers of sediments surrounded the mountains of Oman. Water infiltrated them and seeped deep into the rock, making it difficult to reach. Second, although the soil on the piedmonts was fertile for planting, the scarcity of water prevented it. Third, seasonal rainfall alternating with periods of drought threatened vegetation and inhabitants. Reliance on rainfall for different crops requiring different quantities of water at specific times was problematic. The inhabitants had to search for water less exposed to aridity. Finally, the topographical nature of the region made it suitable for the capture and accumulation of underground water (Ibrahim, 2006), but extracting ground water situated at deep levels was very difficult using traditional methods (Al-Hagri, 1998; Al-Zorkah, 1998). Local people had to find a solution for extracting underground water with minimal loss of time and physical effort. Consequently, they became skilful and proficient at setting up Aflaj, tunnels and descending canals buried within the layers of sediment, to transport water from its mountain source. Field observations and the discussions with informants confirmed this expertise.

Testimonies from local informants illustrate the extent to which local people are proud of their ancestors' ability to establish and develop a water irrigation system to guarantee their survival and stability in the region. Dawudi Aflaj require a purely human effort. Two major phases establish a Falaj; the first step is choosing the location. Saud, the executive (Wakil) of Falaj Alkhotmain, described this phase:

> ''It is important to consider the operation of choosing the right place for digging as the first step to construct the Falaj. The place must include specific geographic factors, which are determined according to some personal observations of the specific nature and environment. These observations include the existence of Wide Mountains and high lands infiltrated by wadis that can attract rainfall and that have no rocks preventing water from sneaking into lower levels. Examples of these places, which are suitable for digging, are places that are made of soil or a mixture of sand, gravel

and soil. These places absorb water, which infiltrates this mixture to form an abundant water supply. They are characterized by an abundance of big trees, such as Acacia, that are a sign for the existence of underground water''.

Choosing an ideal place to set up the Falaj does not always mean avoiding layers of solid ground, such as conglomerate layers. People dug many Falaj through such ground, some reaching more than 10 metres in depth and lengths of more than 15 km. With only primitive digging tools, Aflaj, such as the tunnel of Falaj Al-khotmain, must have demanded extreme physical effort.

As shown in Figures 7.8 and 7.9, access shafts, constructed every 10-30 metres, matching depths along the tunnel, provide for ventilation, light and maintenance. Sarooj, burned clay, wrapped around the mouth of every shaft, prevents floodwater from entering the tunnel and destroying the Falaj; and the covers prevent animals and people from falling into them and maintain the cleanliness of the water.

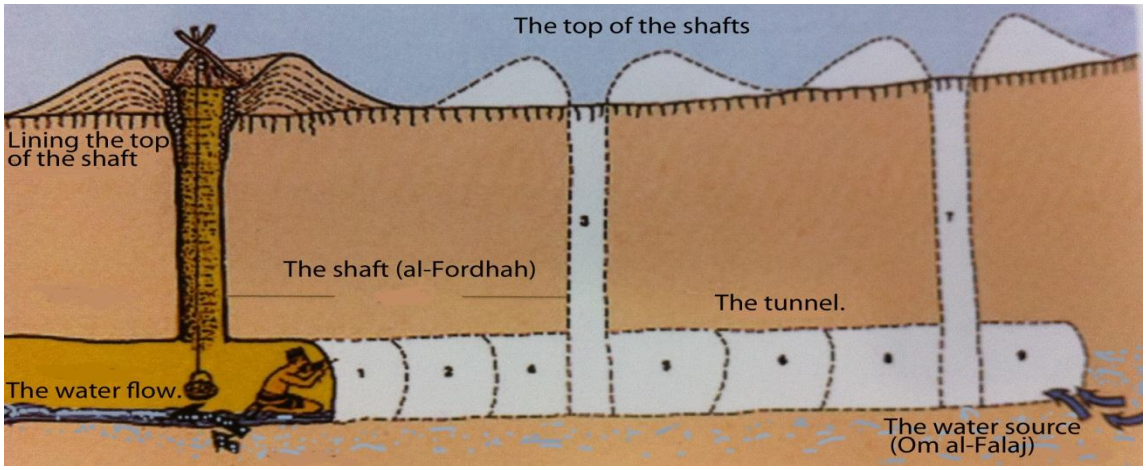



Figure 7.8 Diagram of the shaft (Fordhah). Source: adapted from MRMWR, 2005.

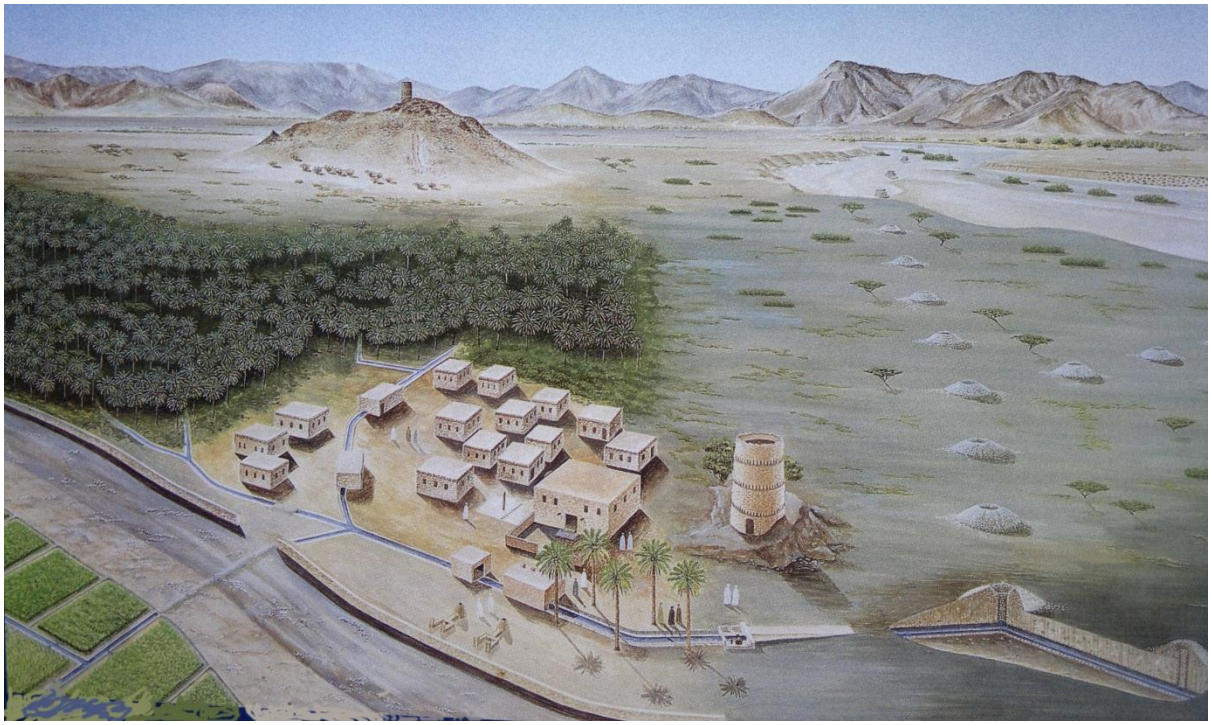


Figure 7.9 The general shape of a Falaj system; the shafts (Fordhah) are on the right.

Source: adapted from MRMWR, 2005.

The second step is the operation of manually digging the Falaj and constructing its canals. Specialists, from local people or from the nearby village (Qalat Al-Awamer), visit the workplace and create a design of the site and its heights, using specific engineering measurements of the site's depth and the amount of existing water. Saud, the executive (Wakil) of Falaj Al-khotmain continued to describe this step:

> ‘‘If the calculations of the specialists are positive, they will start by digging two observation wells. The first is at the source of the Falaj at the top point of the chosen location and the second at the place where the Falaj will come out from the depth to the surface of the Earth. After finishing their calculations concerning the level and the amount of running water from the source to the point of exit and being sure that their calculations are positive, the incision operation to build the canals from the source (Om al-Falaj) to the exit (Al-Sharei’ah) will start forward taking into account the inclination’’

From this testimony, one can infer the quality of the geographic and engineering knowledge the people possess. After identifying the likelihood of groundwater through the presence of dense vegetation, the planning and the designing of the Falaj depends on calculations and engineering expertise gained from simple observations and practices by people without any prior formal education. The importance of this expertise continues during the construction and digging of the Falaj canals. When a deep wadi blocks the path for a canal, people use one of two technical solutions for crossing wadi beds, as also described by the Falaj Wakil. The first is the bridge solution - a flyover bridge over the wadi to transfer the water from one side to the other (Figure. 7.10), and the second is the siphon solution, locally called Fallah Ghraq - a U-shaped tunnel under the wadi for water to flow under the wadi to the opposite side (Figure 7.11).

Figure 7.10 A small bridge to transfer the Falaj's Water.

Source: MRMWR, 2009.

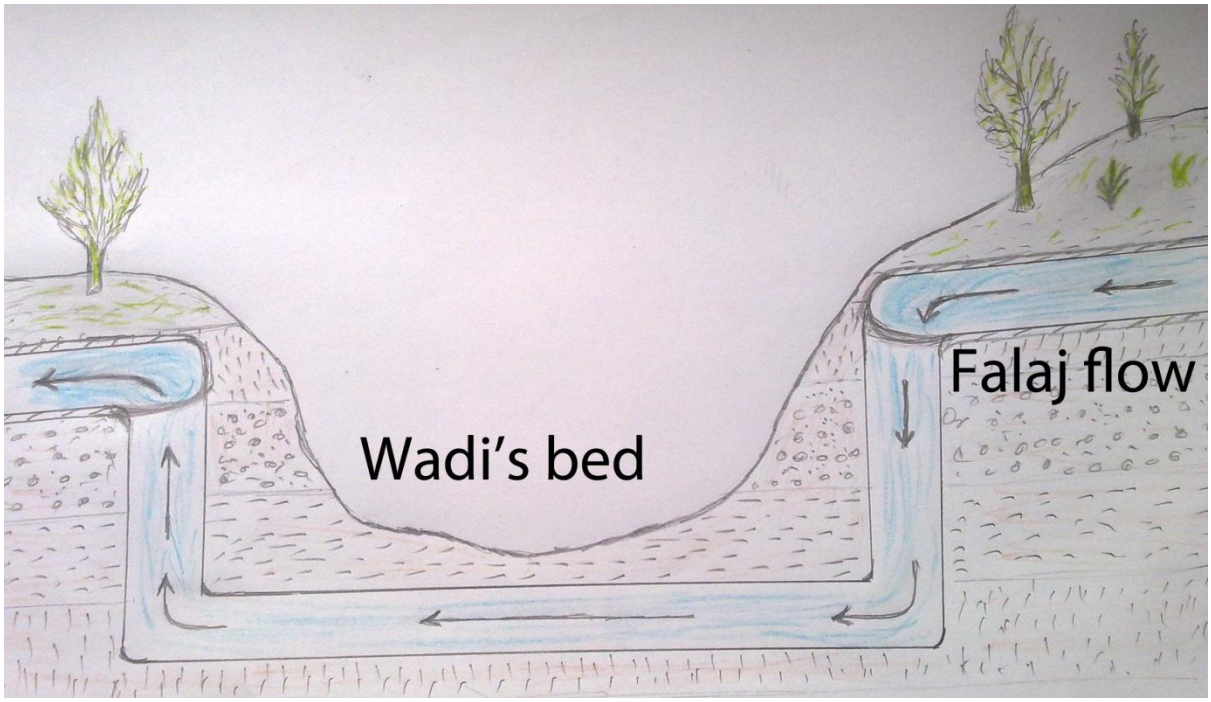



Figure 7.11 Diagram of Fallah Ghraq

Ainy and Ghaily Aflaj interrupt water from springs, from occasional perennial surface flows, or from the bottom of a wadi-bed and their construction is quite simple, as in Dawudi Falaj. With regard to Ainy Falaj, Saud (Wakil of Falaj al-Khotmain) said:

> ‘‘ With a source of suitable water, which is usually at a mountain position that has a fault, after determining the area of arable and housing land, the people start building the waterwheel (the channel), from the source towards the agricultural area. As for the al-Ghaily Falaj, firstly people identify a proper place in the wadi to establish a stone dam in the path at the wadi-bed. This dam is often constructed in the lower width of the wadi, so that there is semi-permanent flow, and often mountains are surrounding both sides. Secondly, people start building channels onward from the dam, going along the wadi side, following the natural slope of the wadi until the access to agricultural and residential area that is usually not far from the wadi’’.

To preserve a proper gradient in the channel to ensure water flow under gravity, workers excavate and construct the channel opposite to that in the Dawudi Falaj. The channels in the Ainy and Ghaily Falaj are often above the ground because the distance from the upstream

area to the agricultural and residential areas is usually short. Sometimes, the channel needs to be raised to ensure gradient compatibility with the water flow. The width is directly proportional to the amount of water needed by the village for irrigation.

Local engineering knowledge and experience, strengthened by trial and error, comes from direct observation of, and reflection about, the local environment. The success in using that expertise has ensured the maintenance of the water supply that is the foundation of the local economy and security.

### 7.2.4 Organization and distribution of the Falaj water:

After the successful construction of a Falaj, its constantly flowing water current, in ordinary situations, irrigates a village or agricultural plots owned by local people. A previously agreed sequential plan divides the water flow into water shares allocated for those who contributed to the Falaj construction, allowing the Falaj to flow and circulate in a constant successive circulation that does not change over time. Moreover, this system includes rules, methods and tools that provide daily water sharing and enable every individual to ensure his/her own water requirements, in terms of quantity and time, for land irrigation, either by direct ownership or by contracts of benefits transmission (Al-Hagri, 1998, Al-Marshudi, 2001, Wilkinson, 1993). In order to ensure the continuity of the Falaj flow, local citizens have established an administration and funding system. The firm social and financial systems that took care of administration and maintenance ensured the continued existence of Aflaj (Sutton, 1984).

Distribution of the Falaj water organizes the water into shares or large time units, restricted in terms of number and equal in terms of quantity. The circulation is successive, locally called

Dawaran. For example, water might circulate every seven, eight, or even twelve days during drought periods, but the beneficiaries receive equal shares of water. The following clarifies three major Falaj systems: distribution, ownership, and share succession. The system of dividing and distributing Falaj water is a complicated but efficient way to ensure fair and adequate water supply for all farming lands. Moreover, this system can differ from one village to another. To understand the variations of this system, it is crucial to know some basic details about the mechanism that allows a Falaj society to solve the problems of fair water division among large numbers of participants. Because the Falaj water is for agriculture, the Falaj society is always trying to find ways to use this water more efficiently. Saud (Wakil Falaj al-Khotain) described the procedures that take place:

> ‘‘When the water reaches the agricultural plot to be reclaimed, people must consider three matters: the Falaj’s discharge and its water flow continuity range, the type of soil and its response to dryness, and the area of the plot to be planted. There must be a certain balance among these factors. If the Falaj supply is plentiful and constant and if the land is fertile or endures dryness well, then the Falaj would have a high irrigation capacity and it could irrigate a relatively large area of land in a short period of time. Thus, people might set a ten-day period of circulation, for example, with the Falaj divided into ten periods of 24 hours. Each period is called Badah. After that, each Badah is divided into smaller units, each one called Athar or Sahla in some villages, and lasts half an hour. This means that a Badah is equal to forty-eight Athars/Sahlah’’.

Many informants saw this water distribution system as an accurate system that guaranteed fair shares to all beneficiaries. As such, it plays an integral role in controlling irrigation stability with justice in timing. It also responds to the climatic conditions of the region and the size of the planted area. The alternative is:

> ‘‘Abandonment (of) this system in some villages, (which) leads to some conflicts on the water intervals and time specified for each individual. This often happens in times

of drought if a beneficiary demands a longer time than the allocated time because he could not irrigate his entire farm’’.

The Athar is the practical time unit in measurement and treatment among users of the Falaj, not only in the AAR but also throughout Oman. It is the basis of every operation of sale, purchase, hiring and inheritance (Al-Hagri, 1998). Some of the villages originally using the water clock (Sahlah or Tasah) measurement unit for water rights turned to the Athar because of its wide use in Oman after watches, as convenient and efficient timing tools, became available after the modern renaissance in 1970.

The main system of water distribution is the Dawran, or the rotation or cycle, which distributes the Falaj water to individual farms, as agreed among the stakeholders. If the Dawran cycle lasts seven days, each shareholder obtains his share once a week on average. Figure 7.12 illustrates the Dawaran system in Falaj Saiq in the AAR.

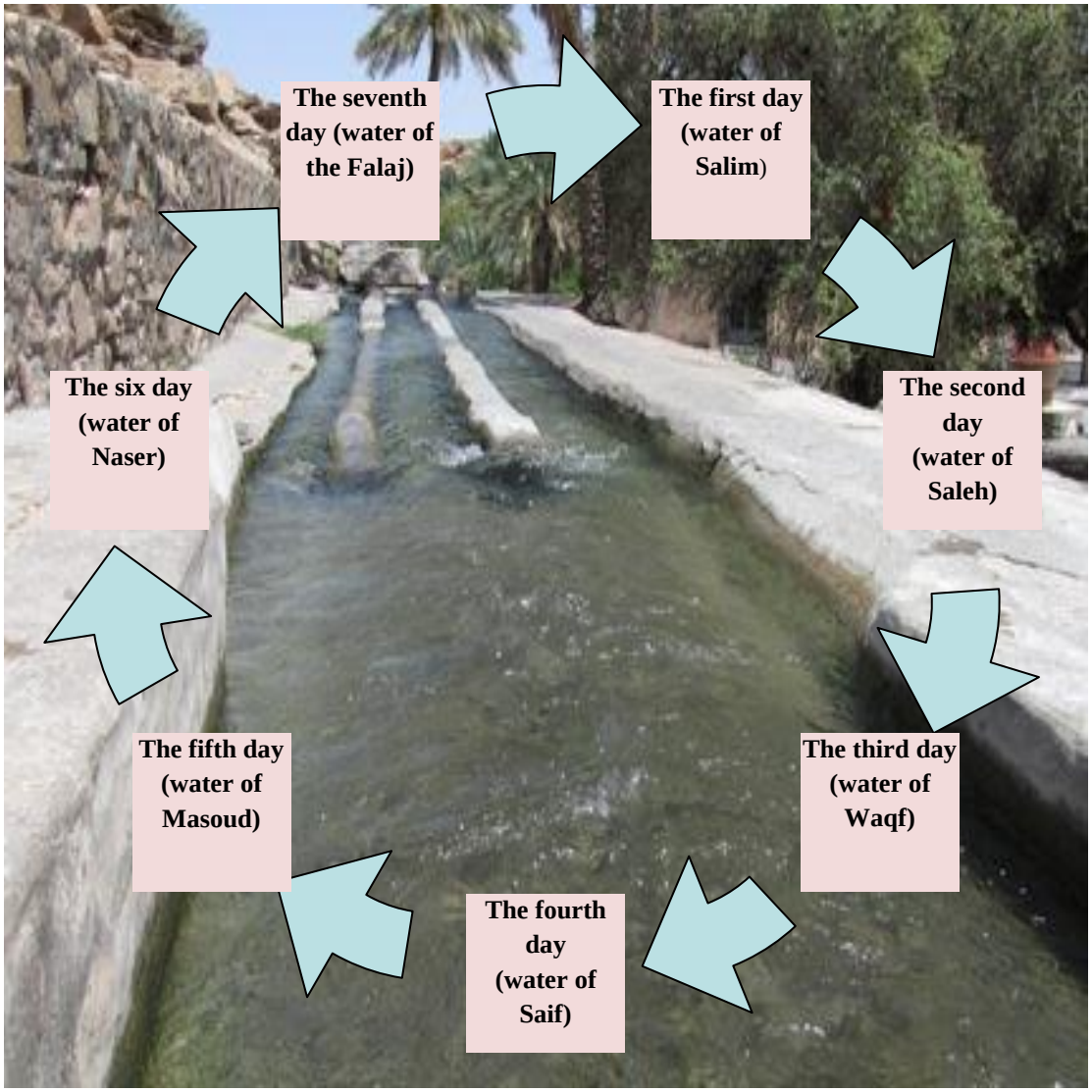



Figure 7.12 An example of Falaj Dawaran.

Sulaiman, one of Al-Shuraijah's residents, gave an example of this. He said:

> ''Let's suppose that eight participants/stakeholders have contributed to the building of a Falaj in an area where they have agricultural land. So, the Falaj water would be shared among them. In this way, they have to divide the water into eight parts and then divide all the amount of water of a single day between them. After that, each participant will have his name attributed to a specific day as the rotation is completed after eight days. In this way, water can reach the land of each contributor in a specific time and a specific place by a water distribution system of channels linked directly to the Falaj. What happens inside the portion of land is not included in the duties and responsibilities of the Falaj organizers and is an individual matter''.

However, the Dawaran system varies from one village to another in terms of methods to control the stakeholders' shares and the timing of their course of irrigation. This means that some villages have written records of the shares owned by each beneficiary, and the exact times of shares within the Dawaran while others have a Falaj agent (Wakil) to regulate succession. Generally, the division of water among individuals relies on exactness, good experience, and some fundamental skills that only a few people may have. This knowledge resulted from lengthy practical experience with three major methods of timing. Sulaiman went on to clarify how the locals controlled the timing in the past with no time device such as a clock:

> ''The first method is (Al-Muhadrah) that has two basic regulators. The first is diurnal: within this regulator, the shadow is relied on when it falls on an elevated mass from the surface of earth such as a tree or a building. But it is usually organized, and its operation is carried on in different steps: a. Choose a plain piece of land, which is not obscured from sunrise to sunset. After razing and cleaning this piece of land, people start to draw a squared patch in its middle with about 3 metres for each rib/side, in some instances; they will build a box with this length and a height of 50 centimetres. After that, they choose a specific point in the middle of this box to form the axis of the circle around which the job will occur. Next, an iron or a wooden linear pillar, having 30-50 centimetres length and 4-5 centimetres thickness, is fixed in the central point, for tracking the path for the pillar's shadow. This pillar is firmly fixed horizontally by Saroj so that nobody and nothing could move it. This pillar is taken from the wood of a wild olive tree called Atm that is known for being extremely solid and resistant to time and white ants. b. The partition of the hours of the day: the engineers start dividing the distance of the west corner from that box. This means dividing from the point in which the pillar is fixed to the end of the corner towards the west into six parts so that each part holds the extension of the shadow for an hour of time. In this way, each part is different from the other according to the course of the sun because the course of the shadow during the sunrise and the sunset is faster than its course during its steadiness around midday. For example, the shadow needs around an hour for its movment between two lines for the distance during the sun's

steadiness, but may need half an hour to do this distance during sunrise or sunset. For that, the distance between the parts gradually increases (Figure 7.13). For each part [line], a sign is fixed in the form of a rectangular stone called Jamood and this becomes a mark of identification for two different times to specify an hour's time between the two signs. The Second is nocturnal. This type of timing relies on astronomy, and thus it is based on the stars that are called Al-Muhadrah's stars. Only a few people who are experts in using the stars to divide water know the names of these stars. 'Experts' add other stars (secondary stars) to facilitate the job. This job of course needs knowledge and experience in the science of astronomy, mastered by few people, as the Athar is the unit used for the division which is equalized by half an hour''.

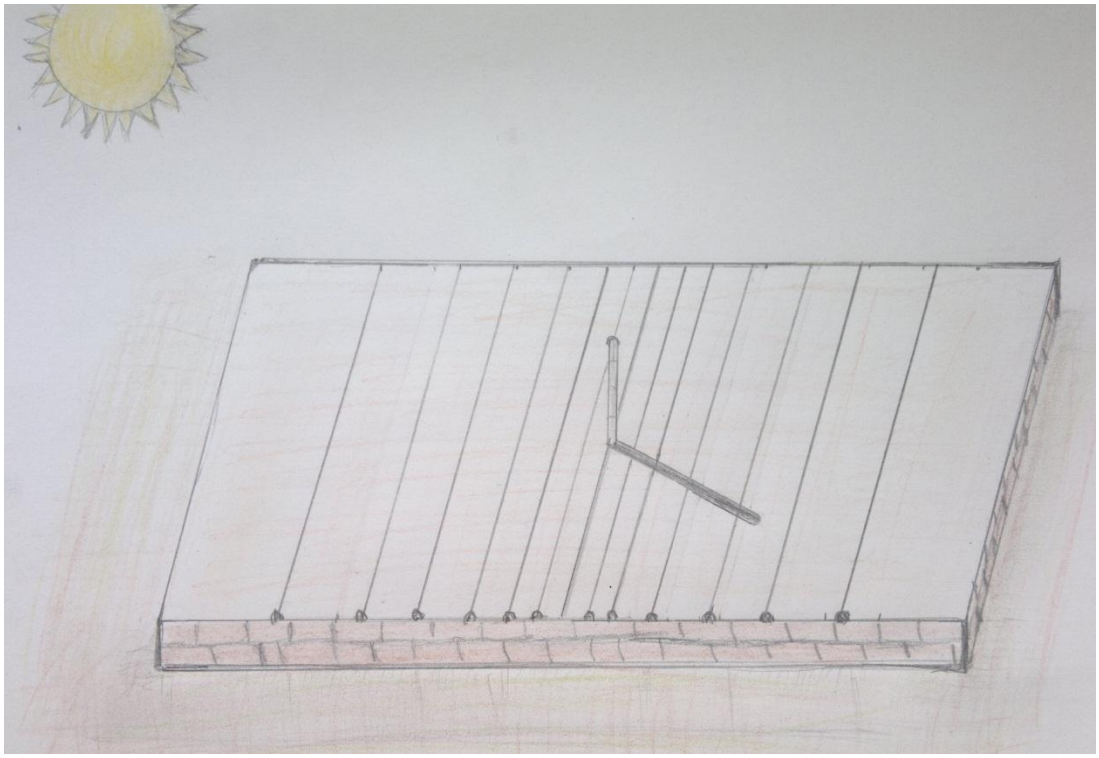


Figure 7.13 The sundial.

Falaj experts enumerated all the known stars and estimated the time and the distance between every two stars. Local people, familiar with twenty-four conventional stars, use those stars to specify parts of the night. They divide the time intervals between the risings of successive stars into time sections, when other smaller stars appear in the sky. In this way, the people

can estimate the distance by estimating the time. Thus, they are able to make estimations of distances around the range of an hour (two Athars), an hour and a half (three Athars), or half an hour (one Athar) from the main stars, while the secondary stars divide the distances between stars into halves, thirds or quarters (Nash and Agius, 2011). The local people use the periods between the rise of one star and the rise of another for night-time allocations of water.

In the focus group, Salim from Saiq went on to clarify the second previous method of timing in the absence of time devices/clocks. He said:

> ‘‘The second method is Al-Sahlah or Al-Tasah, which depends on using two pots/pans. One is big, usually made of clay, and filled with water, and the other is a small copper pot with a fine hole beneath; the smaller pot is placed on the surface of the water in the big pot and the filling time of the small pot is then monitored (Figure 7.14). The time from putting the small pot on the surface of the water until it is completely filled with water is usually half hour (one Sahlah). The process repeats to measure any number of Sahlah. The Areef of Falaj and the person whose turn is at that time cooperate in doing this. Of course this method was used before the introduction of watches, 45 years ago, but now it has disappeared and instead watch timings are used’’.

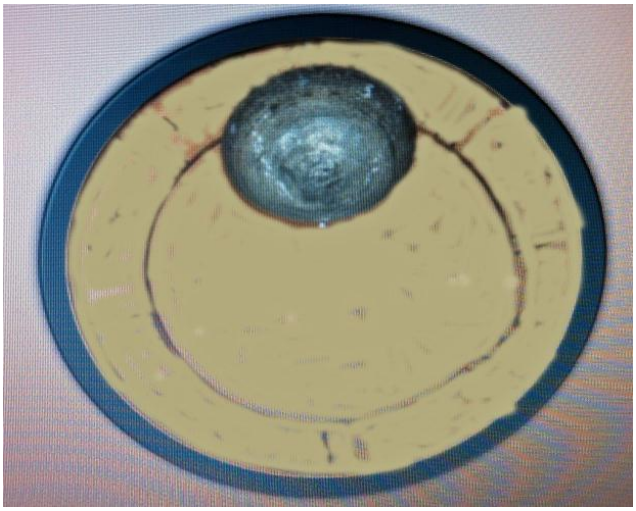


Figure 7.14 Water clock (Al-Sahlah). Source: adapted from (Nash and Agius, 2011).

Only the farms of those who own water in the Falaj of the village benefit from irrigation, because the water is private property; those who are not shareholders in the Falaj have to rent a portion of water to irrigate their farms.

The third method is Al-Tewaf. In this method, farmers appoint two guardians to supervise irrigation by turns or shifts; this can take between 7 to 15 days, depending on the quantity of water available. This system irrigates all the farms in the village regardless of whether the owners of a farm have water ownership or not, because in this case, the water is the property of all the village residences. Ahmed, from Masirat Al Jawamid, of the focus group, went on to clarify this third method of timing used in the past:

> ‘‘In the village of Masirat Al Jawamid, irrigation is done by the Al-Tewaf method where the Falaj water is collected in four pools (Galol), two of the pools to irrigate the low valley farms (Al-Khumurs ) used for planting dates, and the other two pools to irrigate the upper valley farms called Al-Suaimya, used for planting fruit trees and garlic. The shifts here last less than 8 days due to the availability of water. The local people decided that the shift system is respected by all, but sometimes there might be a priority for the farmers who are badly in need for water for their crops, such as garlic and sweet potato. A type of understanding is reached between the owner of the farm and the person whose turn of irrigation is fixed on that time to exchange shifts temporary.’’

