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The Future of Agriculture in the High Atlas Mountains of Morocco: The Need to Integrate Traditional Ecological Knowledge

Bernadette Montanari

1 Introduction

The High Atlas Mountains in Morocco as other mountains throughout the world are landscape providing major economic resources and ecosystem services. Mountain systems represent one-fifth of the world's land and are home to 570 million people. Mountain zones are also important suppliers of water, food, hydroelectricity, timber, other mineral resources and biological diversity, increasingly vulnerable to climate change (Smethurst 2000; Knippertz et al. 2003). As precipitation in Morocco is expected to reduce by 5 % in mountainous areas and 30 % in the southern regions of the country for the period between 2011 and 2050, water as a prime commodity will be greatly affected by these changes. Water shortage is in turn likely to alter agricultural production. Indeed, it is anticipated that agricultural land in Morocco will be reduced to 8 % by the end of the twenty-first century compared to the current 12 %. Further quantitative data suggest a general decrease of water resources from 10 to 15 %, which could in turn affect water availability for irrigation (Knippertz et al. 2003). As a measure to counteract the climatic conditions in the country, the government has launched the Green Moroccan Plan (2012–2020). It proposes a long-term development plan based on agricultural activities to combat poverty and raise the Gross National Product, to create employment, to bring technical support to liberate environment markets, to increase citrus and vegetable exports and to attract major economic capital, even to conserve natural resources (Ministry of Agriculture and Fisheries 2009). The Green Morocco Plan therefore, presents tailor-made solutions and practical

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measures that offer sustainable solutions to the current climatic conditions and food security, but also to promote socio-economic development.

Although it is at present difficult to predict how this will affect the livelihood of mountain communities, it is, however, important to draw attention to how mountain population will cope with such changes. This chapter describes how the inhabitants of a Berber community in the High Atlas Mountains of Morocco have managed to maintain subsistence over the past centuries, for which agricultural activities and traditional ecological knowledge have played a major role for the continuity of the community's livelihood. It further suggests that in the face of climate change and the government's measures to cope with the increasing problem of water scarcity, the communities' traditional way of natural resource and water management need to be integrated into government initiatives. This chapter is partly based on the author's PhD dissertation which has closely examined the mechanisms to implement an essential oil distillation project as part of the government new measures to overcome natural resource erosion, desertification and poverty alleviation. Although the research was conducted in eight villages of the Agoundis valley, this chapter refers only to the traditional activities that occur in El Maghzen, to illustrate the importance of traditional ecological knowledge in the context of climate change.

2 Climate Change and Mountains

Climate change is at the heart of world preoccupation and undeniably the most persistent challenge of the twenty-first century (United Nations world water assessment programme 2010; Neil Agder et al. 2003). Mounting evidence shows that the global hydrological cycle is intensifying and accelerating due to global warming, resulting in increased floods and droughts and dramatic alterations of long-term precipitation patterns throughout the world (Speth and Fink 2010). North Africa is not excluded from these changes and both environmental and anthropogenic systems in the zone are affected. Therefore, a global temperature rise of 2 °C is likely to lead to a corresponding warming of 1–3 °C, and further prediction foresee a temperature increase of 1.4–5.1 % expected to take place in the Mediterranean region by 2055 (Giannakopoulos et al. 2005; Bravo et al. 2008). Morocco, therefore, with a recorded spring rainfall decrease of 40 % and increased dry spell periods (particularly towards the end of the rainy season February to April), since the 1960s, is undeniably affected negatively both at the national and regional levels (Abdelfadel and Driouech 2009). While further predictions anticipate that precipitation in North Africa will further drop by 10–20 % and a rise of temperatures between 2 and 3 °C by 2050, arid conditions will undoubtedly be exacerbated. Agricultural activities, in particular those concerned with non-irrigated rain fed crops are most likely to be negatively impacted by these changes (Schilling et al. 2012).

As it is well recognised, the delicate balance of mountain environment, one of the planet most fragile ecosystems, is affected by any subtle change in climatic conditions