Ahmed explained this method with another example:

> ‘‘There is a joint Falaj for the villages of Al Ain, Al Aqar, and Al Qasha’a. Since Al Ain village is located at a higher place, irrigation is made to this village at day time for seven days, and the night shifts are dedicated to the other two villages, the first half of the night for Al Qasha'a and the second half for Al Aqar. The Bidar is the person who manages the irrigation system’’.

This quotation clearly shows two regulation issues: first, the commitment and respect shown by the villagers to the Dawaran systems, and, second, the flexibility in temporary share exchanges on which the villagers agree according to the various needs for irrigation. This usually occurs in small villages, such as Masirat Al-Jawamid, with less than 50 farms.

### 7.2.5 The structure of Falaj ownership

The structure of Falaj ownership varies depending on the villages and the Aflaj themselves. Most Aflaj combine both individual properties and those owned by Bait al-Mal, which in the past meant the treasury or state fund but which now acts as a ministry of finance. In this way, individuals own the large majority of the Falaj's Badah, with one Badah belonging to the Falaj itself, called 'Zaydah,' an extra Badah. This extra Badah is to benefit the Falaj and the Falaj receives its annual revenue. If one Badah is not sufficient, then the village adds another Badah. The Falaj's Badah is public property and no one has the right to use it for any other benefit, such as building fences, towers or mosques, or for personal gain. Al-Hagri (1998: p43) asserted:

> ''One of the reasons of Bait al Mal ownership is the punishment of the corrupt and the tyrants. The government used to seize the properties of the tyrants who abused of their wealth in order to compensate their victims. If those who were tyrannized were dead, the properties they seize is kept as an entailment in the treasury (Bait al Mal)''.

Water shareowners could also keep the Badah or a number of Athar as an endowment for Bait al Mal and could use it/them to fund public religious or social benefits, such as building mosques or teaching the Koran. Philanthropists can recommend uses for philanthropic endowments.

Furthermore, water share ownership varies according to individuals in the community. Some people own half or a whole Badah. Others possessed only one to four Athars. Villages consider those who possessed the biggest water shares to be respectable people, often chosen as custodians over the Falaj and influencing decisions concerning the Falaj. They have elective power, in modern concepts, the same as big shareholders in the stock market today (Al-Hagri, 1998). The Falaj's Badahs assume the names of the owners, whether tribes, families or individuals; the names of the water shares of Falaj al-Khotmain are Mkhlef Saif, bin Ismail, and Al-Asailah. Sometimes names are parts of the villages as in Al-Azizi Falaj in Saiq (Table 7.3).

Table 7.3 The names of the water shares of Falaj Al-Azizi in Saiq

| The name of the share | The time |
|---|---|
| Alzerib | Daytime |
| Khomr Alkor | Night |
| Al-Salil | Daytime |
| Allejmah | Night |
| Al-Salil | Night |
| Al-Sharakeh | Night |
| Al- Rieheh | Daytime |
| Mezre'a Al-Asfel | Night |
| Mezre'a Al-Asfel | Daytime |
| Al-Shakhreh | Night |
| Al-Dehmaniyah | Daytime |

### 7.2.6 The Falaj's water access system

There are three ways to access Falaj water rights among beneficiaries of the system today: ownership through purchase or inheritance; renting; and endowment. If owners have excess quantities of water beyond their farms' needs, they can either sell part of it or rent it to someone who does not own a share in the Falaj. The unit of transaction is the Athar. Its value depends on the discharge of the Falaj, the continuity of its flow and demand, which depends on the agricultural areas needing cultivation and on individual incomes. Consequently, Athar

prices vary. Salim (50 years old) from Al-Ain, in an interview, compared the prices of water shares between villages and between times:

> ‘‘Recently, the value of one Athar in Falaj Al-Ain (Lokbairi) is 4000 Omani Rials (1000 Omani Rial = 1.650 British Pounds), whereas one Athar in Falaj Al Khotmain is 7000 Omani Rials. These prices, 30 years ago, were 1000 Omani Rials and 3000 Omani Rials’’.

Another method of access is through renting, locally called Al-Quadah. Farmers who benefit from this method are those who cannot afford a share through purchase. The contract can be for a week, six months or a year, decided by the farmer and the owner. The renting rate depends on supply and demand, and on the seasons, as, explained by Salim (50 years old) from Al- Ain: ‘‘The renting price increases when there is low supply - in the summer time and in the drought periods. On these occasions, one Athar of water can sell for 30 O R. In contrast, prices fall in the wintertime, especially during the rainy season’’. People most often rent the Falaj’s extra share of water. Owners can also offer their extra shares for rent but these are often more expensive than the Falaj’s because private owners enjoy more freedom to refuse a less than desired price and retain their extra share, whereas the Falaj must rent its share.

### 7.2.7 Maintenance, management and financing of the Falaj

A Falaj is like an owned establishment whose owners have rights, incomes and expenditures (Al-Hagri, 1998). Consequently, a specific management system has developed. Although the previous Falaj management systems were not as specific as modern ones, they did exist in practical terms, as the construction works illustrated. Today, to clarify Falaj management

systems, one must explain the administrative organization of the Aflaj and the types of Falaj restorations, including their expenses, funding, and registration and recording systems.

The Aflaj administrative management systems of the region are similar in structure, with differences in the numbers of Aflaj overseers and regulators according to the Falaj size and the extent of irrigated agricultural areas. For example, three agents (Wakil) and one identifier (Arief) manage Falaj Al-Khotmin while only one agent (Wakil) and one Bidar (who does all the work the farm needs) manages Falaj Al-Azizi in Saiq. Figure 7.15 summarizes the administrative organizational structure of the Falaj; the distribution of tasks and functions follows the names contained in this structure.

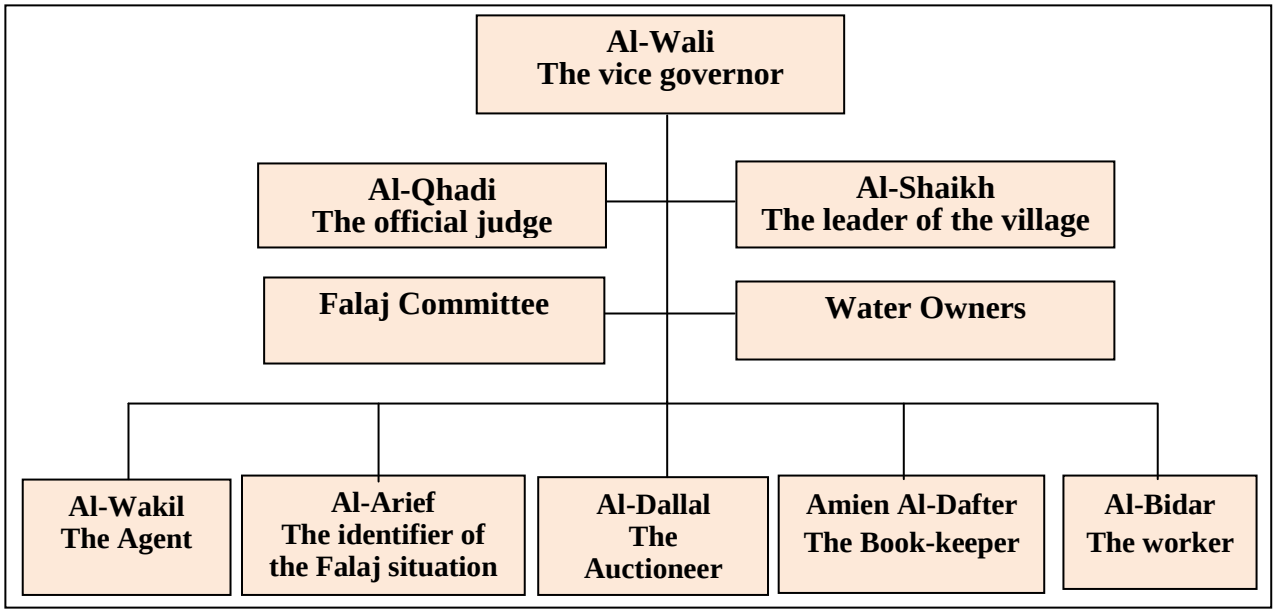



Figure 7.15 An administrative organization of the Aflaj (The Administrators' Board in the large villages).

It is important to note that the Administrators' Board presented in Figure 7.15 is limited only to large villages, where the farm area exceeds two square kilometres ($km^2$). The missions of the vice governor (Al-Wali) and the judge (Al-Qhadhi) are limited to solving problems that

the lower levels of the Administrators' Board cannot handle, as this level is responsible for all the technical and administrative work required for successful Falaj transactions.

The agent (Al-Wakil), the identifier (Al-Arief), the auctioneer (Al-Dallal) and the book-keeper (Amien Al-Dafter) comprise the lower level of the Administrators' Board. Local villagers nominate each one after consent from village members, including the owners of the greatest shares in the Falaj's Badah. The agent (Al-Wakil) is in charge of the Falaj treasury. He keeps records, identifies rental revenues and collects the tenants' money when due. He is also in charge of maintenance expenditures and detailed transactions records, from which he must be ready to justify the annual budget of the Falaj to the villagers. Al-Wakil's role coordinates with that of the book-keeper (Amien Al-Dafter), and small villages integrate the two positions.

The identifier (Al-Arief), selected for his skill and experience, must keep up-to-date with the strengths, weaknesses and requirements of the Falaj so that he can suggest and justify maintenance, such as deepening the level of the Falaj when necessary. Al-Arief and Al-Wakil receive payment from the Falaj's annual revenues according to agreements between them and the Falaj committee. The auctioneer (Al-Dallal) announces the weekly auction sessions and looks for potential renters and bidders in the audience until he gets a satisfactory price for each lot of offered water. The book-keeper (Amien Al-Dafter) records the renter's name and the amount. Al-Dallal's decision on the conduct of the auction is final; he can withdraw lots from sale, or alter the lots offered for rent. He receives a certain percentage of the rental money for the Falaj water, according to the villagers' traditional practice. This percentage varies between 10%, when the Athar (half an hour of Falaj water) price is more than five OR, and 8% when it is less. The worker (Al-Bidar) implements all farming work: ploughing,

planting trees, irrigation, nocturnal or diurnal timing, and channel maintenance. In a small village, there are only one or two Bidars. However, some large villages, such as Al-Shuraigah, have five Bidars or more, as the village farms require. Al-Bidar receives a certain percentage of the farms' yields, for example, the yield of one or two of pomegranates, dates or rose trees.

This system is a convention among owners of the Falaj, and the appellations of these titles, the payments and the agreements vary according to different villages. The structure of the Administrators' Boards in small villages where not all functions are necessary is simple, as presented in Figure 7.16.

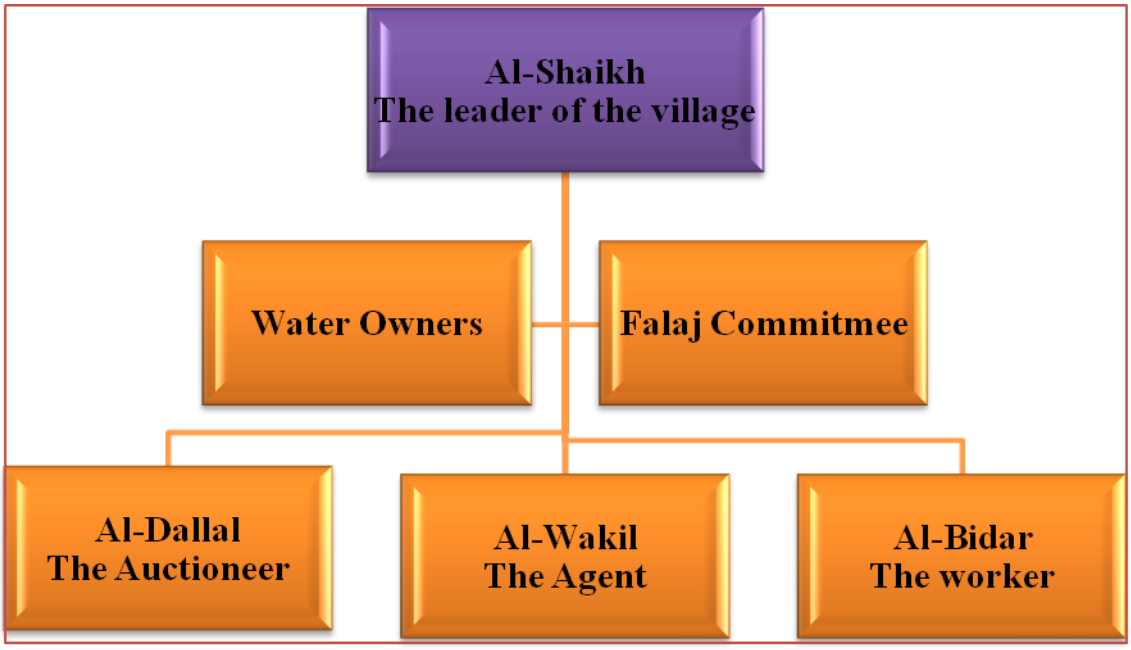



Figure 7.16 An administrative organization of the Aflaj (The Administrators Board in the small villages).

Given the authority and the power of the Board of Administrators of Falaj systems, despite the vice governor (Al-Wali), the judge (Al-Qadhi), and the Sheikh at the top of the administration board, their role is often to solve difficult cases referred by the agent (Al-

Wakil). Normally, Al-wakil is responsible for the overall administration of Falaj affairs, such as water distribution, rent, maintenance expense, and conflicts between farmers (Al-Ghafri and Norman, 2001). Because the agent's authority derives from the water rights holders, and because of his experience and knowledge, he enjoys the respect of the village community as he efficiently exercises his authority.

The Falaj can require three types of restoration or maintenance. The first includes updates, such as deepening the Falaj or extracting mud caused by water flow. This work mainly concentrates on the general tunnel from the location of the mother well, which is the main source of the Falaj, to the first open access of the Falaj (Al- Sharia), where water first comes to the surface, and where drinking water is drawn, free to all. This maintenance is the Falaj's expense, and the budget of the Falaj funds the work. Suad (45 years old), from Berkat Al-Moz, clarified how to repay a Falaj budget deficit, if that happened during necessary maintenance:

> ''If the revenue of the rental of the Falaj's water is not enough to fund the maintenance, then it is allowed to sell a share of this water, for the sake of common benefit, and for fear that it might be lost. Sometimes another Badah is added to the property share of the Falaj, which means that the Dawaran (rotation) of the Falaj will increase by one day. If it is running on ten days, for example, it will increase to eleven, and so on''.

However, presently, the government subsidises the villages' Aflaj in cases of excess demand, as there is a specialized department (Department of Aflaj) in the Ministry of Regional Municipalities and Water Resources. Vice Wali of Nizwa in the Al-Jabal Al-Akhdar commented:

> ''The Department of Aflaj provides financial assistance to farmers for the maintenance of Aflaj channel; such assistance was provided to Falaj Al- Kobari in the

village of Al-Ain, Falaj Wadi Bani Habib and Falaj Al-Azizi in Saiq. This aid is part of the efforts of the Department to enable farmers to maintain a continuous flow of Aflaj water, based on the objectives of the Department to enhance water resources and protect them against depletion, pollution and rationing water consumption''.

The second type of restoration is partial maintenance inside the village channel, such as repairing the channel or replacing it. Local people and owners of agricultural areas fund this type of activity, depending on their share of water. Sometimes, financing might receive help from voluntary donations, locally called Al-Hattah or Mosahemeh. However, this Hattah is sometimes a mandatory duty to achieve a just water distribution, particularly in drought periods or in tunnel or channel collapses. Finally, the maintenance of the subsidiary irrigation channels inside some parts of the village falls on the owners who benefit from the subsidiary irrigation channels. Those who do not use them are exempt.

There are different methods of documentation and registration of the Falaj's water. Despite the importance of registration to administration and finance, it remains open to individual interpretations (MRMWR, 2009). Today, documents known in some villages as Al-Noskhah or script documents, register ownership of water, while in other villages, such as Saiq, registration documents, known as Al-Daftar, record the distribution of turns and the circulation of the Falaj. Saud, the Wakil of Falaj al-Khotmain explained more about this:

''In these documents a record is kept by the list of Falaj days, each day is divided into two Badah and each Badah lasts 12 hours. Badah also has sub-divisions throughout the quarters (Rob'ah = six Athars) and single share (one Athar). It also records the turn of every stakeholder (A'ad), which determines the sequence in which the irrigation process happens. The purpose of this is to avoid disputes and abuses. If people agree to change the system of circulation, the records must document it. They also document any water purchase or sale using a Title deed kept by the purchasers''.

The village's notary used to oversee this operation, but today it goes to the legal courts in the main city (Nizwa). When the purchaser acquires the purchased water, evidenced by legitimate instruments, and continues to use it, ownership is established. The legitimate instruments gradually lose their importance as the owner of the water shares and his water rotation become known to the whole farmers' community. Even without the legitimate instrument, his water rights remain and the authorities can issue another legitimate instrument if two local people confirm his ownership to the legal court.

### 7.2.8 Religion and water resources:

It is important to analyze religious rituals when dealing with water in this region; local people think of water as a gift bestowed on human beings by Allah from water, all existence is generated (The Koran, Surat Al-Anbiya, Verse 30). As Man is the hand of God on the earth, his task has always been to improve people's living conditions while on earth, following Allah's Sharia and commandments. One of God's trusts to humans is to preserve water and to respect such a heavenly gift. The following examples illustrate the mystical dealings with water resources.

Firstly, the cleanliness and purity of water are vital, especially around the source of the Falaj, as people use this water for drinking. Nasser (45 years old), from Wadi Bani Habib, said:

> "I remember when we were young, our grandparents were very anxious about teaching us how to keep water clean and constantly flowing. My father used to prevent us from direct bathing in the Falaj using soap. He would make us take water from the Falaj in a bucket or any other container to bathe aside away from the Falaj water course''.

Suleiman (50), from Berket al-Moz, said:

> “Our ancestors used to tell us that if any of us threw a stone deliberately in the Falaj, he would later on be ordered to get it out with his eyelashes after D-day. So we would rush to remove any stones or other barriers that fell in the Falaj, even if we had not caused it to fall down".

Rashid (60), from Heil Lomsept, also explained how the Falaj was clean:

> “Every one of us used to drink from anywhere all along the Falaj course because everyone, then, would respect the cleanliness of such water; it was part of the religious rituals people practised. It was also a token of one's loyalty and faithfulness to God's most precious gift".

These testimonies suggest the extent to which people ensured the clean and continued flow of the Falaj. Any dropping of stones or debris in the Falaj stream hinders the water flow, which influences crop production and maintenance costs.

Secondly, many believe that paying the Islamic alms tax (Zakat) keeps the rain falling. The alms tax, levied on possessions, normally assists poor and needy people. Many associated stopping this practice with God stopping the rain. Continuing to cherish such a religious practice ensures that God will also continue to bestow people with rain. Mohammad Al-Tobi (45 years old), one of the local people from Birket Al-Moz, explained this perspective:

> ‘‘In the past, we were a helping community. The rich helped the poor and the people were all as one all the time to the extent that you couldn't make a clear difference between who really were rich and who really were poor and so everything was alright; rain fell regularly, water was abundant, and land was most of the time green. Now, however, many rich people stopped paying Zakat on the pretext that it is the government’s duty to help the needy people. Rain also has become scarce and most of our land is now thirsty and arid’’.

Although local people associate the scarcity of rain and the shortage of water with a lack of religious piety, some of them acknowledge that irresponsible behaviour towards environmental issues are, in fact, the real causes of their environmental dilemma. Abdullah, 40 years old from Saiq, illustrates the problems of the region's water resources:

> ‘‘Irresponsible activities of some individuals or some government agencies caused significant water pollution, which in turn may have caused diseases for plants, humans and animals. Washing dishes or clothing directly in the Falaj’s water is an example. Meanwhile, diesel leakage from the worn-out/corrosive tank that accrued in the army camp in Saiq in 1997 caused water pollution for Falaj Al-Azizi, where the diesel smell continued in the water for a month requiring government intervention to remove the tank’’.

Finally, in the past, people were committed to the system of sharing among other people, neighbours, to get part of the water for non-irrigation uses. Thus, the local people developed a system that gave everybody a daily share of water for everyday needs without disturbing the water flowing course to the farming lands. Hamed (50 years old), one of the local people from Al-Ain, explained:

> “All the village dwellers had the right to get water for their daily needs from the Falaj. People got their share of the drinking water by transporting it in special containers from the upper part of the Falaj near the source, called Al-Shuraigah. Anyone, even non-villagers, could get water there. Another spot, usually near the mosque, provided ablution and bathing in preparation for prayer - one for men and another for women. Water continued to flow down to the farming lands for irrigation with each farmer having a fixed time and share to do irrigation work. No one could transgress such a tradition; otherwise he would be sued in court.’’

The transportation of water from the Falaj to houses tends to be in relatively small quantities since only women carried out this task; it was shameful for a man to do such work. Most

containers transporting water are between 4 and 8 litres. In practice, this water distribution method is highly efficient in managing this scarce natural resource

### 7.2.9 The Aflaj today

The field data obtained during this study show that there were fundamental rules influencing this system. Many still apply today. Water distribution is mainly to the contributors (stakeholders or owners) and they inherit shares, while others might buy a share or rent according to their water requirements (Quadah). Water shareowners must identify one Badah or more for the benefit of the Falaj (Waqf, plural Awqaf). Those with no water ownership generally rent the water of Waqf, and revenues provide Falaj maintenances, schools, mosques, donations to the poor, and food for Ramadan breakfasts (Iftar). Turns (A'ads) come at different times in systematic succession (A'ad). This provides a fair system of allocation among beneficiaries. In drought periods that can continue for one or two years, farmers use an agreement to ensure proper adaptation to the circumstances. They give priority to plants for certain economic crops, reduce cultivated lands, and refrain from planting new trees, although they cater to the existing ones. They also increase the Dawaran days, so that they irrigate these trees less often in drought, and they reduce the agricultural season to two seasons instead of four. In some Aflaj, Al-Wakil decides the Dawaran system but decisions need agreement among the original contributors to the Falaj. If there are objections, the case shifts to the arbitrator/judge who decides, according to the overall benefit of the Falaj society. Once the arbitrator declares his verdict, everyone must be committed to its application; otherwise, the aggrieved parties can appeal to a supreme court headed by the Minister of the Interior. In terms of the Falaj committee, this committee still plays an important local role to value and utilise TEK. This will continue in the future as long as Aflaj system continues.

All the people recognize the importance of Aflaj in their lives; therefore, they want to maintain it as a tradition and a heritage - as a witness to their precursors' ingenuity in the management and use of natural resources and the environment. The best testimony to this was the Vice-Wali of Al-Jabal Al-Akhdar's declaration in the interview. He said:

> ''Aflaj are considered unique Oman specialties, not only as unique irrigation systems, but also as social systems started and continued in the region. Last but not least, the documents of Aflaj contain much of our heritage and our identity; we should take care of them - protecting, researching, and using inference, as in other fields of knowledge''.

## 7.3 Natural resources management and traditional environmental knowledge: agricultural land resources

Tables 7.4 and 7.5 display the perspectives of government officials and the local people regarding the TEK and practices related to the management of agricultural land in AAR. There seems to be partial agreement between government officials and the local people. This appears in the items addressing conventional agricultural systems and the Islamic way of managing the inheritance and sale of agricultural land, which were rated first and second, respectively, at the top of both of tables. There is also agreement with regard to the integration of local agricultural knowledge in government NRM programmes, which is rated at the bottom of both tables. Despite this agreement, however, the tables show that local people are more likely to agree on the presence of such knowledge and practices than are the officials. This is verified by the proportion of 54.2% of local people who strongly agreed with the presence of the first item (conventional agriculture system, Table 7.5), whereas the proportion is 22.5% in the officials' results (Table 7.4). Moreover, the sum value of the local

people's response to the first item is 532 compared to 494 for officials; this also suggests support for the statement.

There is another statement highlighting the difference between the results of officials and local people, which is the item addressing the planting and harvesting operations that are carried out with conventional methods, which is placed sixth in officials' results (Table 7.4), where only 9.2% of officials strongly agreed about the presence of this practice. However, this item is placed third in the local people's results (Table 7.5), with 36.7% of them strongly agreeing the existence of this practice. This can be explained by the fact that farmers are more directly linked to the land on a day-to-day basis.

Table 7.4 Perspectives of government officials regarding the TEK and management practices of agricultural land in the AAR.

| | TEK and management practices. | Mean score | Sum | Distribution | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 5 | 4 | 3 | 2 | 1 |
| 1 | Pursuing the Omani conventional agriculture system. | 4.12 | 494 | 27 | 81 | 11 | 1 | 0 |
| 2 | Land holdings are managed in terms of the Islamic way regarding to inheritance and sale. | 4.08 | 490 | 33 | 65 | 21 | 1 | 0 |
| 3 | Local people depend on their traditional knowledge in cultivation and harvest. | 3.97 | 476 | 13 | 95 | 8 | 3 | 1 |
| 4 | There are special norms which govern the operations of agriculture and harvest. | 3.92 | 470 | 23 | 68 | 25 | 4 | 0 |
| 5 | People in AAM have useful traditional knowledge relating to agriculture. | 3.86 | 463 | 16 | 81 | 13 | 10 | 0 |
| 6 | Planting and harvesting operations are carried out with conventional methods. | 3.78 | 453 | 11 | 83 | 17 | 6 | 3 |
| 7 | There is a satisfied integration of local agriculture knowledge in the government NRM programs. | 3.17 | 380 | 5 | 40 | 55 | 10 | 10 |
| Total of respondents = 120 | | | | | | | | |
| 1 = strongly disagree, 2 = disagree, 3 = not sure, 4= agree, and 5= strongly agree | | | | | | | | |

Table 7.5 Perspectives of local people regarding the TEK and management practices of agricultural land in in the AAR.

| | TEK and management practices. | Mean score | Sum | Distribution | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 5 | 4 | 3 | 2 | 1 |
| 1 | Pursuing the Omani conventional agriculture system. | 4.43 | 532 | 65 | 46 | 6 | 2 | 1 |
| 2 | Land holdings are managed in terms of the Islamic way regarding to inheritance and sale. | 4.25 | 510 | 49 | 55 | 13 | 3 | 0 |
| 3 | Planting and harvesting operations are carried out with conventional methods. | 4.25 | 410 | 44 | 64 | 10 | 2 | 0 |
| 4 | Local people depend on their traditional knowledge in cultivation and harvest. | 4.15 | 498 | 33 | 73 | 13 | 1 | 0 |
| 5 | People in AAM have useful traditional knowledge relating to agriculture. | 4.13 | 496 | 33 | 74 | 10 | 2 | 1 |
| 6 | There are special norms which govern the operations of agriculture and harvest. | 3.78 | 454 | 22 | 64 | 23 | 8 | 3 |
| 7 | There is a satisfied integration local agriculture knowledge in the government NRM programs. | 3.26 | 391 | 12 | 28 | 64 | 11 | 5 |
| Total of respondents = 120 | | | | | | | | |
| 1 = strongly disagree, 2 = disagree, 3 = not sure, 4= agree, and 5= strongly agree | | | | | | | | |

Furthermore, the results of the officials regarding the traditional management practices of water resources (Table 7.1) broadly match the results regarding the traditional management practices of agricultural land (Table 7.4). More precisely, the items addressing conventional systems in water harvesting and agriculture, and the Islamic way of managing the inheritance and sale of water shares and agricultural land were rated at the top of the both of tables. This also occurred in the results of the local people (Tables 7.2 and 7.4). This can be explained by the association between, and the overlapping of, knowledge and practices relating to both water resources and agricultural land resources, where most of the water resources in the region are exploited in agriculture through traditional irrigation systems (Aflaj).

### 7.3.1 Local practices of agricultural land management in the AAR

Agriculture and its related pastoral production play a vital role in the AAR. Not only are they important for local economic and social prosperity, but also they are a part of Omani identity.

However, the land best suited to agricultural production in the region is limited (Al-Busaidi, 2009). Consequently, local people have made efforts to conserve these lands, based on their traditional knowledge, norms and practices. Doing so, local people, like most farmers, focus on the protection of the key land properties that contribute to profitable production and a healthy soil, maintaining and avoiding their degradation. Local practices in managing agricultural land are, consequently, mainly determined by a set of conventional technical principles, local knowledge of dealing with natural resources and their constraints, and economic considerations of profitability after achieving self-sufficiency.

An analysis of the interviews and the focus group results suggest that management issues relate mainly to climatic situations, water supply, soil fertility and field management. Such management practices will be reviewed in an integrated context, in which management practices related to climatic situations, for example, can be distinguished from those management issues related to soil and fertility supply.

Knowledge related to climate conditions and their impacts on crop production are an important part of local knowledge. Since ancient times, local people have recognized that the climate, locally called Al-Gaw, affects crop production directly through temperature, rain, air humidity and wind. They also recognize that they cannot solely rely on rain-fed agriculture due to the unreliability of rainfall and the regular occurrence of drought periods. Therefore, they rely on irrigated agriculture that in turn relies on the exploitation of groundwater through traditional irrigation systems (Aflaj), presented in the preceding section. The clearly defined circulation of water shares among farmers gives them the capacity to decide the crop and the area to be cultivated or left fallow, and this enables them to use the scarce water efficiently.

Figure 7.17 illustrates the irrigation calendar for perennial and seasonal crops cultivated in the region.

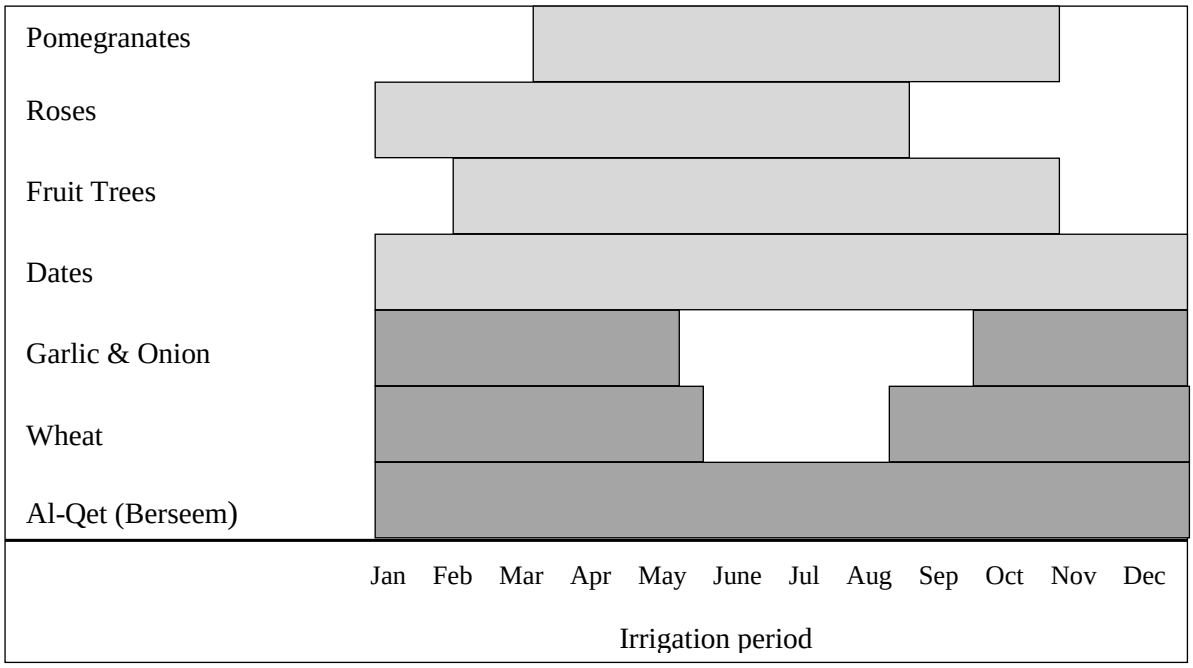



Figure 7.17 Irrigation calendar for perennial (light gray) and annual (dark gray) crops cultivated in the AAR.

Local people recognise that they cannot grow all the crops they need at the same altitude in the mountains, due to the different crop needs for varying temperatures. The lower altitudes are for the date-palm trees, while pomegranate, peach and roses grow at higher altitudes. Maryam, 50 years, explained:

> "We usually take advantage of the rainfall for agriculture, but we cannot rely entirely on an irregular rainfall. Some crops need a regular amount of moisture during the growing period, and this is only available through the use of the irrigation process, where any increase in supplying water for the crops (increase or decrease) directly affects the nature of crops growth and the quality and quantity of the crops ".

Shethra, 60 years old from Saiq, clarified the situation further with this example:

> "Pomegranate, for example, its irrigating needs a particular organization; it should be left without irrigation in the winter (December - February) and then irrigated regularly

every eight days during the flowering period (March), then irrigated every six days in the summer (June-August) when temperatures are higher, then back to eight days during the period of fruit ripening. We must be cautious of increasing the amount of irrigation water during the fruit ripening period, otherwise fruit will segment, leading to its mouldiness, which leads to reduced market value".

This has led local people to a careful selection of perennial and annual crops, as well as the appropriate selection of agricultural operations for crops in different agricultural seasons: ploughing, fertilizing, watering, and harvesting, then marketing and selling or storing. As will be shown later, the performance of those people, based on a systematic agricultural calendar, is evidence of carefully thought agricultural practices. In fact, the people of Al-Jabal Al-Akhdar follow an agricultural calendar limited to their particular local environment - a calendar that is not based on the cyclical running of universally known months. Generally, people there used to observe for themselves the stars' location in the sky, the apparent movement of the sun, particular climatic signs and general changes in the local flora to identify the beginning and the end of the farming seasons. This agricultural calendar of the region can be summarized as follows:

**Winter:**

Winter starts, according to the local people of al-Jabal Al-Akhdar, by the completion of the reversal of the Sun's ebbing to the south in the sky. This is actually identified, at very early time, after observing sunset, after the 20$^{th}$ of June, as a sign in the sky for three consecutive days at a particular locally well-defined place. This is confirmed when some stars like the Pleiades Al-Thureya are clearly noticeable in the sky. Here starts the first of forty days of winter, known locally as Sardat Al-Ardh, meaning the surface of the ground is becoming cold. The types of agricultural activities in this time of the year include the following:

First, taking care of the rose trees by trimming them, ploughing the soil around them and fertilizing them. Watering them, however, starts later, approximately at the beginning of February at Sardat Al-Hawa when the weather begins to become gradually warmer and the trees start blossoming.

Second, undertaking agricultural work of pomegranate trees, as well as the vines: ploughing the soil around them; trimming and fertilizing them using local natural fertilizers such as animal manure mixed with the plant remnants; and planting the seeds of seasonal crops such as garlic, onion, corn, wheat and barley. It is worth noting that pomegranate trees and rose trees are intentionally deprived of water for about two months (December and January).

Third, the end of January starts the second period of winter, which is characterized by the blowing of the western and northwestern winds continuing intermittently during February. With the appearance of Al-Meyazin stars in the middle of December starts the sowing of wheat. After nearly one hundred and twenty days the harvesting season starts. Al-Meyazin is a set of stars, about seven, which shows up in the sky twice a year in December and July. A further sign of the second period of winter in the lowlands is the appearance of palm trees' fruits around the end of December.

It should be noted that there is typically a supportive partnership between all family members in agricultural operations throughout the year. Hamed (50 years old) from Berkat Almoz described this thus:

> ‘‘All family members are urged to participate in the agricultural operations. However, everyone has a particular role to play according to their abilities, knowledge and gender. Men are the workers who do the operations that need a physical effort such as ploughing and fertilization, whereas women specialize in the operations that require flexibility and care such as extracting harmful weeds between seedlings and garlic.

> Children participate in the light activities that do not require muscular effort or considerable knowledge such as handling and catering. It is important to emphasize that some works are regarded a women's duty, and it is shame on the man to do it; most of these are dealing with livestock feeding and milking and buttermilk production are among them''.

**Spring**

Among the signs of the beginning of the spring season are the blossoming of the surrounding flora, frequent rain showers, and the gradual rise in the ambient temperature. There are also astronomical signs, such as the appearance of the Kawkabane, meaning literally the two stars, in the sky fifteen days before the appearance of the Pleiades, approximately in the middle of May. This is the last date when the pomegranate trees blossom. In the lowlands, however, spring is marked by the blossoming of the dates palm trees that require human effort to complete the process of pollination, which is called locally Al-Tenbit. By the end of this season, dates, especially the first types known locally as Al-Nneghal, start ripening. A further sign of this season is the blossoming of specific important wild trees, such as Rhamnus (Al-sidr) and Acacia tortilis (Al-Talh); their flowers constitute an attractive source of food to honey bees.

Among the different agricultural activities practiced at this time of year are:

First, the starting of the watering sessions for roses and pomegranate trees after not doing so during the whole winter season. The watering process is conducted in a rigorously calculated way so that the trees' yields, which constitute the main source of income to the farmers in the region, will be optimal. Thus, watering sessions take place again every twelve days in times of rain, and every six days from the local Falaj when there is no rain. As pomegranates ripen,

between August and September, there need to be longer intervals between watering sessions so that the fruit will not split open.

Second, the end of March and the beginning of April marks the harvesting of roses, collecting them and temporarily storing them until they are later distilled. Roses are temporarily stored for not longer than two days before they distilled, so that the aromatic smell is preserved.
Third, there is the ploughing around annual crops like garlic and onions, known locally as Tanbeer, along with the removal of parasitic grass known locally as Helal; the adding of organic fertilizers, especially animal dung, is undertaken.

Fourth, the harvesting, storing and marketing of garlic begins. Hareb (70 years old from Al-shuraigah), described three ways of storing garlic. He said:

> ‘‘After we pull up the garlic, we store it in three ways: (a) gathering the garlic sticks, with all its bulbs and semi-dead leaves on, into relatively small bunches and then hanging them in special rooms aerated enough or on the branches of the trees scattered in the house enclosure or the farm. (b) stringing up of the garlic in some sort of a rope about two metres long with the sticks and leaves braided like a girl’s hair and this is actually an attractive way for the marketing of garlic afterwards. (c) the separation of the semi-dead leaves of garlic from its bulbs to be directly sent to the market afterwards. The semi-dead leaves are then scattered under the sheep and cattle’s feet to be part of the organic fertilizer obtained from animal dung’’.

It is also worth noting that some of the garlic, especially the best part of it, is stored to be used as seeds the following year.

Fifth, the end of May starts the harvesting of wheat and this relies on cooperative labour. Farmers start by cropping the wheat and putting it in a sunny spot of the ground, called locally Al-Jannour, so that the wheat tufts/ears are dried before they are separated from the hay. This is done by hitting the wheat ears with a type of thick stick often cut from palm

trees. This work is usually done by men; the role of women comes later in the process of winnowing the crop to separate the grain from the straw. Aeshah (65 years old) describes wheat harvesting thus:

> ‘‘Wheat harvesting has special ceremonies that are when the crops of wheat are ready to be harvested; the locals work mutually and cooperatively. They all work, daily to harvest each ones land. When they complete, the wheat is dried in a place called locally Al-Jannour. The locals gather again to hit the wheat with sticks taken from palm leaves or olive trees. The hitting process aims to separate the grains from the straws, then it is filtered in the open air until the straw (Teben) is totally removed. Finally, the crops are filled in sacks, locally called Goniyah made from thin robes; the sacks are transported to be sold in the neighbouring markets of Nizwa and Rustaq’’.

**Summer**

Among the signs announcing the beginning of the summer season, as identified by Abdulah (60 years old) from Saiq, are the following:

> ‘‘The falling of rain especially in July, called by the local people as the fertile month, when the phenomenon of Gharqat A’sha’ara appears and goes on for about twenty days with rain often falling in the afternoon. There are also astronomical signs related to the season as the appearance of the Soheel that is the Nova Soheel star around the end of August and the beginning of September. The appearance of such a star is a clear sign to the farmers of the full ripening of the pomegranates which are not normally picked until they have been watered twice during the full light of the Nova Soheel star, after at least twelve days since its initial appearance. This season is also announced by the ripening of the first fruits of the fig trees and dates of the Bal’aq type’’.

Among the different agricultural activities in such a season are:

First, the first harvests of apricots, figs and berries, followed by pomegranates, most of which are sold in the neighbouring markets of Nizwa, Bohla and Rustaq. The method of cultivation, storing and marketing the pomegranate is described by Sulaiman Al-Mayahi (55 years old) from Al-Shuraigah thus:

> ‘‘First the pomegranate is put in a special room and arranged carefully in order to ensure that the pomegranate pieces won’t be crushed or destroyed. When the product is marketed in this stage the outer layer of the product is dried perfectly. The pomegranates are filled in special sacks or bags called Goniyah, but before putting the pomegranates in the bags they are saved by special cushions to protect the product. These cushions are from Elias and Ashaa’s leaves which are soft ones used to ensure the protection of pomegranates from bruising. The product then is marketed and sold in the neighbouring souks of Nizwa, Rustaq and Samail. This product is also sold in the Mutrah Market in Muscat where the farmers go themselves. Also, the traders may come from Muscat to buy the pomegranates at source’’.

Second, the watering of fruit trees, such as pomegranates, apricots, figs and berries continues, as well as of the seasonal crops, such as radish, onions, coriander and tomatoes. Third, the sowing of maize seeds and, for the second time, wheat around July. Fourth, tilling the soil and leaving it exposed to the sun is one of important tasks in this season.

Fifth, the harvesting of Al-Se’ater thyme is done by clipping the upper part of the plant. Thyme is a medicinal wild plant, but local people use it as a flavouring in many types of food, but especially in tea with milk. Abdulah (60 years old) from Saiq explained more about Thyme harvesting:

> ‘‘Al-Se’ater is a kind of a grassy plant growing in the northern parts of Al-Jabal Al-Akhdar on the sloping sides of the head of the mountain. This plant is harvested in early summer, after it has grown benefiting from the spring rainy conditions. The harvest requires a knowledge of the places in which it grows as it usually grows in shady places in front of the entrance of the caves, for example. This plant growth is

> limited to the northern slopes of Al-Jabal Al-Akhdar, as it does not grow on the southern slopes. Local people explain this by the brightness of the star Nova, Sohail, that faces the northern slopes, and that this tree does not grow in places that face this star''.

Clearly, the local explanation of this phenomenon cannot be explained by the brightness of some stars since plant distribution is mainly related to soils and climate. The mountain supports a number of climatic zones that are characterised by temperature level and types of plant. Thus, plants and trees such as Acacia tortilis (Al-Somr) grow within a zone where temperature ranges between 25°C in winter to 40°C in summer (MTC, 2010). Olea africana (Al-Atem) grows at higher altitudes at lower temperature ranges between 10°C in winter and 30°C in summer. Juniper (Al-al'alan) trees need lower temperatures and so they grow on the highest parts of the mountain above 2000 metres, where temperatures range between 8°C to 25°C (MTC, 2010).

**Autumn**

As previously discussed, the people of Al-Jabal Al-Akhdar are accustomed to using instruments such as sundials to identify the beginnings of the different agricultural seasons. These features are set up on the highest part of the mountains, at cave entrances, or even around the perennial trees. Among the signs announcing the coming of autumn are the days becoming shorter and the nights longer, the end of the pomegranate harvest season, and the end of date harvesting in the lowlands.

The major agricultural activities in this season are:

First, the farming "hundred days" or what is also locally called Rab'aaniat. Farmers start to prepare for farming work like ploughing, maintenance of the irrigation ditches of the Falaj, preparing organic compost by evacuating manure from the corral, and transfering it to the agricultural terraces to fertilize the land.

Second, the sowing of seeds for the annual crops, such as onions and legumes, also starts at this time of year in line with the follow-up of the irrigation cycle of the second wheat crop. After that, wheat, onions and legumes are harvested by the end of the season. Third, the irrigation cycle of the roses' trees is stopped in November and continues through to February. Fourth, there is an evaluation of the seasonal calendar in preparation for the next year. In this regard, Abdulah (60 years old) from Saiq, in the interview,

> ''Actually, this season, as it is the latest season of the year, is a good occasion to stop a while to assess the previous farming operations. Did farmers actually gain the financial value that they had planned? In the light of this and in preparation for the new season [winter], farmers do the necessary maintenance of the agricultural terraces and irrigation channels, and plough the farmlands that will be fallowed all the autumn period. Usually the farmers cooperate with their neighbours to extract compost gathered during the last period under the feet of cattle, because this process needs a physical effort in evacuating, lifting and transport, which was usually done on the backs of the donkeys''.

From the discussion, it can be seen that such a well-organized agricultural calendar, both the seasonal and the annual one, is the result of a constant accumulation of observations, experiences and inherited knowledge, such as that related to the suitable timing to plant fruit and nut trees, and to sow grains. Such experienced knowledge of the climatic and astronomical conditions and the nature of the land itself supports agriculture and creates a sense of food security. The seasonal nature of the crops grown has also guaranteed farmers

enough permanent income and enough permanent markets. Sulaiman Al-Mayahi (55 years old) from Al-Shuraigah confirms this thus:

> ‘‘The people in Al-Jabal Al-Akhdar depend on varied crops such as fruits, grains, legumes and vegetables as a sustainable source for their income. Add to that such crops were important commodities to supply neighbouring markets, Nizwa for example; this supplying contributes significantly to the continued presence of these goods in these markets’’.

The great expertise and knowledge that the local people have about the environment and the different farming methods to make best use of that environment, have contributed much to the success of the agricultural sector in the region. Nasser (40 years old), one of the farmers of Wadi Bani Habip, described the great expertise that the local farmers have about farming,

> “Walnut trees need a special way for growing them on mountain terraces. Farmers, put a kind of flat stone at the bottom of the hole the walnut tree is going to be planted in, and, then, cover it with soil so that they guarantee that the root of the tree will stretch rather horizontally than vertically because the soil in the terraces is not deep enough. Our ancestors noticed that when they plant walnut trees without using such a technique, the trees would soon die because they would grow against the mountain foot where no nutrients or water is available”.

As can clearly be noticed here, the local people also learn by trial and error and by drawing conclusions from their observations. They also show a deep knowledge of the type of soil they are dealing with. Many know that the soil in such a system is of poor quality; some resort to using organic fertilizers, especially those made locally from mixing animal dung with farming litter, to improve soil quality and so increase production. Others prefer to resort to fallowing, giving the farm land some rest for one season at least. This is done, of course, when the farmer has enough space on his farmland to allow him to do this. For example, if a farmer has 10 terraces he may fallow 3 or 4 of them to be planted the next year. Many have

learned how to differentiate between the irrigation needs of argillaceous soils and those of sandy soils. Salim (60 years old), an old farmer in from Al-Manekher, said:

> ‘‘The soil of Al-Shuraigah, for instance, is rather sandy and so it is kind of porous and, thus, needs much water, whereas the soil of Wadi Bani Habib is mostly argillaceous and so doesn’t need a lot of water because it is not porous and holds water longer than sandy soil. Moreover, both soils need quantities of organic compost; sandy soil to increase its fertility, and argillaceous soil to increase its absorption of water”.

This indicates that local people are well aware of the properties of the soil and its need for water and fertilizer, a knowledge which does not conflict with the findings of Western knowledge in this regard, as these types are mentioned by scientists of soil such as Finkl, (1982) and Guillet (1992).

In times of drought, the local people also have developed contingency plans based on their traditional knowledge, what might be termed crisis management or risk management. Thus, people have been able to deal with drought in ways that provide continuous production of some important crops for everyday life and for the generation of appropriate revenues, in preference to others. Nasser (60 years old), a farmer from Al-Qush’a, explained more about this:

> ‘‘When it is drought or lack of rain, people resort to the following solutions. First, they stretch out the intervals between the irrigation cycles of the plantation, that is instead of doing irrigation every six days they do it every twelve days or every eighteen days and this is applicable only when the plantation stands it. But if not, as a second measure, they stop growing seasonal crops like garlic, onions and legumes, and devote themselves completely to the taking care of the permanent crops like pomegranates, nuts and roses which tend to be closer to the Falaj springhead and so the faraway fields remain abandoned. To ensure a good flow of water in the channel,

water is usually collected in a pool (Legel) prepared for this purpose before directing it to irrigate the crops’’.

Figure 7.18 illustrates unplanted terraces during drought periods in Al-Shuraigah in the AAR, as one of the solutions to deal with the impact of drought.

Figure 7.18 Unplanted terraces during drought periods in Al-Shuraigah in AAR.

In terms of the management of water and land ownership, as earlier discussed, the water of the Falaj is shared by all the people who built it and who pay their contributions to maintain it. The shares of the Falaj water are also distributed according to the efforts exerted to carry out the construction and maintenance works, the money paid to achieve that, and the amount of land a shareholder has. These shareholders, in their turn, can bequeath such shares of the Falaj water or their farmland to their children after their deaths. This way, the circle of the shareholders has widened, which, in turn, has led to the fragmentation of Falaj water shares into small single shares (Athar), and the fragmentation of the land into sometimes very small parcels. This situation has greatly affected the quantity of produce obtained and the amount

of income earned from selling such produce. Although many of the families have tried hard to avoid such situations by keeping the marriages of their sons within the circles of the family or tribe, this does not always work. However, if one of the farmers wants to increase his area of land, and so widen his share of the Falaj water, he can buy more land from his neighbouring farmers, especially since the Islamic laws are the ones applied in land matters and may permit any farmer to use the law of priority. This law (Shof'ah) allows the purchase of neighbouring land as long as the offer meets the prices claimed. For example, if a farmer wants to sell his land for 3000 RO (£4,812), according to Shof'ah the right of first refusal, is to the neighbour, if he offers the required amount.

## 7.4 Natural resources management and traditional environmental knowledge: pastoral resources

The perspectives of government officials and the local people regarding the TEK and practices related to the management of pastoral resources in the AAR are displayed in Tables 7.6 and 7.7. Four themes appear to be dominant. First, officials did not share all the local people's opinions about the presence of some of the traditional management practices of the pastoral resources in the region. This can be seen in the rank difference of the item 'adhering to the Islamic legislations concerning the management of pasture and animal husbandry', which was ranked first by government officials, as 81.7% of them (Table 7.6) agreed or strongly agreed that local people still adhered to these legislations, whereas this item was ranked fifth in the local people's results with a percentage of 75% (Table 7.7) agreeing or strongly agreeing.

Table 7.6 Perspectives of government officials regarding the TEK and management practices of pastoral resource in the AAR.

| | TEK and management practices. | Mean score | Sum | Distribution | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 5 | 4 | 3 | 2 | 1 |
| 1 | Adhering to the Islamic legislation concerning the management of pasture and animal husbandry | 4.08 | 490 | 33 | 65 | 21 | 1 | 0 |
| 2 | Local people depend on their traditional knowledge in pastoralism. | 4.00 | 480 | 22 | 80 | 14 | 4 | 0 |
| 3 | Local people rely on the special knowledge in animal husbandry. | 3.91 | 469 | 18 | 80 | 16 | 5 | 1 |
| 4 | Local people are grazing in traditional methods. | 3.90 | 468 | 20 | 79 | 11 | 9 | 1 |
| 5 | People in AAM have useful traditional knowledge relating to pastoralism. | 3.86 | 463 | 16 | 81 | 13 | 10 | 0 |
| 6 | There are special norms govern the operations of pastoralism. | 3.80 | 456 | 22 | 61 | 29 | 7 | 1 |
| 7 | Local pasture knowledge is integrated in natural resource government NRM programmes. | 3.13 | 376 | 5 | 40 | 51 | 14 | 10 |
| Total of respondents = 120 | | | | | | | | |
| 1 = strongly disagree, 2 = disagree, 3 = not sure, 4= agree, and 5= strongly agree | | | | | | | | |

Table 7.7 Perspectives of local people regarding the TEK and management practices of pastoral resource in the AAR.

| | TEK and management practices. | Mean score | Sum | Distribution | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 5 | 4 | 3 | 2 | 1 |
| 1 | Local people depend on their traditional knowledge in pastoralism. | 4.21 | 505 | 42 | 65 | 9 | 4 | 0 |
| 2 | Local people are grazing in traditional methods. | 4.15 | 498 | 37 | 69 | 9 | 5 | 0 |
| 3 | People in AAM have useful traditional knowledge relating to pastoralism. | 4.13 | 496 | 33 | 74 | 10 | 2 | 1 |
| 4 | Local people rely on the special knowledge in animal husbandry | 4.02 | 482 | 31 | 69 | 13 | 5 | 2 |
| 5 | Adhering to the Islamic legislation concerning the management of grazing and animal husbandry. | 3.96 | 475 | 43 | 47 | 13 | 16 | 1 |
| 6 | There are special norms govern the operations of pastoralism. | 3.78 | 453 | 23 | 63 | 22 | 8 | 4 |
| 7 | Local pasture knowledge is integrated in natural resource government NRM programmes. | 3.26 | 391 | 12 | 28 | 64 | 11 | 5 |
| Total of respondents = 120 | | | | | | | | |
| 1 = strongly disagree, 2 = disagree, 3 = not sure, 4= agree, and 5= strongly agree | | | | | | | | |

Second, there is a positive view of the reliance on traditional knowledge in pastoralism, as this item was ranked second in the officials' results with 84% of them (Table 7.6) agreeing or strongly agreeing on the existence of this practice, while it was rated first in the local people's results with 89.2% of them (Table 7.7) agreeing or strongly agreeing with the officials' opinion. Third, there is a contrary opinion about practicing 'grazing by traditional

methods' and the existence of 'useful traditional knowledge relating to pastoralism', as these items rated second and third respectively in locals' results (Table 7.7), whereas they are rated fourth and fifth respectively in the officials' results (Table 7.6). Fourth, there is a shared similar perspective towards upholding the norms of grazing, as both officials and local people perceive that people in the region become less dependent on inherited norms that govern the operations of pastoralism, with a proportion of 69.1% of officials (Table 7.6) and 71.7% of local people (Table 7.7) who agree or strongly agree about the existence of these norms. Officials also share their negative perspective about the integration of local pasture knowledge in government NRM programmes with local people, with a proportion of only 37.5% of officials (Table 7.6) and 43.3% of local people (Table 7.7) considering that this integration to be evident.

Local people appear to regard their practices as rather more dependent on their traditional knowledge and traditional methods, while Islamic legislation is regarded only as a reference point, to which they resort only in conflict situations. So they rated 'dependent on traditional knowledge' first, and 'adhering to Islamic legislation' fifth (Table 7.7). This is contrary to the officials' results (Table 7.6). Vice Wali of Nizwa in Al-Jabal Al-Akhdar explained the reasons which prevent local people from having recourse to the Islamic legislation that are often presented by judges in Sharia courts:

> ''Grazing is practiced by traditions and customs generally accepted by everyone. It serves as the umbrella or the public authority that regulating various matters of grazing. Thus, as long as shepherds follow these norms, they are not needed to prosecute according to Islamic Sharia; this only happens if troubles get beyond those norms. For example, theft or killing of animals that rarely occurs''.

These results clearly indicate that officials, despite their apprehension about some of the traditional practices in the region, remain remote from a real and complete awareness of these practices. This could be attributed to the lack of positive communication between those officials and local people, as the communications occur through formal channels, which are sometimes not enough to comprehend all issues. This statement is supported by the following from the Manager of Pastoral Resources in the Ministry of Agriculture. He said:

> ‘‘At the moment, communication with local people goes through the official channels, through the Sheikh (chieftain), for example, in which case there will be some compliments from some chieftains, as they look to cooperate with the government. However, in fact, what we aspire to is to communicate with people as individuals and groups so that we can extrapolate their opinions, needs and problems’’.

A further view came from the Director General of Natural Conservation in the Ministry of Environment and Climatic Affairs, when he described the participation of the public in decision making:

> ‘‘This will be a future challenge between decision makers and the current generation regarding the way to deal with similar issues. More coordination and cooperation should be made between the concerned government agencies and the office of the Wali to involve the local leaders and local people in programmes that deal with the management of the natural resources in Al Jabal Al Akhdar’’.

Local people deal with pastoralism through three major parallel management practices, all of which rely on traditional knowledge accumulated over successive generations: firstly, there are management aspects related to rangeland; secondly, management aspects related to the animals; and thirdly, management aspects related to marketing and selling. However, the management of rangelands and the requirements of different grazing operations result from a clear understanding by local people of the importance of this vital sector in the region. Many

local people consider rangelands to be the basis of their sustainable pastoralism operation. This is especially important as the pastoralism sector continues to experience extraordinarily increasing pressure resulting from natural- and human-induced factors (Figure 7.19). Natural pastoralism systems offer grazers the capability to let the animals' environment and their immune systems work together, thereby gaining a suitable level of production while naturally preserving the integrity of the ecological connections between animals, the soil and the pasture plants (Rinehart, 2008). In this regard, local people maintain profitable pasture-based operations that can ensure reasonable production, reduce input costs, and achieve a suitable revenue.

Figure 7.19 Goats forage for food in front of a house built by the government (social housing) in a grazing site.

These profitable pasture-based operations, according to local people, are achieved as animals are mainly raised for the purpose of slaughter or sale, and because prices for Al-Jabal Al-Akhdar goats in local markets are high, reaching up to 250 OMR (approximately 418.156 GBP) for mature goat bucks (Figure 7.20). Local people, therefore, achieve two outcomes: first, to provide meat for celebration occasions; and second, to gain appropriate amounts of

money from the sale of goats. In addition, they benefit from the animal dung as fertilizer, and from wool as a raw material for fabric production.

Figure 7.20 Animals auction in Nizwa Market.

Pastoralism in the region, as described by pastoralists in the interviews, is well-organized and managed, based on the administrative organization of the region that is divided into several villages, and based on the natural and seasonal climatic conditions. This means that the pastoral operations are not established in the same place year-round or season-round, but are allocated or divided into more than 10 grazing places according to the villages' locations, and, in each village, the pastureland is allocated or divided according to the year's seasons. Sulaiman Al-Mayyhi (50 years old) from Al-Shuraigah, described the pasture operation in the region thus:

> ''Pastures are defined to each village, where the shepherd monitors and follows the goats while they graze in a specified range that is not allowed to encroach it. This means that goats are forced to graze in one place of not more than 1 $km^2$). For example: pastures in Al-Manacher village are vast and there are about 30 pastures

identified for grazing, on which the animals used to graze from each pasture once a month which lets the grass grow and be renewed frequently''.

As confirmation of the preceding description, Maryam (60 years old from Saiq) described the process of grazing:

> ''Grazing is carried out on specified pasture areas specific to each village and it is not permitted for another village to occupy these pastures (Figure 7.21). Mobility between the grazing areas is agreed upon between the shepherds and Sheikhs of the villages. In cases of drought, another agreement is reached between the Sheikhs of the villages on the sharing of pasture that is not affected by the drought. The journey of grazing starts at 7 o'clock in the early morning, then finished before sunset. The animals, then, are kept in their barns to be additionally fed and watered''.

The organization of grazing that the local people follow makes it clear that they are aware of the benefits of such methods, both to the pastures and the goats. Although this method is ancient, it is still followed today in the area, and may be carried out under different names, such as ''rotational grazing, management-intensive grazing, multiple-pasture rotation, short-duration grazing, cell grazing and controlled grazing'' (Beetz and Rinehart, 2004 p: 1). These methods are all grazing management strategies, characterized by periodic movements of animals to fresh grasslands, so that pastures are allowed to recover before the next grazing time.

Figure 7.21 One of the Saiq's pasture areas.

In some villages, more than one strategy of grazing is used. The following explains the one used in Wadi Bani Habib:

> ''Wadi Bani Habib has a large area for grazing, and we follow the rotation of grazing. In addition, we have an estate system (Al-Hawzah) to enhance the growing of the grass and the plants. Al-Hawzah is a specific place surrounded by a low wall of rocks, and entering it is limited to only one day in the year. This day is known by all dwellers of the village, and when it comes, each family member allows accessing Al-Hawzah to mow grass and weeds or pick some wild fruits, so that each individual is permitted only one load. Then Al-Hawzah will be closed until the next year. Whoever intentionally enters goats within Al-Hawzah outside this period, these goats will be slaughtered as a punishment, and the lamb will be given to all the dwellers'' (Naser 45 years old).

This type of grazing arrangement is seeking the greatest benefit from the pasture, but with the least harm. No one is allowed to let their goats graze near the farms to protect the crops. Similarly, sick goats are not allowed to graze with others, but kept isolated in a barn until

they are cured or they die. However, when the goats return to the homestead in the evening, they are kept in the barn and are fed suitable amounts of dried dates, dried sardines and any available cultivated green fodder, such as alfalfa, barley or maize.

There are two main ways of implementing the grazing operations. These were explained by Saleimah (65 years old):

> ‘‘Grazing operations are usually done in two ways: firstly, by hiring a shepherd who is specialized in such tasks and he will be paid for his efforts. The payment will be collected from those dwellers who sent their goats to the pasture. Secondly, grazing is carried out by the dwellers themselves and in shifts, depending on the number of goats, those who own more goats shepherding more days’’.

In normal situations, when the pastures have enough grass to satisfy the animals’ needs, the goats are left to graze independently without any supervision. However, in dry seasons, the shepherd helps the goats by cutting tree branches, such as the wild olive (Al Attom), or by hitting branches with sticks to let the leaves fall on the ground where the animals start to eat. The latter usually applies to acacia. People do not believe that these methods cause any harm to the trees. On the contrary, they believe that the trees, after cutting some branches from them or hitting them with large sticks, grow back again, perhaps even better than they were in the first place. However, observations of the status of some trees that have been affected by branch cutting indicate that these trees differ from those that were not eligible for cutting. The differences were noticeable in the size and natural shape of the tree, as well as in the appearance of cut marks (Figure 7.22).

Figure 7.22 A comparison between branches-cut tree (right) and this that is not eligible for the cut (left).

In addition, people like to cut branches, believing that the wild olive tree leaves give the meat a better taste. This, encourages people from the neighbouring areas to buy AAR goats, and this, in turn, provides good prices for goat breeders. Marketing and sales operations depend on religious occasions (e.g. Eid al-Fitr and Eid al-Adha) and goat breeders' needs for money. The sale of goats is a good source of income, and prices range from 50 OMR for a young goat to 250 OMR for a mature goat (1.00 OMR = 1.67321 GBP). This is explained by Sulaiman Al-Mayyhi (50 years old) from Al-Shuraigah:

> ''Marketing the goats is one of the most important stages for goat breeders. Thus, they are keen to get the equivalent amount to what they spent on the goat. Marketing operations are carried out in two ways: one is in the village when goat traders come to the villages and buy them from the owners themselves. The other one is through the people themselves when they take the goats to Nizwa market. The distance and resting period take almost a whole day. However, the journey difficulty becomes trivial after selling the goats and other products achieving plentiful profits''.

The secondary income they receive is from the sale of animal products such as leather, ghee and wool textiles. These products also have a high demand from customers, and therefore, products are profitable. Shazra (60 years old) clarified more about animal-related crafts:

> ‘‘A lot of crafts are based on animal products such as weaving goat and sheep wool, dairy production, tanning leather and leather handicrafts. For wool textiles, the wool is taken from the goats after the end of winter, then it is gathered on a special mat called Semmah and after that, the wool is hit until it becomes flexible and then is cleaned. Finally, it is sold or weaved as ropes or woollen clothes, nets or mats (Seihah). For leather products, the goat’s leather is salted and dried, sold to the Shamar, the person who specializes in dying leathers, who produces water containers which are called Kerbeh or Se’an, leather shoes, belts, and sheaths for knives and swords. For dairy products, they are produced from cow’s milk. These could be butter, yoghurt and Omani ghee, which are sold for suitable prices for the local people’’.

Traditional medicine is the basis of treatments for animal diseases - herbal medicines in which medicine is extracted from specific natural herbs and herbal materials (medicinal plants). People use such herbs or solutions prepared from them in the maintenance of health, as well as in the prevention, improvement, or treatment of physical diseases such as trachoma, fever, wounds, stomach aches and scabies. However, local people believe that the more animals freely graze on open pasture, the healthier they are. This belief is supported by modern knowledge, which associates low level of disease infections with natural grazing, due partially to reduced stress, whereas animals that are subjected to stall-feeding have their digestive physiology running a higher metabolism with the use of high-grain foods that can cause health problems (Rinehart, 2006).

Both government officials and local people agree that traditional knowledge is not integrated into the government programmes relevant to NRM, as this is ranked at the bottom of Tables 7.4, 7.5, 7.6 and 7.7, and penultimate in Tables 7.1 and 7.2. The percentage of officials who agreed or strongly agreed on the existence of the integration did not exceed 37.5%, while this percentage did not exceed 33.3% for the local people. This rare congruence of perspectives between officials and local people is difficult to explain, but it is an indication of the officials' ignorance towards this knowledge, as well as a lack of willingness from local people, especially their sheik, to highlight their own local expertise and knowledge. This negligence was apparent in the answers of some of the officials in interviews when they hoped that government agencies would take practical steps in order to preserve this knowledge and to benefit from it. Indeed, the Sheikh Deputy Wali of Nizwa at Al Jabal al Akhdar said: ''I hope that the government department that is responsible for natural resources will initiate immediately a documentation of traditional practices and knowledge for future reference''. Moreover, the following testimony proposed an ambitious scheme for the integration of traditional knowledge in the plans and programmes adopted by the government for the management of natural resources in the region. The Engineer Director of the Irrigation and Agricultural Lands Department in the Ministry of Agriculture and Animal Wealth said:

> ''I would like to recommend some suggestions to integrate traditional practices and knowledge with the government efforts to ensure the sustainability of natural resources in Al Jabal Al Akhdar. These are: (a) there is a need to study traditional methods and knowledge and document them for the future generations; (b) design projects and programmes that are in line with traditional knowledge and practices so that the locals can benefit from them; (c) incorporate local traditional practices in projects or programmes when designing them, during their implementation and during their evaluation, because we design projects based on modern scientific information instead of the traditional knowledge, and ignoring such knowledge deprives the project of a major vital component, and may lead to limited participation and thus to

social failure; and (d) a gradual transfer of these traditional practices to scientific practices in order to ensure the success of these projects from social point of view''.

Such an idea clearly indicates that some officials are at least aware of the situation of traditional knowledge despite the ignorance from other officials in the NRM programmes. However, one could question why they do not implement such an idea? The answer could be because they do not have decision-making power, as well as the absence of the region's right in the implementation of their own programmes without reference to the centre. Alternatively, the answer can be in the lack of convincing arguments that justify the implementation of such ideas. Whatever the reason is, traditional knowledge and practices are the losers. Obviously, there is no superlative way to integrate traditional knowledge and practices into the government's plans of NRM. However, one approach lies in addressing the deficiencies of such plan, and activating the role of the local people and their involvement within the decision-making processes for the NRM in the region.

## Summary

The Aflaj irrigation system, as a historical water harvesting method, is a well-known local technique in AAR, which is used to tap groundwater and convey it to the surface. The tunnel and the channel gradient of the Falaj intersect the water table and exploit the water by gravity, without pumping or the aid of any mechanical device. If the level of the groundwater drops, due to lack of recharge, the outflow rate of the Falaj declines consistently. Consequently, the Falaj does not force more water out of the aquifer than the latter can securely produce. This clearly demonstrates that sustainability is integral to this system. This fact is enhanced by the rotational system that has been used to distribute water among the

shareholdings who follow a complex principle in order to adhere to the detailed time schedules for the irrigation of individuals plots. In addition, the administrative and the financial organisation of the system, which are established by the local people, help to maintain sustainable flows of the Falaj. All of these facts, and the adherence of local people in AAR to Islamic legislation regarding water and land property management, are among the key factors that were agreed upon by both government officials and local people.

Government officials and local people, again, share similar perspectives about traditional practices in agricultural land management in AAR, where village settlements have been established near Aflaj, and their agro-pastoralism communities use Aflaj water for human consumption, livestock watering and the irrigation of terrace gardens. These terraces, of up to 14 hectares per village (Luedeling and Buerkert, 2008), are cultivated with a variety of perennial plants and trees, mostly pomegranates and roses at altitudes above 1500 metres, as well as dates, limes and bananas in gardens at lower altitudes. Vegetables, mainly garlic and onions as well as fodder crops, mostly maize, barley and alfalfa (Al-Qet), are also cultivated beside, or under, other fruit and citrus trees. The agricultural system that is pursued in the region owes its survival to traditional knowledge and practices that ensure and improve the quality and productivity of crops.

Until recently, pasture productivity in AAR has remained stable despite the fact that livestock is regarded as one of the main income streams for local people. This is because of the appropriate techniques and practices that local people pursue in livestock breeding. While goats and sheep rotationally graze the natural pasture vegetation, cattle are typically stall-fed. However, local perspectives as well as other studies, such as Dickhoefer (2006), indicate that

the quality of natural pasture is deteriorating due to the expansion of constructions and changing lifestyles in the area; consequently, the traditional practices continue to be progressively abandoned. This may partially explain the shared negative perspective towards upholding the norms of grazing between government officials and local people, as both officials and local people perceive that people in the region become less dependent on inherited norms and traditional knowledge that manage the operations of pastoralism.

# Chapter 8

# The challenges facing sustainable development in Al-Jabal Al-Akhdar (AAR)

## 8.1. Introduction

Oman was among the 189 Member States of the United Nations that met at the 2000 UN Millennium Summit to discuss sustainable development. The outcome was The Millennium Declaration and Development Goals: A Blueprint for Progress which identified environmental sustainability as the seventh Millennium Development Goal (MDG), calling on countries to reverse the loss of environmental resources by 2015. However, achieving this goal has proven to be a challenge for Oman and other countries (World Bank, 2005), at least in part because of a lack of indicators of sustainable development (Stutz, 2012; World Bank, 2005).

Furthermore, the United Nations' final document of the Rio+20 Conference 2012, ''The Future We Want,'' reaffirmed a global commitment to accelerate the full and timely achievement of the internationally agreed MDGs. The United Nations recognized, however, that targets and indicators must accompany progress toward the achievement of the goals and that assessment of progress is necessary, while taking into account different national circumstances, capacities and levels of development. Consequently, there is a real need to mainstream sustainable development at all levels, integrating economic, social, and environmental factors and recognizing their interdependency. Specifically, the Rio+20 Conference 2012 called for greater effort toward the conservation of mountain ecosystems and their biodiversity.

This Chapter presents, in four parts, the context of livelihood sustainability in the AAR, a critical perspective on government efforts to protect the AAR's environment, the challenges to sustainable development in the region, and suggested pathways to more sustainable natural and environmental resource management and development.

## 8.2 Livelihood sustainability in the AAR

The AAR's farmers and agro-pastoral systems reflect remarkably effective approaches to the management of environmental and natural resources. Four factors have thus far helped maintain the livelihood sustainability of the local people: (1) efficient management of natural capital; (2) efficient management of financial capital; (3) physical capital achievements; and (4) human and social capital.

First, the efficient management of the region's natural capital (water, agricultural land, soil, biodiversity and pasture resources) is crucial to the sustainability of the livelihood of the local people. The single most important component of the region's irrigated agriculture is the Falaj water harvesting system (Figure 8.1). Other studies have shown that the terraced cultivation system promotes the planting of a mix of perennial and seasonal crops, as well as periodic fallows, and coordinates well with efficient water use in the Falaj (Norman et al., 1998; Siebert et al., 2007).

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Figure 8.1 Falaj's channel conveys water from source to the farms in AAR.

Linked to water resources, the continuous maintenance of terrace soils is an important component of resource management that has sustained the agricultural productivity and the agro-ecological system of the region. Annual additions of organic fertilizer, primarily animal manure, have enriched terrace soils (Figure 8.2). This balances carbon loss through the mineralization of organic matter resulting from the relatively high temperatures and regular irrigation (Buerkert and Schlecht, 2010). This practice has been largely responsible for the maintenance of soil productivity, as a balance between nutrient degradation processes and

conservational enhancement (McCool et al, 1999). Consequently, the practice has ensured local livelihoods and financial returns.

Figure 8.2 Annual surface application of composted goat dung to the terraces' soil in Al-Shuragah in AAR has produced a productive soil resource.

Source: (Buerkert and Schlecht, 2010:11).

It is also evident that the biodiversity of cultivated plants has contributed to sustainable livelihoods over thousands of years. The between- and within-species diversity in cultivated plants has contributed to the continuity of trade exchange between the region's residents and merchants in the surrounding areas (Buerkert and Schlecht, 2010). The Vice Wali of Al-Jabal Al-Akhdar explained:

> ''The local people recognize that the profit gained currently at the expense of the future cannot be considered real capital. Therefore, they were careful not to exaggerate the exploitation of natural resources, leaving the appropriate amount for tomorrow to ensure their children and grandchildren a decent livelihood. In this simple awareness, these dwellers were able to strike at the core meaning of sustainability''.

Second, interviews and focus groups suggest that the efficient management of financial capital, such as income, financial savings, and access to credit, are also vital factors that have facilitated the optimal use of natural resources. Social solidarity (between family members and other village families) is the most prominent feature of this community. As a Muslim community there is an additional spiritual dimension which obliges everyone to collaborate, especially in times of poverty and need. Ideally, the village sheik organizes and manages this, as he is responsible for the affairs of the village. However, individuals also manage their financial affairs. In this context, interviewee Mohammed Al-Tupi from Birket Al-Moz clarified the financial management in the region:

> ‘‘Dwellers in the villages of Al-Jabal al-Akhdar are characterized by an appropriate professionalism in dealing with financial matters. The rich invest money in the form that guarantees rewarding annual revenue, and at the same time, they perform the duty imposed by Islam, which is Zakat. The poor, despite their knowledge of their entitlement to the Zakat, are tireless in searching for the source of livelihood that ensures a decent life for themselves and their families. Because, on the one hand, he is obligated by the teachings of Islam which urges individuals to work in order to get money, and, on the other hand, he does so in order to safeguard his dignity and prestige’’.

There is another important financial facility for individuals in need of money. It is easy to get a loan, without interest, from the richer people in the village. A legitimately documented instrument ensures this, and Hamed (55 years old from Al-Ayn) clarifies the process:

> ‘‘We are in our village (Al-Ayn) - as in the most parts of Oman – characterized by solidarity and cooperation in various aspects of life. For example, if the individual needs an amount of money to manage some affairs, he can borrow from any known wealthy person. There are reasons for this in the community, including that all the inhabitants of the village belong to one tribe or two tribes at the most; they are descended from one family and relate to each other. In addition, Islam urges helping the neediest and facilitating their needs. The borrower benefits from the prohibition of

usury by Islam, so the borrower returns the same amount of money that he borrowed without interest. It is natural to ensure the creditor right of his money to be returned, as the debtor must register the amount borrowed at the notary, and the creditor gets the original copy of this legal instrument in which the period of pay back the money should be determined''.

Third, physical capital improvements are important elements that have contributed to the sustainability of mountain villages by limiting demand on adjacent land. Irrigation canals have facilitated the sustainable transfer of water as long as village members maintain them annually. The construction of canals and the formation of sophisticated irrigation systems (Figure 8.3) have been major endeavours of the local people that converted the tough and arid terrain into a fertile agricultural region.

Figure 8.3 Irrigation works and agricultural terraces in Al-Ain, Al-Aqur, and Al-Shuraigah in AAR. Source: (Buerkert and Schlecht, 2010:126).

The invention of Sarooj cement (burnt clay) allowed the waterproofing of the sophisticated irrigation canal system and in used which are terrace maintenance (Buerkert and Schlecht, 2010). The irrigation systems are innovative and critical components in the livelihood sustainability of these mountain villages.

Fourth, human and social capital contributes directly to livelihood sustainability in the AAR. The relationships between environment, society and the economy are fundamental to sustainable development, and human and social capital influences livelihoods (Woodhouse et al, 2000). Social capital, such as the quantity and quality of the workforce available at the household level, the educational levels and skills of individuals, and the local administration, define livelihood strategies. These, in turn, depend on either NR-based activities, such as cultivation, livestock, and non-farm management or non-NR-based activities, such as rural trade and handicrafts (Newport et al, 2003; Samimi et al, 2011). The links between livelihood and environmental resource use are clear in rural AAR where the household size (number of individuals in the family) influences income stability. Dwellers in the AAR maintain an extended family and, since Islam allows polygamy, it is common for some local men (especially the richest) to have two or three wives. Thus, family size may exceed twenty individuals (three families in Saiq, two families in Al-Shuraijeh and four families in Al-Manakher exceed twenty, and ten of the forty households in Saiq have over fifteen members). The extended family is not only a social entity, but also an economic unit for shared aid and support, its members carrying out social and economic activities together so that the whole family benefits. The presence of family members facilitates the exchange of human capital, knowledge, experience and skills. Such a lifestyle has existed for generations and contributes to the environmental sustainability of the region. Moreover, traditional social systems can identify and prevent environmental vulnerability and help set society on a pathway to better environmental sustainability (Newport et al, 2003; Samimi et al, 2011). The wealth of oil has a reflective social impact; bring prosperity to the region, as is often to most of Oman. Some of locals who work for oil companies receive higher economic than those who work elsewhere, offering long-term sustainable employment alternatives at the regional level. This could be an additional provision to traditional support system.

## 8.3 Government efforts to protect the AAR's environment: a critical perspective

The AAR is important for sustainable development in the local, regional and national contexts because it provides key ecosystem services and goods to fulfil the needs of the region's population, as well as those of adjacent regions. The important concept is the maintenance of human life, a key motive for humans seeking environmental sustainability (Goodland, 1995). However, in AAR, urban expansion and climate change now threaten the environmental and natural resource capital of the region. Since these resources are vital for sustainable development, it is clear that the current governance system currently underestimates the value of a sustainable AAR to Oman (Buerkert, 2008; Victor, 2011).

In spite of this, the Sultanate of Oman claims to value the conservation of the environment in general, and biodiversity in particular. Royal Decree No. 119/94 officially committed Oman to the Convention on Biological Diversity in 1994 and the National Biodiversity Strategy and Action Plan (2000) requires every agency to be responsible for the environment to secure the sustainable use of biological resources. Since biodiversity conservation is a shared responsibility, most Government agencies in the Sultanate participated in the preparation of the Strategy, which identified the preservation and sustainable use of biodiversity, and raised Omani public awareness of the importance of preserving environmental health. This is in accordance with Islamic instructions for the conservation of the environment and to ‘‘respect the capacity of natural ecosystems to restore themselves and preserve the potential of natural capital to produce renewable resources’’ (Hamdy, 2000:7).

The Strategy document includes nine key objectives:

- Protection of natural habitats and renewable resources for sustainable utilization;

- Conservation of natural habitat environments and the biodiversity of significant fauna and flora;
- Provision of a high-quality natural environment for recreational and tourist activities;
- Improvement of knowledge on ecosystems and resource management capacities;
- Increased awareness of the importance of biodiversity management and the sustainable use of biological resources;
- Regulations to ensure biodiversity conservation and the sustainable use of biological resources;
- Equal distribution of the returns yielded from the sustainable use of resources at the local and regional levels; and
- Promotion of cooperation with regional and international agencies in the fields of biodiversity conservation and the sustainable use of natural resources (MRMWR, 2001:8).

The National Strategy identified many options to facilitate environmental sustainability and biodiversity conservation, and classified them into 15 topics, each of which included prioritised objectives and procedures (Table 8.1). Although there is no direct reference to environmental sustainability in the priority actions, sustainability indicators inspired the formulation of priorities. Therefore, targeting protection necessarily meant targeting sustainability. Table 8.2 shows this connection.

Table 8.1 Proposed strategic options and priority measures in the NBSAP.

| No | Subject | | Number of proposed strategic options | Number of priority measures |
|---|---|---|---|---|
| 1 | Conservation of natural resources | Protected areas | 11 | 5 |
| | | Threatened species | 7 | 4 |
| | | Conservation outside the parameters of natural environments | 11 | 2 |
| 2 | Terrestrial and freshwater species | | 2 | 1 |
| 3 | Marine species and fisheries | | 17 | 7 |
| 4 | Terrestrial and aquatic plants | | 9 | 4 |
| 5 | Agricultural resources | | 11 | 24 |
| 6 | Energy resources | | 11 | 1 |
| 7 | Mineral resources | | 5 | 3 |
| 8 | Industry, technology and services | Biotechnology and bio-safety | 4 | 1 |
| | | Tourism | 2 | 1 |
| 9 | Urban environment | | 7 | 5 |
| 10 | Water resources | | 15 | 8 |
| 11 | Environmental emergencies | | 3 | 1 |
| 12 | Participation of local communities and the Private Sector | | 5 | 2 |
| 13 | Social values | Awareness, guidance, education, research, and training | 6 | 3 |
| | | Environmental Impact Assessment EIA | 3 | 1 |
| | | Institutional and legal framework | 4 | 4 |
| 14 | Quality of life | | 10 | 3 |
| 15 | Spiritual values | | 2 | 1 |
| Total | | | 145 | 81 |

Source: MRMWR, 2001.

Table 8.2 Examples of Omani Biodiversity Strategies as guidelines for sustainability.

| Subject | Priority measures for achieving the proposed goals |
|---|---|
| 1. Conservation of natural resources:<br>a. Protected areas<br>b. Threatened species<br>c. Conservation outside the parameters of natural environments | a. Issuance of the proposed legislation for nature conservation areas.<br>b. Review and implementation of management plans for current protected areas.<br>c. Definitions of new protected areas.<br>d. Economic assessment of resources.<br>e. Establishment of a national database on ecosystems, nature conservation areas, and species at risk.<br>f. Development of a national programme for assessment and recovery of endangered species.<br>g. Application of the Red List criteria.<br>h. Establishment of a plant genetic resources centre.<br>i. Identification and collection of species in need of protection to grow or multiply |
| 4. Terrestrial and aquatic plants | a. Enhancement of services for pasture management, forest rehabilitation, and combating desertification.<br>b. Plant survey and assessment of the status of desertification.<br>c. Management of pastures and forests in the Southern Region.<br>d. Stabilization and re-plantation of sand dunes |
| 5. Agricultural resources | a. Establishment of a plant genetic resources centre.<br>b. Establishment of a specialized Department or DG of animal production and health and a veterinary laboratory for the production and import of serums and for the training of Omani employees.<br>c. Adoption and implementation of education and management systems that consider environmental aspects.<br>d. Studies of soil and plant pollution resulting from the utilization of agricultural lands.<br>e. Reclamation of agricultural lands and rationalization of the use of irrigation water.<br>f. Studies on agricultural management.<br>g. Comprehensive development of Al-Najd area in Dhofar.<br>h. Enhancement of research on new and alternative crops.<br>i. Implementation of a trial project on organic agriculture.<br>j. Livestock and meat marketing.<br>k. Assistance for farmers to increase productivity and conserve water resources. |
| 10. Water resources | a. Development of agricultural reformation.<br>b. Programs to study, evaluate, and monitor Regional water resources.<br>c. Development of groundwater resources.<br>d. Preparation and implementation of drought emergency plans.<br>e. Expansion of the range of wastewater collection, treatment, and reuse processes.<br>f. Implementation of a system for water portioning and distribution per sector (including the environment)<br>g. Preparation and implementation of procedures for the management of demand on irrigation water by wells.<br>h. Development of agricultural reformation to improve water use effectiveness and boost economic returns.<br>i. Increased public awareness and implementation of educational programs to promote Government environmental policies. |

Resource: adapted from MRMWR, 2001.

Table 8.2 (Continued) Examples of Omani Biodiversity Strategies as guidelines for sustainability.

| Subject | Priority measures for achieving the proposed goals |
|---|---|
| 11. Environmental emergencies | Coordination and enhancement of organizational responsibilities for the management of natural disasters. |
| 12. Participation of local communities and the Private Sector | a. Programme for motivating initiatives on biodiversity conservation and management.<br>b. Definitions of procedures for compensation and most adequate incentives that lead to the protection of the environment. |
| 13. Social values | a. Environmental awareness programme.<br>b. Support for academic (fundamental) research at Sultan Qaboos University in the conservation and use of natural resources, environmental activities, and public health.<br>c. Establishment of a central laboratory for scientific and environmental analyses. |
| 14. Quality of life | a. Incorporation of natural resources accounts in the Sultanate's national accounts system.<br>b. Incorporation of environmental considerations in socio-economic planning.<br>c. Establishment of vocational health services at the Ministry of Health. |
| 15. Spiritual values | Incorporation of the concept of biodiversity conservation in the current schooling of Islamic studies. |

Resource: adapted from MRMWR, 2001.

Importantly, the environmental resources of Al-Jabal Al-Akhdar should have warranted specific attention within the strategy, but this did not occur. This is not unusual in developing countries since it is rare to find development projects that give adequate and comprehensive attention to all significant areas in their design. Many frequently discard exit projects and then need complementary projects to fill the gaps (Critchley, 2003). The very general phrases that were formulated for AAR proposed only simple solutions to control desertification and halt desert creep. The proposed measures for containing AAR desertification were:

> ‘‘a) to introduce watershed management measures; b) to prepare adequate land use plans before starting the implementation of the proposed development plans for the area, and before the building of new infrastructure, particularly roads; c) to conserve and protect the already scarce water resources; and d) to introduce ecological farming, especially shelter-belts, and to improve contour farming practiced in the Jabal’’ (MRMWR, 2001:26).

These rather superficial measures demonstrate an inadequacy within the strategy in the formulation of conservation priorities. For example, one of the clearest omissions is the neglect of biodiversity in the AAR, even accounting for the comment on water and farming.

It is also clear that government actions in the AAR, such as watershed management measures, have been incomplete. For example, the strategic land use plan has yet to be fulfilled. In any case such plans were comprehensive, and this clearly inhibits the achievement of sustainability. The lack of an integrated plan for development, and especially the lack of a land use plan, was highlighted by the Shora Council to the Government (Shora Council, 2010), whose report called for a comprehensive and integrated vision on development in the AAR. To implement the plan, the report called for the allocation of adequate financial resources within the Eighth Five-Year Development Plan (2011-2015) (Shora Council, 2010). In the words of the HE Engineer, the Undersecretary of the Ministry of Agriculture:

> ‘‘I would like to suggest that the government initiate a comprehensive programme for the management of natural resources in Al Jabal Al Akhdar in which all concerned ministries should be involved, a detailed plan should be set out to achieve this goal and the expertise and traditional methods of the locals should be included in this plan’’.

Other officials consider the absence of an adequate land use plan to be a major obstacle to natural resource management in the region. The Director of the Agricultural Quarantine Department in the Ministry of Agriculture commented:

> ‘‘The different development projects being implemented without proper planning and coordination reflect and represent the major problem threatening the natural resources in Al Jabal Al Akhdar. By this, I mean the lack of a master plan that takes into consideration the fragility of the region. It is clear that the random establishment of development projects that are implemented and supervised by different government agencies has contributed to increasing pressure on the resources of the region,

especially water and pastoral resources as a result of population growth in the region, as well as the increasing number of tourists''.

In short, the nature of governance, or lack of it, is an important driver that has an impact on sustainable development in a mountain area such as the AAR, as it determines national priorities, classifies what areas are important, and in turn, determines development initiatives. As a signatory state of Agenda 21 and the Convention on Biological Diversity, Oman's government, is obligated to protect the environment and produce strategies and action-plans. However, this does not mean real success in terms of the state protecting its environment, as full implementation of such strategies has always been a problem (Victor, 2012).

### 8.4 Challenges to the sustainable development in the AAR

Evaluation of sustainable mountain development in the AAR is a difficult task since few databases exist to aid evaluation. However, a discussion based on what has occurred in the AAR over the past 40 years, shows that the region is becoming embedded in the mainstream of development, and therefore is subject to both the positive and negative impacts that affect all of Oman.

It is clear that Omani planners want to maximize the viability of the region to accommodate more people, especially with regard to increasing its tourism appeal. The government also wishes to increase tourist attractions in order to increase revenue. Planned and implemented development projects in the region support this statement: paving roads, authorizing the establishment of hotels, tourist resorts and restaurants, and providing the long-awaited cable cars (Shora Council, 2010). However, planners have overestimated the carrying capacity of the region's environmental and ecological services. These survives are the key to sustaining

development into the long term. All of the above projects will increase the region's population and so threaten the carrying capacity of the region. In this sense, they are inconsistent with targeted sustainability. In fact, the evidence indicates that the resources of the region have thus far been unable to accommodate recent increased human pressure, far less any future increase. For example, there are already insufficient local water resources to meet the current needs of the population and to satisfy irrigation demands. To this end, in 2010-2012, the government funded a RO 28.9 million (£46,357) project to carry water to the AAR from the Barka coastal desalination station some 200 km away (MRMWR, 2010, 2). This project could directly benefit the ground water, maintaining it to only irrigation use. And this can help to sustain the agro-environment system.

A second indicator of resource inability to meet the demands of development is the Royal Court Fruit Farm, which has negatively impacted on a nearby village. The farm is located in the highest area of villages in the AAR, in the region that feeds the spring for the Falaj of Al-Shuraigah. This has compromised the ability of the Falaj to meet the irrigation needs of the agricultural terraces in the village and these have become less productive (Figure 8.4): ‘‘in Ash Sharayjah, the area of terraces growing field crops decreased gradually from 4.7 ha (32.4% of the terrace area) in 2007 to 3.1 ha (21.6%) in 2008 and 3.0 ha (20.5%) in 2009’’ (Al-Rawahi, 2012:25).

Figure 8.4 Agricultural terraces in Al-Shuraigah are now affected by water shortage.

Cognizant of the complications caused by the establishment of the Royal Court Farm in 1995, the Deputy Director General for Water Resources Management said:

> ‘‘After the Diwan (Royal Court) decided to establish a farm to plant fruits for the benefit of the Sultan Royal Court, and as this move was not welcomed by me, I decided to withdraw from the project and returned to Muscat. The reasons for my withdrawal from the project can be attributed first to my conviction about the damage that may result from the establishment of the farm, where plants need large amounts of water, and this could drain the groundwater that feeds (the) region’s Aflaj. This is what happens now, with the decreasing levels of water flow of Aflaj, exacerbated as drought continues’’.

One expert from the University of Sultan Qaboos goes further saying:

> ‘‘Development is overrunning the Jabal ecosystem. It is a matter of time before it becomes a tourist trap. Each Ministry is a law unto itself. Everyone knows what is good for the Jabal. People do not understand sustainable resource management. One farm and one hotel is enough to destroy natural resources. What will be the situation when there are more farms and more hotels?’’.

The establishment of surface storage dams has also impacted on the ability of resources to meet the demands of development. The Ministry of Regional Municipalities and Water Resources established many surface storage dams in order to provide water for animals and irrigation. However, since dams constrict water flow after rainfall, areas located downstream are now deprived of an important source of water. The Director-General of the Ministry of Environment and Climate Affairs said:

> ‘‘The vast number of storage dams in the Al-Jabal Al-Akhdar prevents wadi water from arriving to residents on Berkat Al-Moz Nizwa. Thus, it is necessary to study the locations of water storage in the region, and to determine their negative and positive impacts on the environment of the region and the areas below (Berkat Al-Moz, Izki and Nizwa), and thus make appropriate decisions about it’’.

Khalef (40 years old, and a local from Berkat Al-Moz), said:

> ‘‘Berkat Al-Moz, which lies at the piedmont of Al-Jabal Al-Akhdar at the exit of the Wadi Al-Moaiden, is fuelled by tributaries and torrents in the highland areas of the mountain. People in the village depend largely on the flow of water in the Wadi, which used to gush whenever rain fell on the mountain, even if the rain was only moderate. Recently, people have observed a divergence in the water flow periods in the Wadi, even if rain falls on the mountain. People here attribute this to the surface storage dams built on some of the wadis in the mountain, which is the source of water for our Wadi. Today, we only see the flow of water in the Wadi in the case of heavy rains, which fall as a result of depressions that pass through Oman, which of course do not occur frequently’’.

Environmental assessment of project impacts is crucial. Planners should be, but patently are not, fully aware of the environmental consequences that may adversely affect the environment. Residents need also to realize that the profit or benefits that may come from the flow of tourists to the region may well be temporary if environmental problems increase and the tourists move elsewhere. However, tourists can contribute positively to environmental

sustainability in the region by pursuing environmentally sensitive activities, and by anticipating and respecting appropriate environmental actions by officialdom (if they exist) or are traditionally pursued in the region.

Clearly, there are currently serious deficiencies in the implementation of some of the options proposed by government as conservation strategies in AAR. These deficiencies make it a challenge to implement sustainable development projects, and the Sultanate's fourth report on the status of biodiversity resources refers to difficulties facing the national implementation of the biodiversity conservation programmes:

> ‘‘National accomplishments in implementing biodiversity conservation programmes focusing on endangered species protection were assessed at 45-65% success. Initiatives to attain these are indeed difficult; various problems highlighted in delaying the attainment of established goals include the need for progressive coordination with stakeholders, more regional cooperation, funding and capacity building, the development of suitable monitoring and evaluation systems, updating of management plans, and more participation and support from local communities. There is a lack of proactive support from concerned agencies combined with their limited understanding of the value and impact of biodiversity’’ (MECA, 2010:8).

What remained unsaid in the document was the fact that the region’s environmental capital (including biodiversity) faces challenges that require immediate intervention from both government and local people. Natural resources are deteriorating and in spite of government interventions to address the problem of water shortage, the water resource situation remains critical. Water shortages affect agricultural land resources, often resulting in the abandonment of many terraced fields (see Figure 8.4 and Table 8.3). The Director General of Natural Conservation in the Ministry of Environment and Climatic Affairs commented:

> ‘‘Al Jabal Al Akhdar depends on the Aflaj irrigation system in small-scale of agriculture and cannot expand more than that due to the limited water resources. This

practice has existed for thousands of years, it is a sustainable system. But if plans proceed to expand agriculture in order to provide food security, then there is a need to introduce high value fruits such as pomegranates or other Mediterranean fruits. The thing that will be most problematic will be the competition between the newly introduced high value species and traditional sustainable practices of agriculture that rely entirely on the small-scale production of fruits like pomegranates and peachs, and fodder to feed animals. If the area of agriculture expands, it will need to find new land space and sufficient water resources. It needs also to use pesticides to control pests and this can endanger agriculture. Thus, there is a need for a sustainable water supply and a whole scheme using new technologies. This will be a challenge in the future for the local community to preserve its region's sustainability''.

Table 8.3 Reduction in terraces at the village of Al-Ayn in the AAR.

| Total village area ($m^2$) | 2007 Area ($m^2$) | % | 2008 Area ($m^2$) | % | 2009 Area ($m^2$) | % |
|---|---|---|---|---|---|---|
| 25200 | 8873 | 35.2% | 6440 | 25.6% | 4988 | 19.8% |

Source: Al-Rawahi, 2012.

The seriousness of the challenge to environmental sustainability, particularly in the agri-environment, has increased with the availability of agricultural imports from elsewhere. This impairs the ability of the region's farmers to compete with these cheaper products and farmers abandon traditional products to focus on those that can successfully compete, such as pomegranates and garlic. This results in genetic erosion of the traditionally cultivated plants of the region and this plant diversity is one of the key elements of sustainability. It is now necessary to promote intervention to conserve and reduce the loss of genetic plant resources (Gebauer, 2010).

Goat grazing and browsing also has a direct effect on species composition, whereby palatable species decline and those that are less palatable increase. Traditional grazing practices that rely on rotational grazing and a traditional (Hema) system have been mostly abandoned, and with the increasing number of livestock (17000 mountain goats (Al-Azri, 2005)), pastures

have suffered from overgrazing (Victor, 2008; Dickhoefer, 2006). Since there is no longer a domestic need for the donkeys they now graze as feral herds. Brinkmann and Patzelt (2010:45), assert that:

> ‘‘heavy grazing over a longer period of time will probably result in a decline of the diversity of plant species and the formation of mono-specific stands of those perennial species most able to survive grazing pressure. Therefore, the conservation of wildlife and plant habitats at Al Jabal Al Akhdar will require the implementation of integrated conservation strategies for the agro-pastoral systems under transformation, including land use management plans’’.

Examples of physical capital, such as irrigation channels and agricultural terraces, are now beginning to lose their integrity and function because of the methods and materials used in construction. Traditionally, stone extracted from the mountainside and Sarooj were used to build channels and terraces, and these two components were characterized by an attractive harmony of colour (Figure 8.5). People were keen to build the external surface of the channel in an aesthetic manner that harmonised with the components of the setting. This traditional method is a key attraction for tourism, yet, today, if traditional canal walls collapse, they are repaired using much less attractive concrete bricks and cement (Figure 8.6).

Figure 8.5 Irrigation channel built with Omani Sarooj in Wadi Bani Habib in AAR.

Figure 8.6 Irrigation channel built with new industrial cement in Al-Ain in AAR.

Human and social capital are also undergoing changes that are not in harmony with customs, traditional practices, or traditional knowledge. The nuclear family system has gradually

replaced the extended family. This is weakening family ties, depriving future generations of traditional communication with family elders, and leading to a reduced likelihood of the transmission of traditional knowledge, skills and experiences across generations. Patzelt, in Buerkert and Schlecht (2010:41), noted the threat to the maintenance of traditional knowledge:

> ‘‘Older people still have a wealth of indigenous knowledge about the uses of plants and traditional agricultural practices. However, the on-going transformation process of these oasis systems leads to rapid loss of this knowledge and it is, therefore, of crucial importance to document existing information’’.

The abandonment of traditional practices clearly produces challenging sustainable development issues. Given the limited, and at times misguided, government and private sector interventions in NRM, Oman must confront these challenges and take steps to maintain the environmental and cultural heritage of the region. Sustainable management of natural resources could achieve this goal by engendering a responsibility to environmental integrity and biodiversity, ensuring a healthy environment, a dynamic economy and social justice for both present and future generations. Documenting traditional plant knowledge is importance to present the contribution of this knowledge to bio-cultural diversity that promote ecologically sustainable Behaviour, as this knowledge is also influence a sustainable NRM and sustainable development.

## 8.5 Suggested pathways to more sustainable natural and environmental resource management and sustainable development

NRM is regarded as a complex area, especially in cases of an imperfect scientific understanding of local natural systems and how best to manage them (Kilpatrick, 2002). As many actors have overlapping responsibilities for managing natural resources in the AAR,

NRM poses many challenges to stakeholders and requires comprehensive solutions regarding the economic, social and environmental dimensions of sustainability. These dimensions connect through complex and active human-environment interactions (Breu, 2006). The human-environment system as a concept was introduced by UNESCO in the 1970s (Breu, 2006; ICSU-UNESCO-UNU, 2008; Bălteanu and Dogaru, 2011), and views land resource management as the interface between the environmental dimension and the socio-economic domain of sustainable development (Figure 8.7). All these sustainability dimensions interact and directly affect NRM (Figure 8.8).

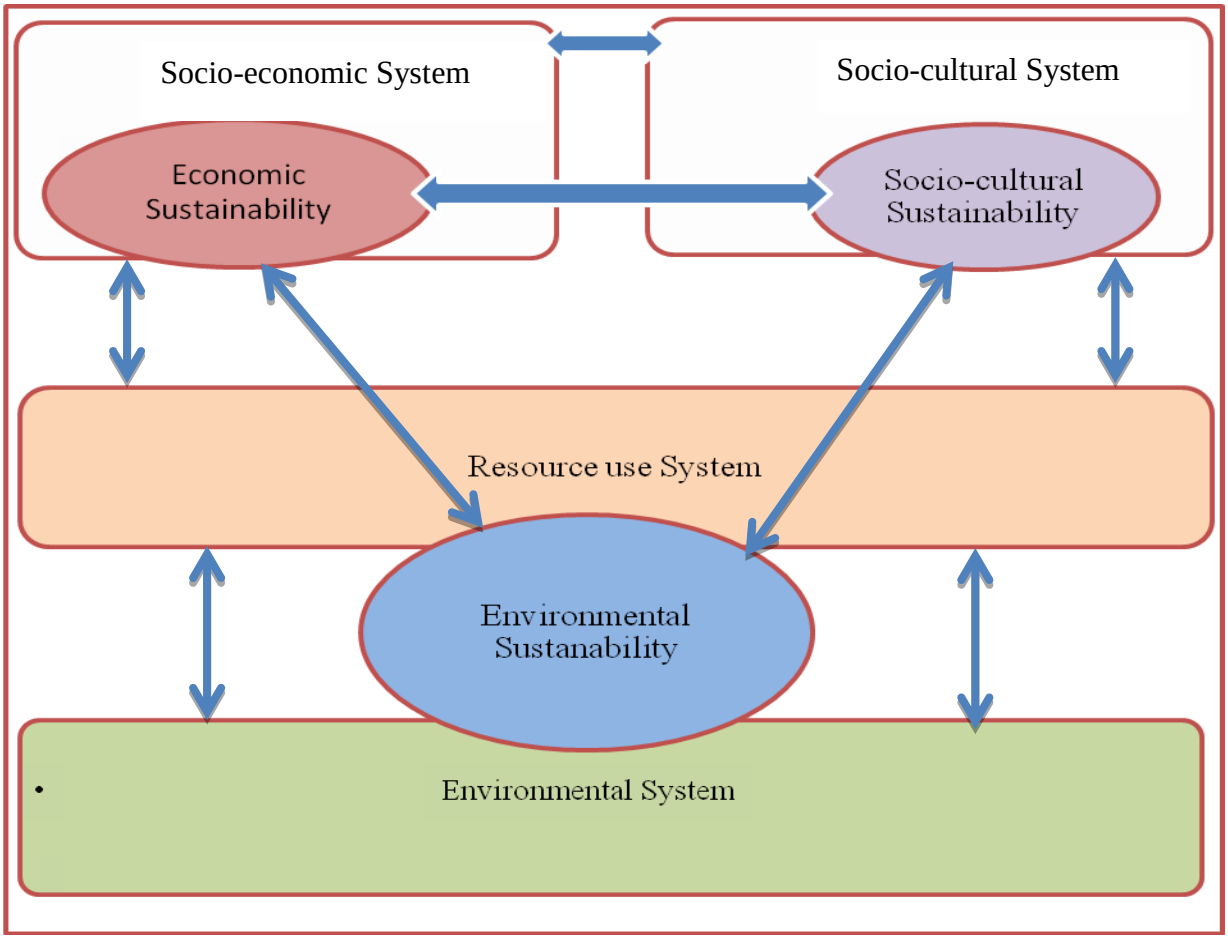



Figure 8.7 Pillars of sustainable development.
Resource: adapted from Breu, 2006.

Using Figures 8.8 and 8.9, pathways towards more sustainable natural resource management (SNRM) in AAR are now discussed. New approaches to SNRM need to respond to the challenges facing natural and environmental resources. Any new direction should reflect the complexity of local community opportunities for NRM, including bio-diversity, ecosystem services, product yields, social values, and the beauty and integrity of the region's environment. In other words, the direction must preserve all of the natural, physical, human and cultural capital (Figure 8.9), while providing the region with access to advanced development and modern spaces.

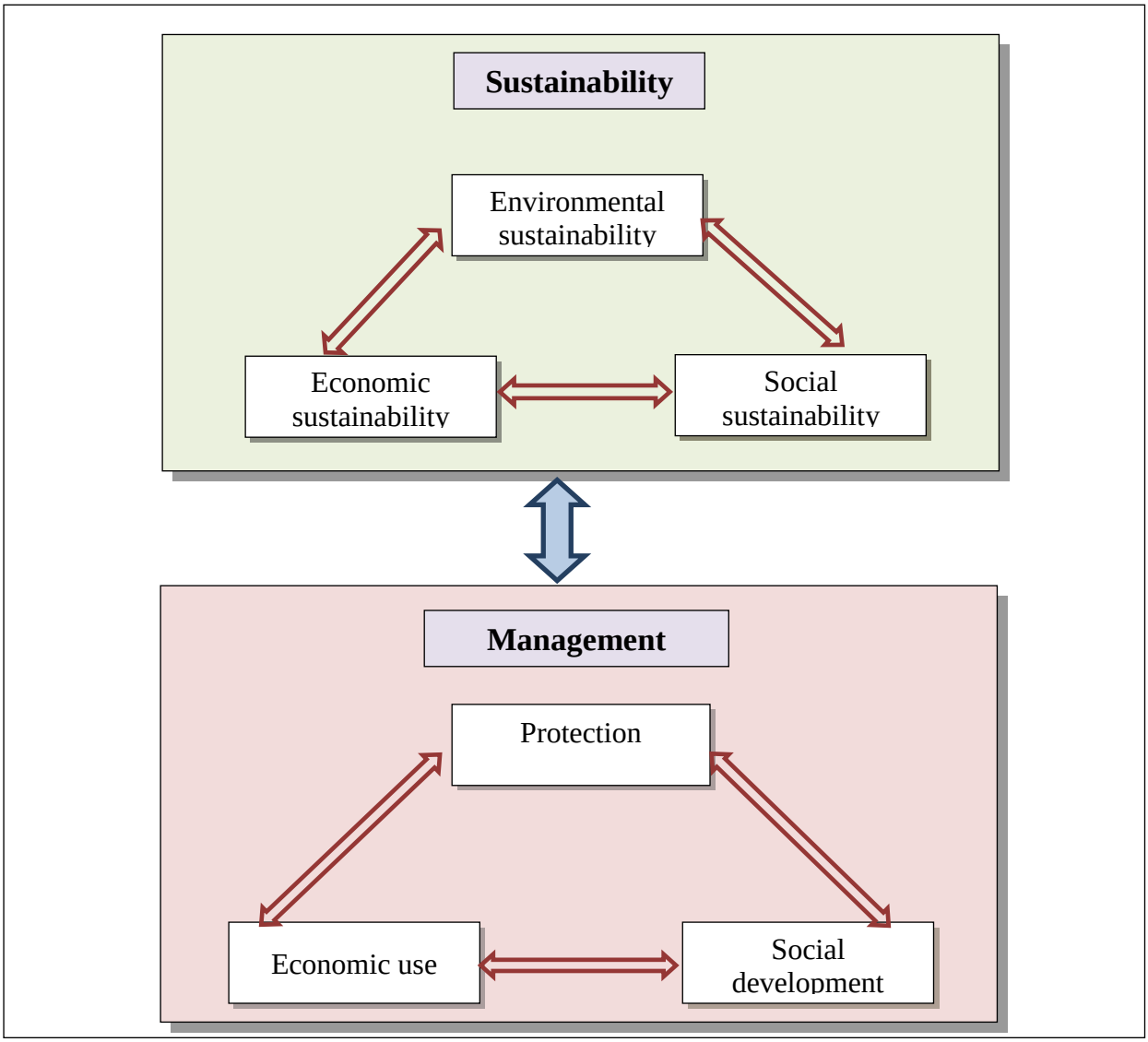



Figure 8.8 Relationships between Management and Sustainability.
Resource: adapted from Harago, 2005.

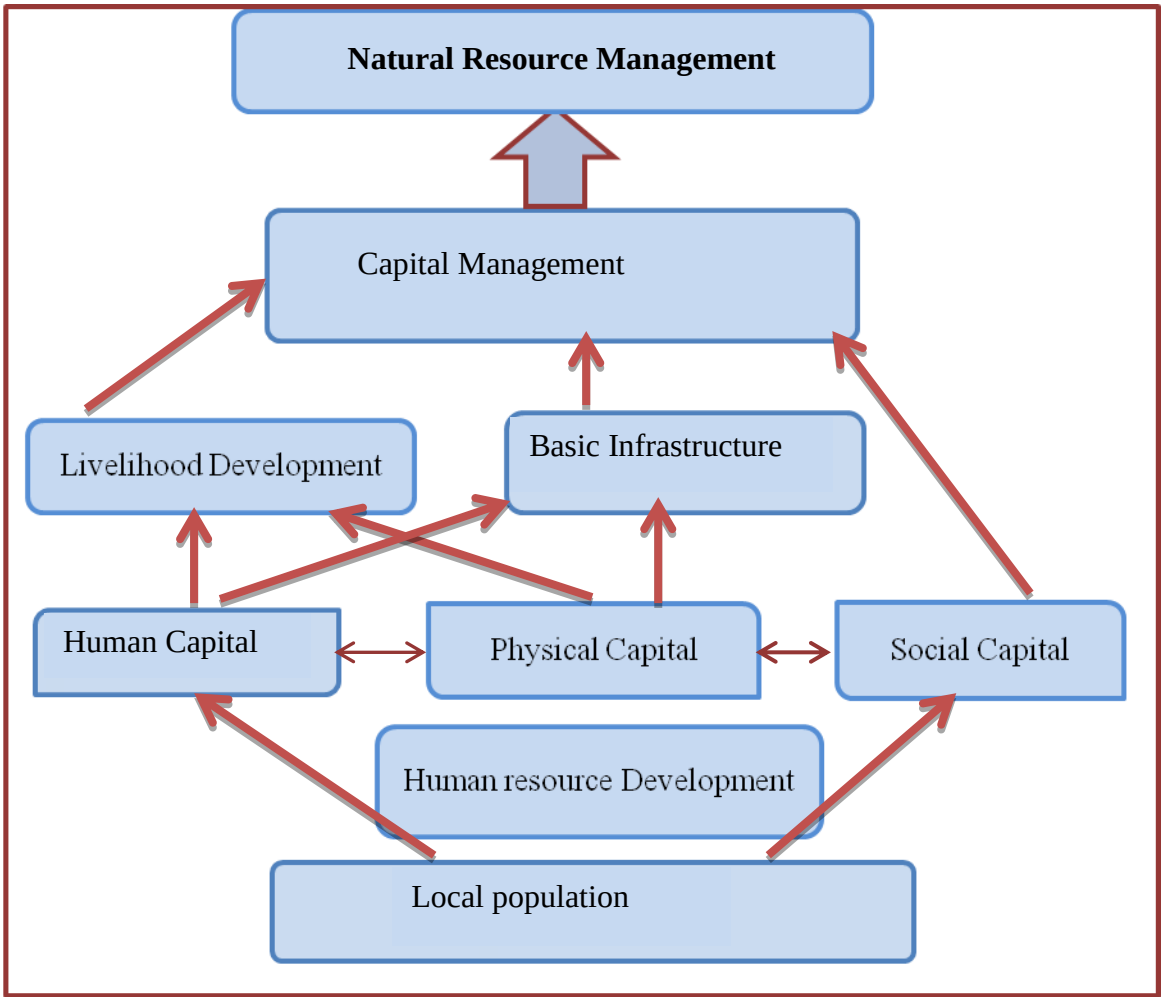



Figure 8.9 The Structure of Natural Resource Management Model (NRMM) biased on a Capitals Perspective. Resource: adapted from Harago, 2005.

Any new direction should also involve a dual management focus, sustaining both of traditional yields and the environment. On the one hand, this will require closer, interactive roles for scientists and government to achieve multidisciplinary research and the adaptive management of natural and environmental resources. On the other hand, government officials must take the results of scientific research as the basis for systematic planning to achieve beneficial NRM in the region, while continuing to connect with all stakeholders, particularly local people.

Just over 76% of the interviewees in this study agreed or strongly agreed that the AAR had many development opportunities that depended on SNRM (Table 8.4). However, models of sustainable development, as Lehtonen (2004) explains, should conceive social, environmental and economic issues as dependent elements. Governance establishments, in any country, should give a similar attention to the importance of environmental governance, which includes NRM, as well as to the social and economic issues.

Table 8.4 Perspectives of government officials regarding development opportunities that depended on SNRM in the AAR

| | Mean score | Sum | Distribution | | | | |
|---|---|---|---|---|---|---|---|
| | | | 5 | 4 | 3 | 2 | 1 |
| Development opportunities depends on SNRM in the AAR | 4.08 | 489 | 46<br>38.3<br>% | 46<br>38.3<br>% | 21<br>17.5<br>% | 5<br>4.2<br>% | 2<br>1.7<br>% |
| Total respondents = 120 | | | | | | | |
| 1= strongly disagree, 2 = disagree, 3 = not sure, 4= agree, and 5= strongly agree | | | | | | | |

Based on the above discussion, six broad approaches may act as stepping-stones towards sustainability in the AAR:

1. **Optimise water resource use by** employing technical and engineering equipment, coupled with awareness-raising programmes for locals. Human activity has formed many landscapes in the world over time (Gonzalez et al, 2009), so NRM in the AAR needs be a co-evolved system, as defined by Kallis (2007), a process of joined change across practices, values, and the biophysical environment. This understanding of NRM involves an interdisciplinary approach to emphasize integrated assessment (Gonzalez et al, 2009). Governments responsible for NRM need to recognise the importance of harmony and organizational functioning of social–environmental interaction, and to recognise the local relationship between human systems and the ecosystem as part of a holistic system. This way, expert knowledge augments local knowledge and the practical use of resources (Gonzalez et

al, 2009). This means that the construction of a framework is necessary to understand more fully the range of local human-environment interactions, including the impact of interactions on societal development and resilience.

The deterioration of water in the AAR is a growing challenge, and resorting to modern solutions, such as drip irrigation, could reduce water loss through evaporation and leakage. Maintenance of irrigation canals against leakage is also critical. Methods to divert water from the main channel to sub-channels need to use semi-automatic taps, instead of depending on rolls of cloth manually placed at conversion points along the Falaj.

Moreover, local people must be encouraged with financial incentives, from the government, to establish underground tanks to store rain water. Local participants in this study stressed that with water storage they could plant at least 15 pomegranate trees in house gardens, each of which could produce 40 pomegranates, worth about 48 OMR (£80). Such water tanks are an extension of the traditional practices of previous generations and represent efficient water harvesting (Oweis and Hachum, 2009). A low external-input technology, it could create additional further farming opportunities in the region.

The policy adopted in 2000 by the Ministry of Regional Municipalities, Environment and Water Resources (MRMEWR) to improve, conserve and protect Aflaj needs to be fully implemented. The Water Resources Master Plan Vision 2000 – 2020 should also guide government management practices to stabilize the rural population and retain the national heritage (Al-Sulaimani et al, 2007). More emphasis on supporting Falaj communities and on the maintenance of systems to reduce water losses, and to protect water supply and quality, could achieve these goals and enable experienced Falaj communities to continue to control

these practices. It should encourage the Falaj committees to sustain their significant role in water management and in controlling new wells that might influence the Falaj water supply. Continuity of maintenance and cultivation of crops that guarantee good financial revenue can contribute to the continuity of the flow of Aflaj, this, consequently, will ensure funding sources for maintenance, a cycle that must continue.

2. **Optimize agricultural land use** by promoting conservation-based agricultural methods employing technical irrigation equipment and using biotechnology. High quality agricultural products such as pomegranates, mountain roses and medicinal herbs for export need support. In this regard, it is useful to suggest a co-evolutionary approach toward agricultural sustainability, as presented by Norgaard (1994) in a paradigm of continuous interaction between social and ecological systems, since

> ‘‘Ecological systems determine the suitability of societies' subsystems of knowledge, value, technology, and organization. At the same time, however, choices in these subsystems determine the suitability of evolving ecological systems. For both systems, development has its roots in the biological principles of mutation (experimentation in social system) and selection’’ (Saifi and Drake, 2008:25).

Applying this to the AAR requires the community to be clear about what sustainability means and why some agricultural schemes may not be sustainable and to understand the processes of development in local communities so that sustainable development can be promoted. Also, sustainability indicators need to be identified in each sector to facilitate communication and interaction among stakeholders (Hosseini et al, 2011; Saifi and Drake, 2008).

New agri-environment initiatives to promote the conservation of the agricultural environment in the AAR might include ‘‘rebuilding the soil, optimizing crop production inputs, including

labour, and optimizing profits'' Peiretti et al (2006:58). Although the procedures involved in these methods are deeply rooted in traditional AAR farming practices, a focus on the benefits that accrue to both the farmer and the agricultural environment alike needs to revive a commitment to these traditions. This may encourage a return to the crops that farmers no longer plant, such as walnut trees. Walnut trees are remarkably useful plants to the AAR environment as their seeds provide a high-density source of nutrients, while the whole tree is useful as an important component of the agricultural environment of the region. They promote a diverse agriculture and are important to the maintenance of the genetic resource pool.

The benefits of these methods to optimize yields and profits may encourage farmers to adopt them again (Table 8.5).

Table 8.5 Practices and benefits of conservation agriculture.

| Some practices and benefits of conservation agriculture | | |
|---|---|---|
| No | Practices | Benefits |
| 1 | Minimum or zero tillage (Direct sowing or direct drilling) Figure 8.10. | Reduction in on-farm costs: savings in time, labour, and mechanized machinery.<br>Increase in soil fertility and retention of soil moisture, resulting in long-term yield increase, decreasing yield variations, and greater food security.<br>Stabilization of soil, which protects it from erosion leading to reduced downstream sedimentation |
| 2 | Maintenance of a permanent or semi-permanent organic soil cover. | Protection of the physical functions of the soil from sun, rain and wind and food for soil biota. Soil micro-organisms and soil fauna will take over the tillage function and soil nutrient balancing, thereby maintaining the soil's capacity for self-recuperation. |
| 3 | Rotation and change of cropping schemes. | Improvement in the nutrient content and texture of soil. |
| 4 | The overall practices of conservation agriculture. | Promotion of ecosystem services as it supports domesticated plants (e.g. crop) and animals (e.g. livestock).<br>Wildlife habitat support.<br>Source of micronutrients for human consumption (e.g. food quality vs. quantity).<br>Buffered & moderated hydrological cycle (e.g. drainage, temporary storage, etc.); watershed protection<br>Decomposition & recycling (e.g. waste disposal). |

Sources: adapted from (FAW, 2001)

Figure 8.10 Direct sowing and direct drilling in a farm in Saiq in the AAR.

Oman can benefit from international experiences of environmental regulation. Inspired by experiences world wide, “The Tragedy of the Commons” Hardin (1968), raised concerns about the integrity of the Earth’s natural environments (Stern, 2011). Hardin cautioned that ‘‘our short sightedness and our tendency to look out for ourselves first’’ had hindered environmental conservation. There is no doubt about the pressing need to save the planet’s natural resources, an issue raised by Meadows et al. (1972) in ‘‘The Limits to Growth’’. This keynote book suggested that the production and consumption of goods and services tends to expand exponentially. This is associated with a short-term individual gain that outweighs the long-term communal gain. Consequently, the Omani government needs to conserve natural resources to serve the common good, rather than promote individual gain.

**3. Support pastoralism**. Pastoralism in the AAR provides ecosystem services that have wider benefits such as the conservation of watersheds or the sequestration of carbon. The

importance of this in supporting environmental sustainability is difficult to quantify, but it is likely to be considerable for pastoralists and non-pastoralists alike (Hatfield and Davies, 2006). Attitudes towards pastoralism need to change, since mobile pastoralism (the traditional pasture system based on interval/seasonal grazing) is agreed to be the most sustainable way to manage the world's rangelands (IUCN, 2007). However, competing land-uses, such as housing and development, come at an environmental and economic cost that affects pastoralism. As the AAR possesses significant degrading rangelands, it is crucial that the government recognises the environmental and economic value of the traditional pasture system. Legal mechanisms and support systems are needed to allow progress towards sustainable livelihoods and promote rehabilitation of endangered pasture areas. Healthy rangelands benefit a wide range of stakeholders beyond pastoralists, a prime example being the tourism industry (Davies and Hartfi 2007) (see also Chapter 7).

**4. Promote knowledge, education and increased awareness** of sustainable natural resource management opportunities via two routes. Firstly, campaigns to raise awareness of the precarious nature of the region's natural resources should highlight the benefits of conservation and protection, adaptation to both drought and water-abundance, and the use of natural resource laws and enforcement of penalties imposed on violators. Ministry of Tourism tours and volunteer work camps organized by the Ministry of Social Development can disseminate brochures, pamphlets, and even video programmes on DVDs. Secondly, there needs to be a focus on cooperation between home and school in educating young people to respect natural resources as fundamental to life in the region. The current Omani generation should learn the lessons of sustainability that framed their ancestors' ways of life. Using water sensibly and fairly, in times of abundance and in times of shortage, is one of

these lessons. Matching water use to water availability, an essential characteristic of the Falaj system, is a vital element in planning water management in the AAR (see Chapter 7). Adults should also be educated in the reality of sustainability in mountain environments.

**5. Promote environmentally friendly activities in areas zoned for ecotourism.** As tourism develops in the region, there is a need for an assessment of the tourism carrying capacity (TCC) and the regulation of tourist flows is needed. In this context, the Omani government can benefit from organizations with experience in assessing TCC, such as the UN World Tourism Organization (UNWTO). Government needs to empower local communities to establish local infrastructural facilities, such as museums and shops selling local products, and to promote the selling of traditional products, such as rosewater, fruits, natural herbs and handicrafts. Local people might take advantage of abandoned houses and convert them into hostels for tourists. The AAR should establish a Visitor's Centre to provide educational materials for all age groups (see Chaudhuri and Ramanathan (2009); Ramanathan et al (2009); Victor and Robinson (2009)).

**6. Standardize sustainable natural resource management (SNRM) practice.** From an ethical and rational perspective, SNRM needs standardization by using instruments to identify and avoid undesirable practices. In this regard, the Constitution of Oman provides the principles guiding the state's policy: ''establishing sound administrative system that guarantees justice, tranquillity and equality for the citizens and ensures respect for the public order and the preservation of the higher interests of the country'' (MOLA, 1996:4). Among the values to which Oman purports to adhere is the conservation of the environment and its

natural resources. Therefore, SNRM governance should adhere to the principles of legitimacy, transparency, accountability, public participation in decision-making, fairness and adaptability as summarised in Table 8.6 (Lockwood et al, 2009; Bernstein, 2005).

Table 8.6 SNRM governance principles. Source: adapted from (Lockwood et al, 2009; Bernstein, 2005).

| Principle | Elements |
|---|---|
| **Legitimacy** | • Validity of an organisation's authority to govern that may be (a) conferred by democratic statute; or (b) earned through the acceptance by stakeholders of an organisation's authority to govern.<br>• Integrity and commitment with which authority is exercised |
| **Transparency** | • Visibility of decision-making processes<br>• Clarity with which the reasoning behind decisions is communicated<br>• Ready availability of relevant information about the governance and performance of an organisation |
| **Accountability** | • Allocation and acceptance of responsibility for decisions and actions<br>• Demonstration of how these responsibilities have been met |
| **Inclusiveness** | • Opportunities available for stakeholders (beneficiaries) to participate in and influence decision-making processes |
| **Fairness** | • Respect and attention given to stakeholders' views<br>• Consistency and absence of personal bias in decision making<br>• Consideration given to distribution of costs and benefits of decisions |
| **Integration (Connectivity)** | • Connection between, and coordination across, different levels of governance<br>• Connection between, and coordination across, organisations at the same level of governance<br>• Alignment of visions and strategic directions across governance organisations |
| **Capability** | • Systems, resources, skills, leadership, knowledge and experience that enable organisations, and the individuals who direct, manage and work for them, to deliver on their responsibilities |
| **Adaptability** | • Incorporation of new knowledge and learning into decision making and implementation<br>• Anticipation and management of threats, opportunities and associated risks<br>• Systematic self-reflection on organisational performance |

The present study clearly shows that many of these principles are lacking or absent in Oman. Despite the legitimacy conferred by the central authority, integrity and commitment are not everywhere in evidence. Therefore, legitimacy should come from the practice of authority with integrity; government actors need to declare interest, behave honestly and seek to advance the nation. Adding rational communicative elements to these conditions would

provide legitimacy (Lockwood, 2009). Government officials similarly should maintain legitimacy by pursuing objectives of the NRM policy, since it is their responsibility to do so.

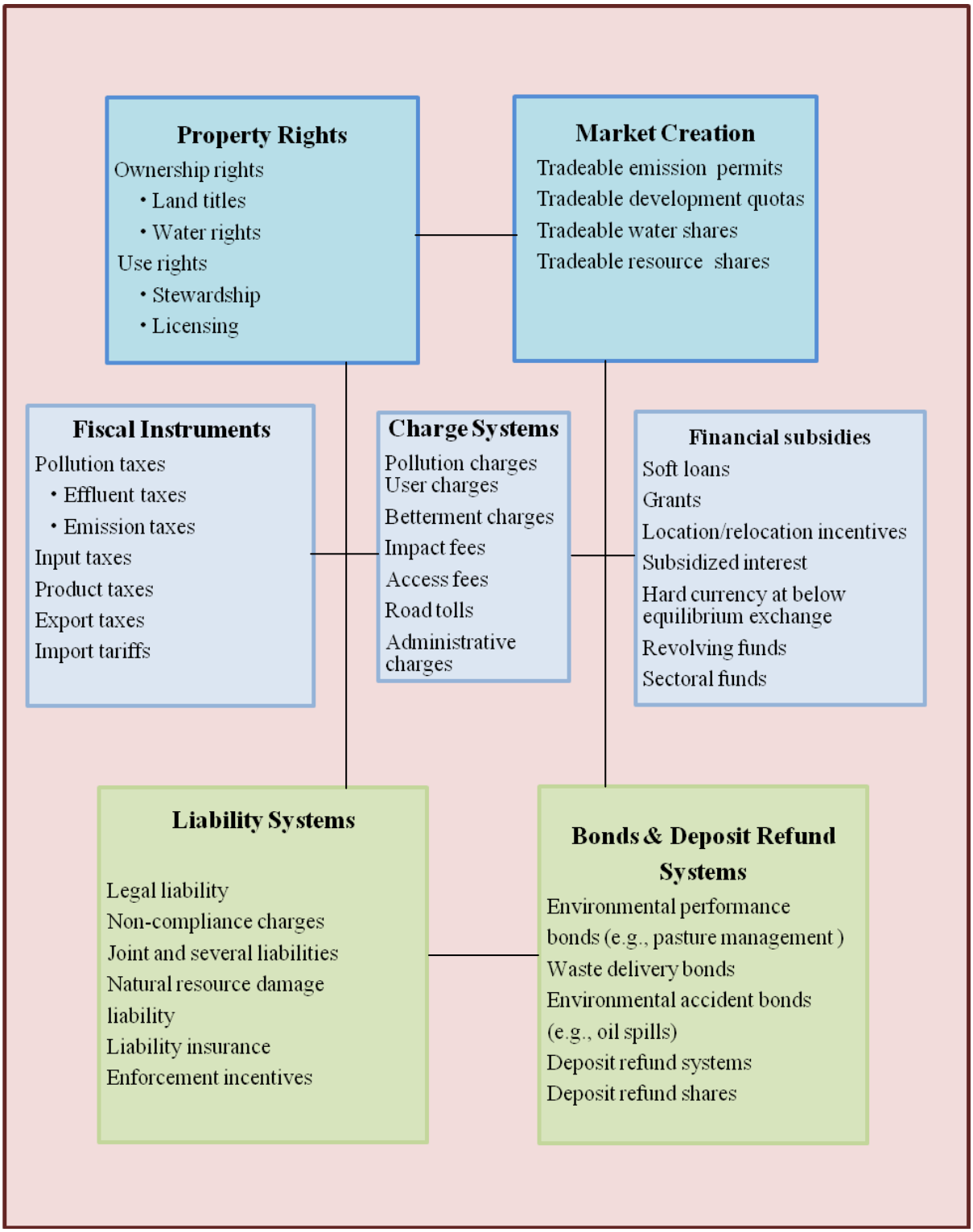
Community participation has become an increasingly important aspect of NRM worldwide (Lawrence and Debbie, 2001; Wang and Wart, 2007; Lockwood, 2009). While retaining ultimate authority, government agencies responsible for NRM and protected areas in several countries have opened their decision-making processes to varied stakeholder input. Correspondingly, NGOs such as the Nature Conservancy, the World Wide Fund for Nature, and Conservation International have all become involved with local and indigenous people to implement initiatives, acting in partnership with many government and non-government organisations (Lockwood, 2009). Using modern approaches to governance provides the potential to engage a greater variety of expertise and knowledge (Davidson, 2006). Yet even in many developed countries, such as Australia, insufficient scientific knowledge and a lack of mechanisms and equipment to support the integration of NRM across a range of disciplines have posed challenges (Head & Ryan 2004; Morrison et al. 2004).

In Oman, there is a lack of data availability and a lack of knowledge and expertise necessary for effective NRM. For example, there is limited availability of skilled staff to carry out management functions (see Chapter 6). SNRM requires a range of knowledge and skills that require investment in staff, for both the inputs and the processing phases (e.g. management planning, natural resource inventory monitoring, human resources management and communication skills). As such, SNRM policy needs to ensure that all staff of government agencies responsible for NRM have adequate skills, preparation, knowledge and capacity. Yet HM Sultan Qaboos bin Said (2005) declares:

> "We did – and still do – firmly believe that the development of these resources is the cornerstone of the development process in any society because the human being – as

> we have always stressed on different occasions – is the ultimate goal and aim of development as well as being its means and its producer" . (MOI, 2006:309).

Despite the Omani government's commitment to fund NRM in the AAR, the ability of most government agencies responsible for NRM to deliver effective management on the ground remains limited. Many of the interviews reported here, with both government officials and local people, highlight this failing. Further, some of the government's own reports identify the disjuncture of environmental policy from economic policy as another obstacle to achieving sustainable development. As such, SNRM policy should explore alternative routes to force integration, perhaps sourcing revenue via the imposition of fees on tourists and directing the proceeds towards the funding of environmental and natural resource management (Box 8.1), similar to those widely used in developed countries (Panayotou, 1994; Driesen, 2006). The challenge for Oman, as is the case in most of developing countries, is to ''identify and adopt instruments that integrate environmental and economic policy and that are parsimonious in their use of scarce development and management resources; instruments that allow differential response by economic units and adjust flexibly to changing circumstances'' (Panayotou, 1994:2).




Box 8.1 Economic Instruments for Environmental Protection and Natural Resource Management.
Resource: adapted from: (Panayotou, 1994; Lemos and Agrawal, 2006; Economic and Social Commission for Asia and the Pacific, 2010).

## 8.6 Summary

Securing sustainable development and environmental sustainability in the AAR is a task achievable only if the Omani government fully commits itself to a strategy of environmental sustainability for the region. The World Bank (2005) declared that making environmental sustainability operational is a challenge for many countries and recognized that the lack of sustainable development indicators to be an issue. Ensuring sustainable development requires strict adherence to regulations and policies that ensure natural resources protection, not only as an important component of the natural environment, but also as an important driver for both local and national economies, implying an important link between resource management and sustainable development.

A long-term programme of SNRM in the AAR is long overdue. Cooperation among the different private sectors, local stakeholders and government is the only way to ensure the success of this programme. Decision makers, together with stakeholders, should seek assistance and expertise from international organizations with experience in dealing with environmental issues, particularly those operating under the banner of the United Nations. With commitment and goodwill, the goal of sustainable development to the benefit of all Omani citizens, and particularly the local people of this fascinating mountain region, is entirely achievable.

# Chapter Nine

# Conclusions

## 9.1 The status of the environment and natural resources of the AAR

The environment and natural resources audit has highlighted the regional environmental and socio-economic importance of the AAR. There is a clear body of opinion that accelerating development in AAR is occurring at the expense of environmental conservation and sustainability of natural resources. Water, biodiversity, rangelands and agricultural land are all considered to be experiencing instability and change due to a variety of natural and human factors. However, this process is not confined to Oman. For example, the Fifth Ministerial Conference on Environment and Development in Asia and the Pacific, held in 2005, indicated that the decline in natural resources was a result of increasing demands placed on these resources by rapid economic growth and development patterns that are environmentally unsustainable. Urgent action was recommended to promote environmentally sustainable development (Economic and Social Commission for Asia and the Pacific, 2010; United Nations and Asian Development Bank, 2012). In the AAR case, local people together with regional and national government officials all support the view that urgent action is need to foster stakeholder dialogue in order to promote conservation and ensure the environmental sustainability of future development projects. Major factors threatening natural resources in the region include the activities of some tourists, together with overgrazing by pastoralists, as they shift away from traditional grazing practices, and the inflated market value of agricultural and natural herbal products (see Chapter 5). It is argued here that these factors should be taken seriously by government if the planning, implementation and evaluation of natural resource management programmes is to be successful.

This study considers that one of the causes of negative environmental impacts is a change in climate, including rising temperatures, decreasing rainfall and unusual extended drought periods. This view is partly supported by recorded climatic data but the length of this data is too short to be able to draw conclusions about whether the short-term trends might be significant over the long-term. To address this issue, more robust climatic data are needed, by installing extra meteorological stations in the region, with qualified personnel able to manage and interpret the data in a meaningful way. The utility of such climate data can be demonstrated in the literature. For example, in 2008, Burundi, Kenya, Rwanda, Uganda and Tanzania established a project entitled "Enhancing Capacities of the Meteorological Services in Support of Sustainable Development in the East African Community Region (EACR)", and suggested that meteorological services, since their initiation in 1929, have played an increasing role in protecting life and properties in the EACR (East African Community Secretariat, 2008). The countries are similar to the AAR in being developing countries, all of which need to maximize the revenue from development projects yet preserve their natural resources. Establishing adequate meteorological and hydrological services and scientifically based advisory services should allow the governments and local communities of AAR to prepare and protect the region from weather-induced natural hazards. Similarly, climatic information can be used to enhance the productivity of agriculture by managing water in a more efficient manner.

This study has also shown that administrative corruption has impacted on the delivery and quality of programmes. These effects are evidenced by several abortive programmes and delays in the implementation of projects targeted at the sustainable management of natural resources**.** Such delays are attributed to inefficient bureaucracy and the lack of the necessary mechanisms for accountability and thus findings are supported by work elsewhere on

corruption in development projects. For example, Myint (2000) asserted that corruption will emerge in a country if discretionary powers are used by managers in interpreting a large number of laws, rules and regulations that restrict business and economic activities, applying them in a selective, secretive and inconsistent and non-transparent way with no accountability for their actions. Clearly, the results from AAR implicitly point to administrative corruption and support the Myint stance. It is clear that in developing countries corruption may be deep-rooted as a result of economic, political and institutional weaknesses (Myint, 2000; Aguilar et al, 2000). Moreover, it should also be regarded that ‘‘since natural resources have high, multiple values, they are often the subject of intense competition. Resource use is best managed by rules, norms and laws, but when these practices fail, competition may evolve into forms of corruption’’ (USAID, 2005:35). The regional environment and its natural resources are no different and corruption threatens sustainability even though the results may not be visible in the short term.

### 9.2 The environmental importance of the AAR

In a country mostly characterised by a harsh climate and subject to drought, any areas of exception to this trend are valued as important national assets. This study shows that the AAR is valued for its environmental importance, not only in Oman, but also across the Arabian Peninsula. It has exceptional geographical, geological and agricultural characteristics, representing in one small area a wide array of Omani biodiversity and natural resources. Linked to this is the importance of the region as a water source for most of northern Oman and adjacent areas.

As an arid subtropical mountain system, AAR has a high proportion of Oman's biodiversity, providing habitat for a wide range of species (about 33% of Oman's 1200 species of vascular plants occur in AAR, 14 of which are endemic to Oman (Patzelt, 2008)). The natural vegetation comprises woodlands of wild olive and juniper, along with deciduous and semi-evergreen shrublands and grassland, and is home to several species of birds. Agricultural crops vary with altitude with bananas and dates in the warmer desert region on the piedmont to pomegranates and roses in the colder summit regions. Messerli et al (2009) found mountain regions to be fundamentally important for ecosystems services and for the quality and quantity of the water provided to the adjacent areas. However, in many parts of the AAR, conservation concerns relate to the pressure caused by the opening up of the region to development projects. These include pressures on habitat from urban expansion, tourism and off-road driving that result in delayed plant regeneration and disturbance to breeding species. These concerns are not unique to the AAR. Al-Hadhrami (2006) investigated ''Developing Sustainability Tourism in Dhofar'', the northern Governorate of the Sultanate of Oman, asserting that recent increases in tourist camping activity can result in a significant negative effect, including impacts on soils, vegetation and wildlife.

The present research shares the concerns of Messerli et al (2009) and Al-Hadhrami (2006) that conservation needs to be urgently promoted to preserve mountain ecosystems in the region ''before uncontrolled degradation progresses further and the last one thousand years-old Juniperus tree is irreversibly lost'' (Messerli et al 2009: p 18). Since the Omani government has now approved some parts of the AAR as a protected area, a full environmental scheme now needs to focus on issues of sustainability, community interests and rights, biodiversity conservation, management effectiveness, planning and sustainable financing.

### 9.3 The socio-economic importance of the AAR

This study has demonstrated that both local people and officials see the economic potential of the region to be manifest in the characteristic features that make it attractive to tourists, and in particular to eco-tourists. This potential, if properly harnessed and supported in a sustainable manner, provides an opportunity to increase the financial income for both local people and the state alike. Local high quality agricultural products (especially pomegranates and mountain roses) may also provide opportunities for the local agricultural sector and for local people, and this applies also to pastoral products, especially mountain goats, which are in high demand for the local Omani markets.

In spite of the socio-economic importance of the AAR, this study suggests that little has been done by the government to secure and sustain this importance. For example, there has been a failure to take practical solutions to reduce the problem of feral donkeys that over-graze the vegetation of the region. In contrast to other countries, activities that adversely affect the environment and impact on its economic sustainability are not tolerated. Australia, for instance, successfully initiated a programme in 2006 to control invasive animals such as rabbits, foxes, feral pigs, donkeys and cats, all of which pose threats to the environment, agriculture, and human health and safety. The programme focused on finding solutions through the development of commercial outputs, integrated strategies that bring together national and international skills in science, management, commerce and industry including new and novel welfare-based solutions to pest animal management problems (Saunders et al, 2008; Invasive Animals Cooperative Research Centre, 2009). Again, in the farming sector just as in the tourism sector, the criterion of sustainability is crucial in order that production is maintained, yet environmental degradation is avoided.

The AAR offers opportunities for scientific studies in various fields of physical, human and biological science, as well as providing a resource base for sourcing medicinal herbs to support homeopathic medicine, and this study shows that the AAR struggles to continue to accommodate and provide livelihoods for an expanding number of people, not least in terms of water resources for domestic and agricultural use. The water shortage problem has led to a deterioration of pasture compounded by overgrazing. Any further development of infrastructure to support growth potential might well have additional, most likely negative, environmental consequences if handled in the same environmentally insensitive way as previous developments. Indeed, this is also the case in similar regions elsewhere. For example, in the Mediterranean basin, Araus (2004) argued that the sustainable use of water resources is affected by problems centring on high irrigation demands and changes in consumer life patterns, with a shift from rural to urban areas, combined with climatic changes in the basin. Thus, sustainable development in such regions needs an integrated approach that manages natural resources and balances conservation and development. In the AAR, both society and policy makers need to be more aware of the importance of regulating sustainable development.

### 9.4 Government practices and effectiveness in NRM

From the government officials' responses regarding management plans and objectives, it is clear that plans for natural resources management (NRM) recognise that governance is key. Among these are sustainability, local knowledge integration into NRM and support from the local community to protect natural resources. Some officials assert that management plans already contain specific natural resources-related objectives, targeting the resolution of natural resource disputes according to local custom, taking into account regulations governing the conservation of resources. However, the analysis of officials' responses in

matters pertaining to natural resources protection (as well as of the plans and annual reports of the ministries responsible for NRM) indicate that these plans and their implementation do not fully support the sustainability of natural resources, suggesting that there is a real gap between perception and reality.

This study shows that the management input is conditioned by the availability of appropriate infrastructure for transportation intended to serve all development projects in the region. Transport infrastructure development is commonly problematic in environmental terms, though it can be a beneficial factor. The availability of transportation alone is not sufficient to promote sustainability. Sustainability improvements around transportation can be better achieved if the government used a Triple Bottom Line (economy, environment and social) as a framework for developing a sustainable outcome. Based on these requirements, the infrastructure developed may reduce failings in respect of other inputs, such as skilled staff, information and the data necessary for sound planning and reliable budgeting. However, in the AAR environmental concerns are not fully considered by government.

Tourist facilities also lack integrated management. Inadequate financial allocations for management training and the lack of spending on data provision for planning purposes cast considerable doubt on their quality and adequacy. This is not to mention the lack of an integrated resource inventory and written programme for natural resource management to allow administrators to deliver realistic and effective NRM. The results call for a review, not only of the inputs of NRM plans, but of the management approaches pursued by the all ministries responsible for NRM in the region.

It seems that the gap between management plans and their application is not limited to Oman. Indeed, the problem of the translation of sustainable development strategies into practice has

been reported in many studies around the World. Some implementation gaps are an issue in Uganda, Zambia, South Africa and some other Middle East countries (Woodhouse et al, 2000; Lent et al, 2000; Gombakomba, 2008; Victor, 2012). For example, Lent et al (2000) criticized the South African government about the divergence between its declared plans and the reality of NRM practices in the Eastern Cape. Although the government highlighted its promotion of sustainable development, sustainability was seen as a mere economic theme. This leads to a deterioration of rangelands and reduction in sustainability. Lent et al (2000) called for greater efforts in the decentralization of integrated water resource management to enhance water sustainability. In Oman, a similar institutional system would be helpful in narrowing the gap between the perception and reality of management delivery, provided that integrated environmental management sits within an integrated legal system. This should avoid the difficulties highlighted by Mfune (2011) who pointed to major difficulties in the translation of sustainable development policies into practice in Zambia. He asserted that changing the direction of conservation discourse and policy into practice failed to articulate adequately the interests and experiences of local actors, making the implementation process of sustainable development strategies difficult. He recommended a greater attention to be paid to the realities of local-level actors in order to successfully achieve the aims of NRM strategies that fulfil the goals of environmental protection and livelihoods enhancement. In Oman, there also remain difficulties attributed to the divergence in the interpretation of nature conservation plans between the central government and local government. For example, the Department of Water Resources faces grave difficulties in providing the water needed for the expansion of development in the region; the Ministry of Agriculture and Fisheries is facing difficulties in maintaining the management of pasture resources in the face of development pressure; and there is doubt about the adequacy of procedures to resolve agricultural land

difficulties in AAR and about the incorporation of agricultural land protection into development plans.

Deficiencies in the development and application of comprehensive and integrated management plans for natural resources in the AAR raise major questions about the government's ability to address the situation and return the region to the condition it was in before the government assumed land ownership and control of the natural resources. Previously it had been managed by local people relying on TEK. However, national and regional NRM engagement now fails adequately to address and resolve the exclusion of some stakeholders from centralised planning processes so that some regional and local actors are marginalised from decision making. This is not an exclusively Omani problem as evidence from Australia as shown (Moore, 2005; Moore, 2006; Robins and Dovers, 2007), the Middle East (Victor, 2012) and Africa (Mohamed-Katerere, 2001; Anderson, 2006; Ncube, 2011). Moore (2006) argued that organizing regional NRM in Australia is far from being achieved and opportunities for local people do not exist. In Oman it is clear that the engagement and experience of all shareholders, if it is considered, could provide real benefit to the success of NRM programmes.

Oman possesses a rich cultural heritage and indigenous knowledge in various fields (Mershen, 2007, Mershen, 2010, Patzelt, 2010), which the government claims it strives to preserve, yet TEK in NRM has not yet been given real attention by government, nor has it demonstrated the required effort to guarantee the protection of this knowledge into the future. The precious heritage of TEK held in the memories of the elders is becoming forgotten. However, the Ministry of Regional Municipalities and Water Resources has been involved in efforts to document traditional knowledge and practices related to traditional Aflaj irrigation

systems. An indication is the inclusion in UNESCO's World Heritage List of the traditional Aflaj (MRMWR, 2008).

The endangered traditional knowledge of the region constitutes a problem that needs to be resolved and the best way sustainably to maintain threatened natural resources is to get local people interested in preserving their agricultural and pastoral activities as an integrated livelihood system. This additionally requires intervention from government that adds local value to local products through local processing, packing and/or marketing. Local people should be included within the stakeholder consultations of the NRM planners, since exclusion from the planning process may lead to the failure of NRM programmes. This is highlighted by some authors who attribute the general failure of regional NRM in Australia adequately to engage with and respect the interests of indigenous people (Lockwood et al, 2009; Lane & Corbett, 2005; Keogh et al., 2006; Moore & Rockloff, 2006; Robins & Dovers, 2007). Indeed, Lockwood et al (2009) recommend that special natural resources governance attention should include all marginalised stakeholders in environmental decisions, and it should receive the assent and confidence of indigenous communities. In the AAR, the notion of local engagement in environmental decisions is undermined by some government officials who believe that decision-making should be by government specialists in NRM. These may be inherited notions that view local people as illiterate. However, such views are out of date, since more than 70% of the local people are now educated with some holding advanced degrees and with experience of reliable environmental decision-making.

## 9.5 Traditional environmental knowledge systems and practices in managing water resources

In the past, people in the AAR were in a favourable position to develop useful and flexible approaches to NRM. Water harvesting systems made water available year-round, the agricultural methods used created green agricultural oases, and efficient pastoral management organised the regular coordination of herd movements. These creative practices harnessed the region's potential to sustain its population. Although this has led to population increase and an increase in the standard of living, pressure on natural resources, particularly water, pasture and agricultural land, remained under control, largely as a result of agreed management practices.

Government and local people confirm that traditional environmental knowledge (TEK) and practices related to the management of water resources in AAR were well utilised and need to be revitalised. The region still depends upon a wealth of TEK techniques, as well as organisation and management practices, which promote cooperation and communication in the utilisation and maintenance of water resources. One of the most important elements of the traditional Aflaj irrigation system in the region is the coherent organisation of the distribution of water among the beneficiaries. This depends on a systematic rotation that takes into account the abundance of water, the climatic conditions and the size of cultivated areas.

The financial and economic context is also very important for the Aflaj system, as it complements other organizational aspects. This context allows a continued self-empowerment insofar as it provides a source of self-funding. The main financial support for Aflaj comes from the water market that contains both the rent of individually owned-water and the rent of charitable endowment water. Indeed, the water market has played an important role in improving water allocation to encourage users to safeguard scarce water

resources and promote efficiency (Al-Marshudi, 2007; Al Sulaimani et al, 2007). Many writers have studied water markets around the world. Al-Marshudi (2007) discussed water market structures in Australia where water market policies have been aggressively implemented since 1994 and the market is divided into ‘‘two markets in water allocations (the right to short-term use of water) and markets for water entitlements (the long-term right to access water)’’ (Al-Marshudi, 2007: p 73). Appreciating the value of water in the AAR, the present study shows that both types of water markets are utilized in the region. This suggests an important conclusion in this study: one of the distinguishing features of traditional Aflaj irrigation system is that individual incentives within the framework of the Aflaj system are the same as the general interest of society. This means that the interest of the individual is represented in the continued efficacy of the Aflaj system to provide water for the individual, while also providing a resource for others.

The importance of water as a rare capital, prompts the local people to value the resource and work to maintain it. The imperative of conservation is deeply rooted in the culture of these people, especially as their religion advocates water conservation. Thus, the traditional management of this resource has become ingrained in individuals through a conservative upbringing and in the traditions of communities. This remains so in modern Oman.

In summary, the Aflaj system is based on the idea of ‘self-sustained development’, as a vital and accessible source of water. It regulates the apportionment and distribution of water, provides opportunities for work and income, irrigates the crops that provide food and agricultural raw materials that are the base of the traditional industries, and, since it is valued as a precious gift, it also supports social integration and solidarity.

## 9.6 Traditional environmental knowledge systems and practices in managing agricultural land resources

The consensus reached by officials and local people about the traditional farming system in the region results from their conviction about the richness of TEK related to the management of the agricultural land resource. The knowledge and practices related to coping with climatic conditions set the agricultural agenda and address problems of drought by reducing the cultivation area, and limiting it to the perennial trees and crops that ensure a financial income.

TEK practices and the efficient use of water resources also operate as a safety valve for sustainable agriculture, especially in the circumstances of water surpluses or drought, where people balance the water requirements of their crops. Thus, in times of water abundance, crops are planted that require regular water, and in times of shortage, crops are restricted to those which can withstand drought, such as pomegranates at high altitudes and palm trees in the piedmont. Local people understand the role of moisture in efficient seedbed preparation and successful growth of the crop, and regulate the distribution of irrigation water depending on agreed shares to prevent conflicts of interest.

Many studies have proven the effectiveness of TEK and related practices in fallow management (Tacher and Golicher, 2004), dealing with uncertainties and seasonality (Tengo and Belrage, 2004) and soil and water management (Shresthaetal, 2005). Similar to the findings from this study, Tengo and Belfrage (2004) found that local practices in agricultural areas in Sweden and Tanzania are varied in time and space, specifying practices for mitigating pest or drought, and this can limit impacts on crop production. In Oman, local people are aware of the field preparation that supports maximum sustainable crop production. Tillage is usually done in summer to reduce weeds within the main crop, and prevent insects

and diseases by exposing them to the summer sunlight. This also aids germination, emergence and growth of the plants. The effectiveness of some of these practices are indicated in Dollo et al (2009) who explore the ecological management of natural and human modified ecosystems in the Himalayas of North East India. They assert that traditional knowledge on crop-soil interaction, ethno-pedology, soil fertility management and water conservation are among a set of ecological knowledges that maintain a sustainable production system in the region. In the AAR, TEK also targets the maintenance of soil fertility and productivity over the long term to ensure the success of agriculture. Local people in the region repeatedly (at least twice a year) add organic fertilizers for seasonal crop uptake as well as for perennial trees. Moreover, local people carefully harrow and prepare their fields in slope-parallel bed-and-furrows to prevent soil loss.

In sum, the agro-ecological systems pursued by local people show a significant knowledge of local natural and climatic hazards, which may be useful for governmental agri-environmental programmes. Such knowledge and traditional practices can help conservation experts relate their own technical knowledge to local values (Fisher, 2000; Mfune, 2011). This means, as Fisher (2000) put it, while local knowledge may be perceived as lacking the 'scientific rigour', it is likely to help solve environmental problems by providing contextual experiences to complement expert knowledge.

### 9.7 Traditional environmental knowledge systems and practices in managing pasture resources

Varying views are evident between officials and local people concerning the grazing system in the region. Although the two groups agree that Islamic regulations control the management

of pastures, the two groups conflict on whether pastoralists in the region have actually become less dependent on the traditions that govern the operations of grazing. Government officials perceive that local people have become less dependent on traditional grazing methods, yet the local people do not agree. This lack of agreement is due to weak communication between officials and local pastoralists. However, regardless of differences in opinions between officials and local, TEK regarding the management of pastoral resources can be summarised in three parts.

Firstly, in rangeland management, there exists valuable TEK that recent modern studies have proved to be useful (Rinehart, 2008). For example, rotational grazing requires sufficient knowledge about the environmental features of the rangelands and this is part of the knowledge tools of the pastoralists. Rotational grazing allows pasture to regenerate when shepherds graze with geographic mobility over pastures allocated to each village. In addition to the geographic mobility between pastures, there exists vertical mobility. In this case, animals graze in lowland areas in the winter to ensure pasture regeneration, with the reverse practice employed during summer. This is similar to the findings of Fernandez-Gimenez (2000) who showed that the ecological knowledge shared by Mongolian nomadic pastoralists was the foundation for bio-socially sustainable resource management institutions, a knowledge that gave rise to a set of norms, attitudes and practices. Mobility and rotational grazing is among these practices, a factor that, if the communities adhere to it, will secure the success of common-property resource management institutions, a cornerstone for resource sustainability.

Secondly, TEK in the management of pastoral natural resources also concerns animal health. Pastoralists regard protecting animals from disease as vital in terms of the relationships between animal well-being, animal health and food safety. Thus, they regard grazing in open

pastures as healthy and useful, not only for the immune system of the animals, but also for soil fertility and ecological integrity. Rinehart (2008) found that pasture animals and their grazing systems, gained an acceptable level of production and also naturally maintained soil and plant integrity.

Thirdly, the decline of traditional pastoral life largely affects TEK. Despite the continuing importance of pastoralism as the main source of livelihood for many local people in the AAR, the norms and practices of pastoralism are affected by two sets of factors working against it at the macro and micro levels. Macro-level factors include development and settlement expansion, which restricts the scope for geographical mobility and the viability of alternative areas for grazing. The spread of central government regulation has also significantly weakened traditional customs that depend on rotational grazing. Meanwhile, donkeys, previously used for transport, have been abandoned to the wild and this has placed considerable pressure on pastures. Such changes have had a major impact on both the integrity of pasture and the viability of wild trees, both of which have become degraded. At the micro-level, a host of circumstances affect individual households in the region, which in turn influence their choices in continuing with pastoralism. Socioeconomic prosperity and changing life styles have led pastoralists to care less about the integrity of the pasture environment. There has been a change toward making quick profits through goat and sheep breeding, the transformation from nomadic to sedentary patterns and from extended to nuclear family arrangements. The last of these sees each family attempting to obtain more grazing animals and to release them onto the pastures, leading to further pressure on land resources. Both the macro and micro level factors have had major influences on changing the traditional pastoral system in the region into what can now best be described as an unregulated pastoral system. This not unique to Oman and is common in other countries of

the Middle (Victor, 2012). In this context, Al-Sirour (1999) found that the Jordanian rangelands are affected by the State's policy so that sheep-herders cannot now graze freely due to the introduction of new allocations of land use. He also pointed to some economic factors such as the increasing demand to supply neighbouring markets in the Gulf, resulting in more pressures on pasture areas. The fading of TEK and practices management of pasture resources is not unique to Oman, as studies from Ethiopia (Homann, 2004), Greece (Petropoulou, 2007) and Tonga (Pelesikoti, 2003) support this issue.. However, although this situation can be applied partially to Australia, the Australian government took it upon itself to promote these traditional practices and their integration into the government programs that aimed at the management of pastoral resources. There is now programmes for pasture management for productivity and sustainability as well as pasture monitoring and decision support systems (Wolfe, 2009).

It has been shown that TEK is a resource that can help solve local problems (Leautier, 2004), help grow more and better food (Larson and Sibana, 2004), maintain healthy lives (Green, 2004), maintain the agro-ecological system (Mfune, 2011) and manage local affairs (Oviedo, 2004). TEK, then, could aid developmental schemes including NRM. In general, many initiatives have proven the importance of TEK to enhance and strengthen NRM throughout the developing countries, where NRM activities and tasks still utilize indigenous knowledge within organizational structures. In this regard, the international community has demonstrated its commitment to recognize TEK in environmental and natural resource management, and to promote synergies between modern science and local knowledge (UNESCO, 2001; UNESCO, 2006). Moreover, much literature demonstrates studies and projects utilizing IK in water (Shrestha et al, 2005; Boelens and Gelles, 2005; Bang-Oa, 2006), soils (Liniger and Schwileh, 2002; Joshi et al, 2004; Shrestha et al, 2005), biodiversity and conservation

(Oviedo et al, 2000; Berkes, 2001; Farooquee et al, 2004; Steiner and Oviedo, 2004). These all indicate the importance of utilizing TEK and integrating it into the scheme of natural resource management, especially as it represents the local people, and this can in turn motivate them to work with the government to ensure the success of NRM projects and programmes. Local people in the AAR, as one of the eco-regions which are identified by the World Wildlife Fund (WWF), have until recently depended on their TEK to manage and utilize their environment, conserving its biodiversity, and this has diversified their cultural lives. Interestingly, this aspect was referred to by Oviedo et al (2000), pointing out that the conservation of these eco-regions is supported by local peoples using their traditional knowledge. Moreover, there is likely to be a strong correlation between areas of high biodiversity and areas of high cultural diversity, and this is explained by the extreme conditions prevailing in such environments, reflecting unique adaptations and a successful awareness in the use and management of landscapes (Oviedo et al, 2000). This clearly applies to the AAR, as biodiversity strongly drives cultural diversity. In addition, the agro-ecological systems created by local people demonstrate a considerable local knowledge. Such local knowledge and experience, as Fisher (2000) noted, can help conservation experts connect their own scientific knowledge with local values.

The previously mentioned examples demonstrate the usefulness of TEK and they recommend encouraging, enhancing and strengthening traditional practices in NRM, and building local people's capacity in order to empower them to manage their lands in a sustainable manner through effective practices and techniques (Bang-Oa, 2006). In contrast, some scholars question the integration of traditional and local ecological knowledge into NRM. Charnley et al (2007) describe the application of this knowledge to forest management and biodiversity conservation as being difficult, and they attribute this difficulty to a number of social,

economic and policy constraints that have prevented this knowledge from flourishing and being applied in forest management and biodiversity conservation. However, these difficulties could be managed by more communication between official managers and local people and sharing management practices and knowledge, toward acquiring mutual benefits (Charnley et al, 2007). In another context, Briggs (2005) argued for not disconnecting local knowledge from its context, and, whilst recognizing the importance of the empirical approaches, he regrets the ignorance of what he described as the lack of economic, social and political contexts in which such knowledge has been acquired and utilized. Consequently, reaching a compromise solution that satisfies both sides of the debate, this study suggests an approach to combine and interlace "modern scientific" and local knowledge to produce a more realistic and sensitive understanding and effective management of natural environmental resources for sustainable development. Clearly, this recommendation is among many suggested by Nakashima and Roué (2002), Cleophas (2004), Ellis (2005), Gilchrist and Mallory (2005) and Gilchrist et al (2007). Doing so will foster the influence of TEK in environmental decision making in order to promote more socially egalitarian and environmentally sustainable relationships between human societies and nature.

## 9.8 Pathways to a more viable natural and environmental resource management and sustainable development

Based on the factors that have thus far sustained the region's environmental and physical resources, and taking into account increased development pressure, a range of management applications that are hybrids of traditional practices and proven modern scientific management approaches are proposed here. The main features of the recommended management approaches are the preservation of the natural, physical, human and cultural

capital of the region, whilst accommodating access to advanced development and modern spaces and pursuing moves toward providing data, trained professional expertise and knowledge about the region's ecosystems and patterns of resource use.

This approach requires cooperation between all stakeholders, including government, the private sector and local people, as well as international environmental organizations (particularly those operating under the banner of the United Nations). It also requires government officials to take seriously both the results of scientific research and the adoption of TEK, using professionally acquired data as a basis for systematic planning in order to achieve SNRM in the AAR. Consequently, this approach will face challenges to manage the natural environment in the AAR. In this regard, Kaswamila (2011) suggests that management can be achieved through the use of systems analysis bringing together collective efforts to manage the complexities and challenges facing the natural environment. This is done by providing an integrated approach which creates a permitting environment from which stakeholders can benefit and sustainably adapt to natural and human challenges, as well as the adoption of flexible approaches to the planning of NRM. In the AAR this may offer hope of transformational change in the management of socio-ecological systems. However, it is important that the local people and those responsible for the NRM in the region are consulted and given full attention when planning for NRM programmes, in line with the requirements of SNRM. In this regard, it is important that their experience and expertise can be adapted to accommodate the nature of the region, the culture of its people and its administrative institutions. Hence, the government's efforts in the field of water resources management should be given credit for acknowledging the management of the Aflaj traditional irrigation system. However, these efforts contrast with the neglect or exclusion of similar institutions regarding agricultural and pastoral land resource management, resulting in irreversible

degradation of these resources. Connecting this to the debate about the suitability of engaging traditional institutions in the governance of natural resource remains an issue (Mfune, 2011; Larson et al, 2010; Barrow, 2003). Many scientists point to the need to include traditional institutions into governance, since these grass-root institutions derive their authority from the communities themselves and therefore represent a key input for effective natural resource management (Massuanganhe, 2005; Berkes, 2004; Mfune, 2011).

It is recognised that managing the challenges facing natural resources depends on a comprehensive understanding of the relevant factors influencing their productivity (Karamidehkordi, 2011). This means that natural resources need to be viewed not only in the context of food production, but as the main resource of livelihood. At the national level, these resources need to be seen as the natural capital of households and communities' livelihoods (Fabricius et al, 2004). A range of considerations should be taken into account when planning for development programmes. For example, in the fragile environment of the AAR, it remains difficult to achieve all the objectives of NRM and protection as set out by government agencies and approved by Royal Decree No 80/2011. Misunderstandings, or inappropriate engagement with the factors that affect natural resources in the AAR, such as ignoring the climatic, physio-topographic and human interactions, serve to put more pressure on these resources.

Given the experiences of developed countries in the management of public parks, national nature reserves and NR, Oman needs to increase both effort and money in order to achieve the objectives set out for natural reserves. Experiences of NRM in countries such as the United Kingdom, the United States of America and South Africa clearly show the need for professionalism in the application of rules, regulations and standards of sustainability, as well

as a desire to achieve environmental integrity. In England, the government works to define pressures and risks to the natural environment and attempts to put in place conditions that conserve and enhance it (www.naturalengland.org.uk). In the United States, the Natural Resources Defense Council (NRDC) is charged with protecting wildlife and wild places and ensuring a safe and healthy environment (www.hg.org/environ). In South Africa, most of the cities have committed themselves to balancing the need for economic growth and development with environmental sustainability (City of Cape Town, 2008). Such efforts, enhanced by theory and practice, promote the success of environmental policies in these countries.

In contrast, efforts to engage in the mainstream of NRM (as supported by the World Bank and others) has been implemented in only a handful of developing countries, and even then it is weak (Bruce and Mearns, 2002). Environmental policy in Oman has not yet yielded the desired results to protect the environment and at the same time to slow or reverse natural resource degradation. This is due to the lack of proper NRM planning in the region, as well as to the limited budgets allocated for applying environmental policies, along with the lack of skilled staff capable of responsibly implementing such policies.

From the results reported here, together with similar studies elsewhere (for example, Lemos and Agrawal, 2006; Borrini-Feyerabend, 2006; Leverington, 2008; Lockwood, 2009; and Bodegom, 2011), the best way to approach sustainable natural resource management (SNRM) is by the integration of environment governance between government, private sector, civil society and local communities. It also is well recognised that changes in function that precipitate alterations in the flow of ecosystem services may have both positive and negative effects on the well-being of local people (Millennium Ecosystem Assessment, 2003; Balmford and Bond, 2005; Roberts, 2010). In Oman, as in the case in most developing

countries, the government is now the most important player in NRM in the region, a NRM approach described by Pelesikoti (2003) as the 'classic approach' that was dominant during 1950-1975 (see Chapter 2 for more detail about NRM approaches). This includes issuing environmental regulations, promoting direct management and establishing nature reserves. Of course it is the responsibility of the government to maintain ecosystem services, but it must also seriously consider the inclusion of other stakeholders as investors in ecosystem services. This approach is the result of many factors related to an increased demand for ecosystem services, especially those relating to the control of drought and the rationing of the use of pastures. ''Rising opportunity costs of sustainable management and continuing demands on national budgets (especially in developing countries) make sustainable management of natural resources increasingly difficult to achieve, from both national budgetary and local job creation perspectives'' (Economic and Social Commission for Asia and the Pacific, 2010 p:5).

Related to the issue of enhancing SNRM in the AAR, another pressing concern revolves around the question of what are the most appropriate institutional changes that could ensure a successful environmental policy and sustainable development. In the context of Oman, leadership, cultural change, knowledge sharing and implementation capacity are prominent factors restricting successful environmental policy implimentation and sustainable development. Consequently, a commitment to sustainable development requires enlightenment within organisations and government (Gloet, 2006; Ross, and Dovers, 2008; Moore, 2010). Science, research, training and skills can contribute to a better understanding of environment functions, and the spatial and temporal interactions between soils, water and vegetation. However, the links between actions and outcomes in NRM are required to measure its effectiveness (Cork et al, 2008; IFAD, 2011) and this requires effective training

courses for NRM staff on environmental knowledge sharing and learning mechanisms. Better systematic measurements of environmental and social impacts are required.

### 9.9 A wider perspective ?

Development and nature are inseparable. Nature is the basis of development which is, in turn, the path that reflects the ability of a community to develop its local natural resources. Consequently, social organization is a key factor in governing the economic, social and environmental dimensions of development. The struggle between nature and development can be seen in terms of the failure of one to meet the requirements of the other. This occurs where a balance is not achieved between development requirements and nature's ability to meet these requirements. This, in turn, occurs if there is a lack of understanding of the impact that development has on nature and a consequent inability or, in the case of Oman a lack of will, to act in harmony with it.

The people of the AAR acquired the TEK which enabled them to develop the area in harmony with its natural environment. Sustainability characterized this development and exploitation of natural resources also had the social aim of resource development within a cultural vision of equitable distribution of wealth and enjoyment of legitimate rights. In this way, environmental damage was avoided. This was successfully organized by the local people themselves, through a tribal organization in which people respected and complied with the communal good.

However, the emergence of the modern Omani state in 1970 resulted in a separation of people from an interest in, and engagement with, their environment and the TEK used to

exploit natural resources. This occurred in parallel with post-1970 urban development and demographic transformation and with central government remotely governing Oman's provincial regions. This resulted in natural resources being viewed as state property. Together with an overarching lack of environmental concern from the state, several environmental problems have subsequently emerged in the region. With the low level of government capacity to control and mitigate the negative effects of development projects, it is largely the responsibility of local communities to respond to such threats to their livelihoods.

This calls for a plea that development needs should be appropriately directed toward particular social, cultural and environmental contexts, in which development projects, defined by local people, support the principle that regards local culture as a core element in development, and not a threat to it (Leathers, 2008). Consequently, any development of the region should be to strengthen the NRM practices that are an inseparable part of the region's cultural systems, as well as to mitigate processes that threaten them. Alternative grassroots approaches to development increasingly attach importance to the empowerment of local communities (Mayo and Craig, 1995; Mohan and Stokke, 2000; Leathers, 2008). While local initiatives should help define the development projects, these initiatives need also to be sustained by effectively trained and resourced officials at both provincial and national levels. This includes building the negotiating capacities of local people to help them to convey their knowledge and wishes directly to policymakers. Based on this vision, a system of NRM in the AAR needs to change from a unipolar system controlled solely by government to a more comprehensive and pluralist system to ensure the participation of all relevant stakeholders in NRM.

## 9.10 Policy recommendations

The above work lends itself to three key recommendations to government aimed at enhancing NRM in AAR. These are:

1. The status of the environment, its natural resources, management practices by government agencies responsible for NRM, the on- and off-site environmental outcomes arising from these practices and their associated costs all vary in time and space. Good SNRM policy needs to take account of this variability in order to make sustainable decisions. A key action is to identify the natural resources that are most at risk in the AAR, together with those that have socio-economic importance due to the nature of the ecosystem services provided. Subsequently, a strategy to include all of the stakeholders of these natural resources needs to be developed using the range of policy approaches and instruments available to policymakers.

2. Capacity-building of government agencies responsible for NRM is needed so that the strategy and up-scaling necessary to apply SNRM to its maximum management effectiveness is possible. This in turn would maximize impacts at the national level. Formal networks of both government officials at national, regional and local levels, and up-skilled technicians able to work together towards more effective management decisions, need to be established by government.

3. Government policy needs to recognize that TEK has a considerable role to play in environmental and natural resources management. Concern over TEK vulnerability in the AAR should be acknowledged by SNRM policy and a revival plan put in place via the integration of TEK into the annual NRM plan and into school curricula. Encouraging community-based research, documentation of TEK, and employing TEK in ventures that facilitate ecotourism, are among the options. Support should be given to several existing initiatives, including the Omani Women's Association initiatives and the Centre of

Distillation of Aromatic Plants. Furthermore, government agencies responsible for NRM, in co-operation with the Ministry of Education (the integration of TEK into school curriculum, particularly in the textbooks of research project course) and the Ministry of Higher Education, need to develop SNRM national policies, action plans and relevant activities in formal and informal environmental educational settings for young people.

In summary, NRM is the key to efficient development in the AAR through an integrated approach that allocates water, agricultural land and pasture to maximise sustainable benefits to local and national living standards. With natural resources conservation as the major objective in Omani national development, government officials need to work with the active participation of all stakeholders, to promote integrated NRM. They should also concentrate on capacity-building in the local departments responsible for NRM. Crucially, NRM practices need to encourage the active involvement of local people whose livelihoods largely depend on the natural resources around them.

# Appendices

**Appendix 1** Questionnaire for Government Officials

**1. Personal and Background Information:**

a) Region: 1. Al-Jabal Al-Akhdar, 2. Nizwa, 3. Muscat.

b) Name of the establishment:
1. Ministry of Regional Municipalities and Water Resources,
2. Ministry of Agriculture,
3. Ministry of Climate Affairs and Environment.
4. Sultan Qaboos University.
5. Vice Wali Office.
6. Ministry of Housing.
7. Ministry of Tourism.

c) Date established: ……

d) Respondent position (post): ……

e) Educational level:
1. Postgraduate,
2. Graduate,
3. Vocational diploma,
4. General education certificate

Date survey completed: / / 2010

**Procedural definitions**

* **Natural resources**: include water resources (groundwater and surface water), agricultural land, natural vegetation, and pastoral resources.

** **Practices based on scientific knowledge**: all the tasks and actions of those responsible for the management and exploitation of natural resources, and scientific applications that scientifically adopted in this area.

*** **Sustainable natural resources management**: the sustainable exploitation of natural resources in administrative and technical ways in order to ensure rights of future generations to these resources.

**2. The Importance of AL-Jabal Al-Akhdar Mountain (AAR):**

**a) The environmental importance:**

Please, Tick the most appropriate preferences according to your information or based on your judgment

**To what extent do you do you agree with the following statements:**

| **1 = Strongly disagree** | | **2 = disagree** | | **3 = not sure** | **4= Agree** | **5= Strongly agree** |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | | |
| | | | | | 1. AAR contains water resources sufficient to residential and agricultural needs. | |
| | | | | | 2. AAR is the head of many wadies. | |
| | | | | | 3. AAR contains a fertility agricultural soil. | |
| | | | | | 4. AAR contains a relatively high number of rare, threatened, or endangered species. | |
| | | | | | 5. AAR has relatively high levels of biodiversity. | |
| | | | | | 6. AAR has a relatively high degree of endemism. | |
| | | | | | 7. AAR significantly contributes to the representativeness of Oman nature. | |
| | | | | | 8. AAR includes ecosystems whose historic range has been greatly diminished. | |

**Notes:**.....
.....
..... .....

**b) Socio-economic Importance:**

| **1 = Strongly disagree** | | **2 = disagree** | | **3 = not sure** | **4= Agree** | **5= Strongly agree** |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | | |
| | | | | | 1. AAR is an important source of employment for local communities. | |
| | | | | | 2. Local communities depend upon AAR resources for their subsistence. | |
| | | | | | 3. AAR provides community development opportunities through sustainable resource use. | |
| | | | | | 4. AAR has recreational value and aesthetic significance. | |
| | | | | | 5. AAR has remarkable features of historical importance. | |
| | | | | | 6. AAR contains plant species of high social, cultural, or economic importance. | |
| | | | | | 7. AAR contains animal species of high social, cultural, or economic importance. | |
| | | | | | 8. AAR contributes significant ecosystem services and benefits to communities. | |
| | | | | | 9. AAR has a high educational and/or scientific value. | |
| | | | | | 10. Development opportunities depends on SNRM in the AAR | |

**Note:**.....
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**3. Pressures and Threats on Natural Resources (Vulnerability):**

Please, Tick the most appropriate preferences according to your information or based on your judgment.

| Pressure: To what extent have development activities had pressure in natural resources in Al-Jabal Al-Akhdar in the last 5 years, regarding to: | | | |
|---|---|---|---|
| 1) In the past 5 years these activities have:<br>❍ Increased sharply<br>❍ Increased slightly<br>❍ Remained constant<br>❍ Decreased slightly<br>❍ Decreased sharply | 2) Extent<br>❍ Throughout (>50%)<br>❍ Widespread (15–50%)<br>❍ Scattered (5–15%)<br>❍ Localized (5-1%)<br>❍ very limited (< 1%) | 3) Impact<br>❍ Severe<br>❍ High<br>❍ Moderate<br>❍ Mild<br>❍ Non | 4) Expected permanence<br>❍ Permanent (>50 years)<br>❍ Long term(20–50 years)<br>❍ Medium term (5–20 years)<br>❍ Short term (5-1 years)<br>❍ very short term(<1year) |
| Threat: To what extent development activities will threat natural resources in Al-Jabal Al-Akhdar in the next 5 years | | | |
| 5) The probability of the threat occurring is:<br>❍ Very high<br>❍ High<br>❍ Medium<br>❍ Low<br>❍ Very low | 6) Extent<br>❍ Throughout (>50%)<br>❍ Widespread (15–50%)<br>❍ Scattered (5–15%)<br>❍ Localized (5-1%)<br>❍ very limited (< 1%) | 7) Impact<br>❍ Severe<br>❍ High<br>❍ Moderate<br>❍ Mild<br>❍ Non | 8) Permanence*1<br>❍ Permanent (>50 years)<br>❍ Long term (20–50 years)<br>❍ Medium term (5–20 years)<br>❍ Short term (<5 years)<br>❍ Short term (5-1 years)<br>❍ very short term(<1year) |
| 9. To what extent have climate changes had pressure in natural resources in Al-Jabal Al-Akhdar in the last 5 years:<br>❍ Severe. ❍ High. ❍ Moderate. ❍ Mild. ❍ None. | | | |
| To what extent you agree that the following parties have had a negative impact on natural resources in AAR? | | | |
| 1 = Strongly disagree 2 = disagree 3 = not sure 4= Agree 5= Strongly agree | | | |

| | | 1 | 2 | 3 | 4 | 5 | | | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | Government departments. | | | | | | 11 | Tribes. | | | | | |
| 12 | Farmers. | | | | | | 13 | Pastoralists. | | | | | |
| 14 | Tourists. | | | | | | 15 | Non-governmental organizations. | | | | | |

**Note:**.....
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***1** Permanence is the duration needed for the affected natural resources to recover with or without human interference. Recovery is meant the restoration of natural structure, functions and processes to levels that existed before the emergence of existence activity as a threat. The recovery time means that the activity finishes, and that site management interventions or natural processes can occur.

**3. (Continued) Pressures and Threats on Natural Resources (Vulnerability):**

Please, Tick the most appropriate preferences according to your information or based on your judgment.

| 1 = Strongly disagree 2 = disagree 3 = not sure 4= Agree 5= Strongly agree | | | | | |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | |
| | | | | | 16. Illegal activities within AAR are difficult to monitor. |
| | | | | | 17. Law enforcement is low in the region. |
| | | | | | 18. Bribery and corruption is common throughout the region. |
| | | | | | 19. Cultural practices and traditional uses conflict with Oman biodiversity strategy. |
| | | | | | 20. The market value of AAR resources is high. |
| | | | | | 21. AAR is easily accessible for illegal activities. |
| | | | | | 22. There is a strong demand for vulnerable AAR resources. |
| | | | | | 23. Department's executives in AAR are under pressure to unduly exploit the resources. |
| | | | | | 24. Recruitment and retention of employees is difficult. |

**4. Government practices in natural resources management in AAR:**

| 1 = Strongly disagree 2 = disagree 3 = not sure 4= Agree 5= Strongly agree | | | | | |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | |
| | | | | | 1. Specific natural resources -related objectives are clearly stated in the management plan. |
| | | | | | 2. Management policies and plans are consistent with the Oman biodiversity strategy objectives and its action plan. |
| | | | | | 3. Natural resources policy and regulation are taken into consideration when planning to natural resources programmes and projects. |
| | | | | | 4. Sustainable natural resource utility is a key issue in the programmes of natural resource management. |
| | | | | | 5. Management policies and plans aim to benefit from local knowledge. |
| | | | | | 6. Local communities support the overall objectives of the protection and maintenance of AAR. |
| | | | | | 7. The AAR has long-term legally obligatory protection. |
| | | | | | 8. There is an adequate policy for natural resource management. |
| | | | | | 9. Natural resources protection is incorporated into formal land use planning and rural development planning procedures. |
| | | | | | 10. Local customs are recruited to resolve conflicts over natural resources. |
| | | | | | 11. The level of staffing is sufficient to effectively manage natural resources in AAR. |
| | | | | | 12. Staff performance and progress on targets are periodically reviewed. |
| | | | | | 13. There are enough numbers of staff who are from AAR area. |
| | | | | | 14. There are adequate means of communication between field and office staff. |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | 15. Existing ecological and socio-economic data are enough for management planning. |
| | | | | | 16. There is effective communication with local communities in AAR. |
| | | | | | 17. Shura Council member's (representative of Nizwa district) recommendations are regarded with respect to the decision-making processes of natural resources in AAR. |
| | | | | | 18. Transportation infrastructure is adequate to perform critical management activities. |
| | | | | | 19. Field equipment is adequate to perform critical management activities. |
| | | | | | 20. There is a suitable infrastructure to facilitate the growing tourism activities. |
| | | | | | 21. The Government Five-Year Plan has ensured adequate funding to conduct critical natural resources management activities. |
| | | | | | 22. Financial management practices enable efficient and effective natural resources management in AAR. |
| | | | | | 23. The allocation of expenditures is suitable to natural resources priorities. |
| | | | | | 24. There is a inclusive, relatively recent written natural resources management plan. |
| | | | | | 25. There is a comprehensive inventory of natural resources. |
| | | | | | 26. There is a strategy for addressing threats and pressures that face natural resources in AAR. |
| | | | | | 27. There are specialized governmental services for natural resource management based in AAR. |
| | | | | | 28. Different department Executives and staff in AAR regularly collaborate with others. |
| | | | | | 29. Local communities participate in decisions that affect them. |
| | | | | | 30. The impact of legal and illegal uses of the natural resources in AAR are accurately monitored and recorded. |
| | | | | | 31. Research on key issues related to natural resources in AAR is frequently carried out. |
| | | | | | 32. Projects and programmes are periodically evaluated. |
| | | | | | 33. Local-level government initiatives exist with public-private partnerships to support private sector involvement (e.g. companies, Chamber of Commerce, and Industry of Oman) in natural resource management-related activities. |

**5.** The effectiveness of government's efforts to manage natural resources in AAR:

**a) Issues related to water resources:**

| 1 = Strongly disagree. 2 = disagree. 3 = not sure. 4= Agree. 5= Strongly agree. | | | | | |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | |
| | | | | | 1. Government departments adequately provide procedures to protect water resources in places that are prone to drought, floods, landslides and other hazards. |
| | | | | | 2. Adequate social protection is available to help vulnerable people to respond to, and recover from scarcity of water resources. |
| | | | | | 3. Government department policies help to reduce dependence on unsafe livelihoods or risk-vulnerable agricultural practices and activities in local communities |
| | | | | | 4. Water resources protection is incorporated into formal land use planning and rural development planning procedures |
| | | | | | 5. There is a comprehensive inventory of water uses arenas. |
| | | | | | 6. Projects are implemented to ensure the safety and sustainability of water resources. |
| | | | | | 7. Staff has sufficient skills to perform their duties in water resources management. |
| | | | | | 8. Local people in AAR are monitored to insure their obligation to water resources conservation policy. |
| | | | | | 9. Punitions are implemented on people who infringe water resources conservation regulations. |
| | | | | | 10. Available environmental and socio-economic data are sufficient to plan for water resources management. |
| | | | | | 11. There is enough awareness of the local knowledge and practices relating to water resources management in AAR. |
| | | | | | 12. Local people are encouraged to manage water resources by their traditional knowledge. |
| | | | | | 13. water resources department faces difficulties to conserve plant and pasture resources because of developmental expansion in AAR. |
| | | | | | 14. water resources department faces difficulties to deal with physical feature of AAR. |
| | | | | | 15. water resources department faces difficulties to deal with local people in AAR |
| | | | | | 16. Water resources department regularly makes local people aware about the plant and pasture resources situation in AAR. |
| | | | | | 17. Appropriate resolutions are decided to water resources difficulties in AAR. |

**Note:**.....
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**5.** (Continued) Effectiveness of government's efforts to manage natural resources in AAR:

**b) Issues related to plant and pasture resource:**

| 1 = Strongly disagree. 2 = disagree. 3 = not sure. 4= Agree. 5= Strongly agree. | | | | | |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | |
| | | | | | 1. There is a comprehensive inventory of plants types and its uses. |
| | | | | | 2. Projects are implemented to ensure the safety and sustainability of plant and pasture resources. |
| | | | | | 3. Staff has sufficient skills to perform their duties in plant and pasture resources management. |
| | | | | | 4. Available environmental and socio-economic data are sufficient to plan for plant and pasture resources management. |
| | | | | | 5. There is enough awareness of the local knowledge and practices relating to the plant and pasture resources management in AAR. |
| | | | | | 6. Local people are encouraged to manage plant and pasture resources by their traditional knowledge. |
| | | | | | 7. Agricultural department faces difficulties to conserve plant and pasture resources because of developmental expansion in AAR. |
| | | | | | 8. Agricultural department faces difficulties to deal with physical feature of AAR. |
| | | | | | 9. Agricultural department faces difficulties to deal with local people in AAR |
| | | | | | 10. Agricultural department regularly makes local people aware about the plant and pasture resources situation in AAR. |
| | | | | | 11. Appropriate resolutions are decided to plant and pasture resources difficulties in AAR. |

**Note:**.....
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**5.** (Continued) Effectiveness of government's efforts to manage natural resources in AAR:

**c) Issues related to agriculture land:**

| 1 = Strongly disagree. 2 = disagree. 3 = not sure. 4= Agree. 5= Strongly agree. | | | | | |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | |
| | | | | | 1. There is a comprehensive inventory of agriculture land and its uses. |
| | | | | | 2. Projects are implemented to ensure the safety and sustainability of agriculture land. |
| | | | | | 3. Staff has sufficient skills to perform their duties in agriculture land management. |
| | | | | | 4. Available environmental and socio-economic data are sufficient to plan for agriculture land management. |
| | | | | | 5. There is enough awareness of the local knowledge and practices relating to the agriculture land management in AAR. |
| | | | | | 6. Local people are encouraged to manage agriculture land by their traditional knowledge. |
| | | | | | 7. Government policies help to reduce dependence on unsafe livelihoods or risk-vulnerable agricultural practices and activities in local communities. |
| | | | | | 8. Agricultural department faces difficulties to conserve agriculture land because of developmental and building expansion in AAR. |
| | | | | | 9. Agricultural department regularly makes local people aware about the agriculture land situation in AAR. |
| | | | | | 10. Appropriate resolutions are decided to agriculture land difficulties in AAR. |

Note:……
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**6.** Local knowledge and practices in the management of natural resources in the AAR and the extent of their integration into government programmes for natural resource management:

In this part of the questionnaire: Please define local knowledge and practices in the management of natural resources in AAR, as well as their integration into government programmes for natural resource management:

| 1 = Strongly disagree. 2 = disagree. 3 = not sure. 4= Agree. 5= Strongly agree. | | | | | |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 1. People in AAR have useful traditional natural resources management knowledge. |
| | | | | | 2. Local people still use local knowledge to manage and exploit their natural resources. |
| | | | | | 3. Local people operate the Omani conventional system (Aflaj) as an administrative organization. |
| | | | | | 4. Properties of water are managed in terms of the Islamic way regarding to inheritance and sale. |
| | | | | | 5. Local people use wells to extract groundwater. |
| | | | | | 6. Local People use traditional methods of water harvesting to provide water needs. |
| | | | | | 7. Local People use traditional tools for the maintenance of water resources. |
| | | | | | 8. Maintenance of water resources is funded through its own resources (endowments and leasing). |
| | | | | | 9. Local people depend on their traditional knowledge in cultivation and harvest. |
| | | | | | 10. Land holdings are managed in terms of the Islamic way regarding to inheritance and sale. |
| | | | | | 11. Planting and harvesting operations are cared out with conventional methods. |
| | | | | | 12. There are special norms govern the operations of agriculture and harvest. |
| | | | | | 13. Local people depend on their traditional knowledge in grazing. |
| | | | | | 14. Local people relay on the special knowledge in animal husbandry. |
| | | | | | 15. Local people are grazing in traditional methods |
| | | | | | 16. There are special norms govern the operations of grazing. |
| | | | | | 17. Local knowledge is integrated of in natural resource management programmes adopted by the government in AAR. |

I kindly request to write some suggestions to activate sustainable natural resources management in AAR by benefit from traditional knowledge:

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## Appendix 2 Questionnaire for local people

**1. Personal and Background Information:**

Please tick the appropriate alternatives or fill in the gaps:
1
1. Personal information:

**a**) Gender: ☐ Male. ☐ Female.

**b)** Age: (20-30) (31-40) (41-50) (51-60) (61-70) (> 70 )

**c)** Number of family members:

Educational level:

1. Postgraduate☐. 2. Graduate ☐. 3. Vocational diploma ☐.
4. General education certificate ☐. 5. Illiterate ☐.

**d)** Profession and sources of income
1. Agriculture only. ☐
2. Agriculture + government work. ☐
3. Agriculture + working in the private sector.
4. Agriculture + other special employer: (Grazing, trade, construction, tourism, industry). ☐
5. Grazing only. ☐
6. Grazing + government employment. ☐
7. Grazing + private sector employment. ☐
8.Grazing + other special employer: (agriculture, trade, construction, tourism, industry). ☐
9.Government Job. ☐
10. Other (please specify)…… ☐

**e)** The farm area: …….

f) The village: …….

**g)** Number of head of sheep: …… goats: …….. cows: ……..

**h)** Number of workers in the family: ……

**I)** Income level (perception of wealth) of the family:

☐.Very High. ☐.High. ☐.Normal. ☐.Poor. ☐.Very poor.

**Procedural definitions**
* **Natural resources**: include water resources (groundwater and surface water), agricultural land, natural vegetation, and pastoral resources.
** **Practices based on scientific knowledge**: all the tasks and actions of those responsible for the management and exploitation of natural resources, and scientific applications that scientifically adopted in this area.
*** **Sustainable natural resources management**: the sustainable exploitation of natural resources in administrative and technical ways in order to ensure rights of future generations to these resources.

**2. The Importance of AL-Jabal Al-Akhdar Mountain (AAR):**

**a) The environmental importance:**

Please, Tick the most appropriate preferences according to your information or based on your judgment

To what extent do you do you agree with the following statements:

| **1 = Strongly disagree** | | **2 = disagree** | | **3 = not sure** | **4= Agree** | **5= Strongly agree** |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | | |
| | | | | | 1 AAR contains water resources sufficient to residential and agricultural needs. | |
| | | | | | 2 AAR is the head of many wadies. | |
| | | | | | 3 AAR contains a fertility agricultural soil. | |
| | | | | | 4 AAR contains a relatively high number of rare, threatened, or endangered species. | |
| | | | | | 5 AAR has relatively high levels of biodiversity. | |
| | | | | | 6 AAR has a relatively high degree of endemism. | |
| | | | | | 7 AAR significantly contributes to the representativeness of Oman nature. | |
| | | | | | 8 AAR includes ecosystems whose historic range has been greatly diminished. | |

**Notes**……
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**b) Socio-economic Importance:**

| **1 = Strongly disagree** | | **2 = disagree** | | **3 = not sure** | **4= Agree** | **5= Strongly agree** |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | | |
| | | | | | 1 AAR is an important source of employment for local communities. | |
| | | | | | Local communities depend upon AAR resources for their subsistence. | |
| | | | | | 2 AAR provides community development opportunities through sustainable resource use. | |
| | | | | | 3 AAR has recreational value and aesthetic significance. | |
| | | | | | 4 AAR has remarkable features of historical importance. | |
| | | | | | 5 AAR contains plant species of high social, cultural, or economic importance. | |
| | | | | | 6 AAR contains animal species of high social, cultural, or economic importance. | |
| | | | | | 8 AAR contributes significant ecosystem services and benefits to communities. | |
| | | | | | 9 AAR has a high educational and/or scientific value. | |

**Note:**……
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**3. Pressures and Threats on Natural Resources (Vulnerability):**

Please, Tick the most appropriate preferences according to your information or based on your judgment.

<table>
<tr><td colspan="4">Pressure: To what extent have development activities had pressure in natural resources in Al-Jabal Al-Akhdar in the last 5 years, regarding to:</td></tr>
<tr><td>1) In the past 5 years these activities have:<br>❍ Increased sharply<br>❍ Increased slightly<br>❍ Remained constant<br>❍ Decreased slightly<br>❍ Decreased sharply</td><td>2) Extent<br>❍ Throughout (>50%)<br>❍ Widespread (15–50%)<br>❍ Scattered (5–15%)<br>❍ Localized (5-1%)<br>❍ very limited (< 1%)</td><td>3) Impact<br>❍ Severe<br>❍ High<br>❍ Moderate<br>❍ Mild<br>❍ Non</td><td>4) Expected permanence<br>❍ Permanent (>50 years)<br>❍ Long term(20–50 years)<br>❍ Medium term (5–20 years)<br>❍ Short term (5-1 years)<br>❍very short term(<1year)</td></tr>
<tr><td colspan="4">Threat: To what extent development activities will threat natural resources in Al-Jabal Al-Akhdar in the next 5 years</td></tr>
<tr><td>5) The probability of the threat occurring is:<br>❍ Very high<br>❍ High<br>❍ Medium<br>❍ Low<br>❍ Very low</td><td>6) Extent<br>❍ Throughout (>50%)<br>❍ Widespread (15–50%)<br>❍ Scattered (5–15%)<br>❍ Localized (5-1%)<br>❍ very limited (< 1%)</td><td>7) Impact<br>❍ Severe<br>❍ High<br>❍ Moderate<br>❍ Mild<br>❍ Non</td><td>8) Permanence*1<br>❍ Permanent (>50 years)<br>❍ Long term (20–50 years)<br>❍ Medium term (5–20 years)<br>❍ Short term (<5 years)<br>❍ Short term (5-1 years)<br>❍ very short term(<1year)</td></tr>
<tr><td colspan="4">9. To what extent have climate changes had pressure in natural resources in Al-Jabal Al-Akhdar in the last 5 years:<br>❍ Severe. ❍ High. ❍ Moderate. ❍ Mild. ❍ Non.</td></tr>
<tr><td colspan="4">To what extent agree that the following parties have had a negative impact on natural resources in AAR?</td></tr>
</table>

1 = Strongly disagree 2 = disagree 3 = not sure 4= Agree 5= Strongly agree

| | | 1 | 2 | 3 | 4 | 5 | | | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | Government departments. | | | | | | 11 | Tribes. | | | | | |
| 12 | Farmers. | | | | | | 13 | Pastoralists. | | | | | |
| 14 | Tourists. | | | | | | 15 | Non-governmental organizations. | | | | | |

**Note:**……
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**3. (Continued) Pressures and Threats on Natural Resources (Vulnerability):**
Please, Tick the most appropriate preferences according to your information or based on your judgment.

| 1 = Strongly disagree 2 = disagree 3 = not sure 4= Agree 5= Strongly agree | | | | | |
|---|---|---|---|---|---|
| **1** | **2** | **3** | **4** | **5** | |
| | | | | | 16) 16 Illegal activities within AAR are difficult to monitor. |
| | | | | | 17) Law enforcement is low in the region. |
| | | | | | 18) Bribery and corruption is common throughout the region. |
| | | | | | 19) Cultural practices and traditional uses conflict with Oman biodiversity strategy. |
| | | | | | 20) The market value of AAR resources is high. |
| | | | | | 21) AAR is easily accessible for illegal activities. |
| | | | | | 22) There is a strong demand for vulnerable AAR resources. |
| | | | | | 23) Department's executives in AAR are under pressure to unduly exploit the resources. |
| | | | | | 24) Recruitment and retention of employees is difficult. |

**Note**:……
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**4.** The effectiveness of government's efforts to manage natural resources in AAR:
**a) Issues related to water resources:**

| 1 = Strongly disagree. 2 = disagree. 3 = not sure. 4= Agree. 5= Strongly agree. | | | | | |
|---|---|---|---|---|---|
| **1** | **2** | **3** | **4** | **5** | |
| | | | | | 1. Government departments adequately provide procedures to protect water resources in places that are prone to drought, floods, landslides and other hazards. |
| | | | | | 2. Adequate social protection is available to help vulnerable people to respond to, and recover from scarcity of water resources. |
| | | | | | 3. Government department policies help to reduce dependence on unsafe livelihoods or risk-vulnerable agricultural practices and activities in local communities |
| | | | | | 4. Water resources protection is incorporated into formal land use planning and rural development planning procedures |
| | | | | | 5. There is a comprehensive inventory of water uses arenas. |
| | | | | | 6. Projects are implemented to ensure the safety and sustainability of water resources. |
| | | | | | 7. Staff has sufficient skills to perform their duties in water resources management. |
| | | | | | 8. Local people in AAR are monitored to insure their obligation to water resources conservation policy. |
| | | | | | 9. Punitions are implemented on people who infringe water resources conservation regulations. |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | 10. Available environmental and socio-economic data are sufficient to plan for water resources management. |
| | | | | | 11. There is enough awareness of the local knowledge and practices relating to water resources management in AAR. |
| | | | | | 12. Local people are encouraged to manage water resources by their traditional knowledge. |
| | | | | | 13. Water resources department faces difficulties to conserve plant and pasture resources because of developmental expansion in AAR. |
| | | | | | 14. Water resources department faces difficulties to deal with physical feature of AAR. |
| | | | | | 15. water resources department faces difficulties to deal with local people in AAR |
| | | | | | 16. Water resources department regularly makes local people aware about the plant and pasture resources situation in AAR. |
| | | | | | 17. Appropriate resolutions are decided to water resources difficulties in AAR. |

**Note**……
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**4.** (Continued) Effectiveness of government's efforts to manage natural resources in AAR:

**b) Issues related to plant and pasture resource:**

| 1 = Strongly disagree. 2 = disagree. 3 = not sure. 4= Agree. 5= Strongly agree. | | | | | |
|---|---|---|---|---|---|
| **1** | **2** | **3** | **4** | **5** | |
| | | | | | 18. There is a comprehensive inventory of plants types and its uses. |
| | | | | | 19. Projects are implemented to ensure the safety and sustainability of plant and pasture resources. |
| | | | | | 20. Staff has sufficient skills to perform their duties in plant and pasture resources management. |
| | | | | | 21. Available environmental and socio-economic data are sufficient to plan for plant and pasture resources management. |
| | | | | | 22. There is enough awareness of the local knowledge and practices relating to the plant and pasture resources management in AAR. |
| | | | | | 23. Local people are encouraged to manage plant and pasture resources by their traditional knowledge. |
| | | | | | 24. Agricultural department faces difficulties to conserve plant and pasture resources because of developmental expansion in AAR. |
| | | | | | 25. Agricultural department faces difficulties to deal with physical feature of AAR. |
| | | | | | 26. Agricultural department faces difficulties to deal with local people in AAR |
| | | | | | 27. Agricultural department regularly makes local people aware about the plant and pasture resources situation in AAR. |
| | | | | | 28. Appropriate resolutions are decided to plant and pasture resources difficulties in AAR. |

**4.** (Continued) Effectiveness of government's efforts to manage natural resources in AAR:

**c) Issues related to agriculture land:**

| 1 = Strongly disagree. 2 = disagree. 3 = not sure. 4= Agree. 5= Strongly agree. | | | | | |
|---|---|---|---|---|---|
| **1** | **2** | **3** | **4** | **5** | |
| | | | | | 1. There is a comprehensive inventory of agriculture land and its uses. |
| | | | | | 2. Projects are implemented to ensure the safety and sustainability of agriculture land. |
| | | | | | 3. Staff has sufficient skills to perform their duties in agriculture land management. |
| | | | | | 4. Available environmental and socio-economic data are sufficient to plan for agriculture land management. |
| | | | | | 5. There is enough awareness of the local knowledge and practices relating to the agriculture land management in AAR. |
| | | | | | 6. Local people are encouraged to manage agriculture land by their traditional knowledge. |
| | | | | | 7. Government policies help to reduce dependence on unsafe livelihoods or risk-vulnerable agricultural practices and activities in local communities. |
| | | | | | 8. Agricultural department faces difficulties to conserve agriculture land because of developmental and building expansion in AAR. |
| | | | | | 9. Agricultural department regularly makes local people aware about the agriculture land situation in AAR. |
| | | | | | 10. Appropriate resolutions are decided to agriculture land difficulties in AAR. |

**Note**……
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**5**. Local knowledge and practices in the management of natural resources in the AAR and the extent of their integration into government programms for natural resource management:

In this part of the questionnaire: Please define local knowledge and practices in the management of natural resources in AAR, as well as their integration into government programms for natural resource management:

| 1 = Strongly disagree. 2 = disagree. 3 = not sure. 4= Agree. 5= Strongly agree. | | | | | |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 1. People in AAR have useful traditional natural resources management knowledge. |
| | | | | | 2. Local people still use local knowledge to manage and exploit their natural resources. |
| | | | | | 3. Local people operate the Omani conventional system (Aflaj) as an administrative organization. |
| | | | | | 4. Properties of water are managed in terms of the Islamic way regarding to inheritance and sale. |
| | | | | | 5. Local people use wells to extract groundwater. |
| | | | | | 6. Local People use traditional methods of water harvesting to provide water needs. |
| | | | | | 7. Local People use traditional tools for the maintenance of water resources. |
| | | | | | 8. Maintenance of water resources is funded through its own resources (endowments and leasing). |
| | | | | | 9. Local people depend on their traditional knowledge in cultivation and harvest. |
| | | | | | 10. Land holdings is managed in terms of the Islamic way regarding to inheritance and sale. |
| | | | | | 11. Planting and harvesting operations are cared out with conventional methods. |
| | | | | | 12. There are special norms govern the operations of agriculture and harvest. |
| | | | | | 13. Local people depend on their traditional knowledge in grazing. |
| | | | | | 14. Local people relay on the special knowledge in animal husbandry. |
| | | | | | 15. Local people are grazing in traditional methods |
| | | | | | 16. There are special norms govern the operations of grazing. |
| | | | | | 17. Local knowledge is integrated of in natural resource management programms adopted by the government in AAR. |

I kindly request to write some suggestions to activate sustainable natural resources management in AAR by benefit from traditional knowledge:

……
……
……
……

## Appendix 3 Interview questions for government officials

**Name:** …….. **Post (Title):** …….
**Tasks of the post:** ……..
**Years of Experience**: …….
**Date and time** ……/……/2010.

**Q1**: What is the current status of natural resources in Al-Jabal Al-Akhdar? Give examples please.

**Q2**: What are the key factors that threaten the sustainability of natural resources in the Al-Jabal Al-Akhdar?

**Q3**: What practices pursued by your ministry with regard to the management and exploitation of natural resources in Al-Jabal Al-Akhdar, depend on the scientific knowledge adopted in this arena?

**Q4**: What are the most prominent programmes and projects carried out and will be implemented to ensure sustainable management of natural resources in Al-Jabal Al-Akhdar?

**Q5**: From your point of view, how do you see the effectiveness of those practices and programmes in terms of the achievement of environmental and developmental sustainability?

**Q6**: What traditional practices are pursued by the local people Al-Jabal Al-Akhdar to manage and exploit their natural resources depend on to their traditional knowledge?

**Q7**: What are the opportunities for sustainable development in the AAR, depending on sustainable natural resources management?

**Q8**: What are the major problems or obstacles that you face in order to carry out professional duties in the management of natural resources in Al-Jabal Al-Akhdar?

**Q9**: To what extent do local people participate in programmes and projects of natural resources management in Al-Jabal Al-Akhdar? And how to encourage them to continue to use their traditional knowledge?

**Q10**: What can you suggest to take advantage of traditional knowledge and practices for the sustainable management of natural resources in the Al-Jabal Al-Akhdar to ensure sustainability of resources and development?

Thanks and appreciation

Mohammed Al Busaidi

# Appendix 4 Interview questions for local people

**Name:** …….. **Job:** …….
**Number of household members** ……..
**Number of agricultural holdings and their areas** …….
**Amount of livestock** ……..
**Years of Experience**: …….
**Date and time** ……/……/2010.

**Q1**: What is the current status of natural resources in Al-Jabal Al-Akhdar? Give examples please.

**Q2**: What are the key factors that threaten the sustainability of natural resources in the Al-Jabal Al-Akhdar?

**Q3**: What practices pursued by you or your family with regard to the management and exploitation of natural resources such as water management depend on the traditional knowledge?

**Q4**: What practices pursued by you or your family with regard to the management of farming and grazing depending on the traditional knowledge?

**Q5**: From your point of view, how do you see the effectiveness of those practices and programmes in terms of the achievement of environmental sustainability?

**Q6**: What are the opportunities for sustainable development in the AAR, depending on sustainable natural resources management?

**Q7**: What are the major problems or obstacles that you face in order to carry out your work?

**Q8**: To what extent do you participate in the programmes and projects of natural resources management that the government established in Al-Jabal Al-Akhdar?

**Q9**: What can you suggest to take advantage of traditional knowledge and practices for the sustainable management of natural resources in the Al-Jabal Al-Akhdar to ensure sustainability of resources and development?

Thanks and appreciation

Mohammed Al Busaidi

## Appendix 5 Questions for focus group discussions

After welcoming the audience and knowing their news in a traditional way, the following questions will be asked to start discussion on traditional knowledge and natural resources management practices, and how they maintain their environment:

First of all, I would like to know the job of each one of you? How many years have you practiced this work? Are you still practicing it? If not: Why?

Regarding water resources: How do you see the importance of water resources in the region?
What are the methods used for water harvesting in the region?
What is the irrigation system that has been used in the region?
How are the Aflaj canals been constructed?
How is irrigation water divided among beneficiaries? What system of measurement is used? Please consider timing, the difference between night and day and differences between summer and winter.
Is there a priority for some of the beneficiaries? Why?
How to divide the irrigation canal for human consumption from the source to the farm?
Who manages the irrigation system? And on what basis is this done? Is there a written law for this in particular? Or is this known as inherited norms, customs and traditions?
What are the problems that may occur among the beneficiaries? What are the main traditions in regards to punish the violator?
What are the procedures in cases of drought and floods?
Does the type of crop differ according to the seasons, fertility and drought?
Does your son practice the same work you have been doing for years? In other words, do you transfer and pass your knowledge to your sons and your grandchildren at the present time?
What is the role of government in the management of water (in terms of regulations and laws, and protection, helping to provide resources in times of crisis, the adequacy of staff and budget to implement administrative procedures? Do you participate in the decision-making processes, especially if there are projects and programmes to manage water resources?
What do you think about the government's efforts in this area? Do you prefer to stay on your system in the field of traditional irrigation?

Regarding agricultural land:
How are agricultural terraces constructed?
How is fertility of the soil maintained?
What is the management system for agricultural land? (planning for faming through tillage, irrigation, monitoring and care, as well as harvest?
What are the obstacles you face in this area? And how to overcome them?
What is the role of government in the management of agricultural land (in terms of regulations and laws, and protection, helping to provide resources in times of crisis, the adequacy of staff and budget to implement administrative procedures? Do you participate in the decision-making processes, especially if there are projects and programs for the management of agricultural land?
What do you think about the government's efforts in this area? Do you prefer to stay on your system in the field of traditional farming?

Regarding natural vegetation and pastoral resources:
What customs and traditions are followed?
How do you benefit from edible plants, medicinal plants and woods?
How grazing is regulated? What types of customs are considered to punish violators of pasture regulations?

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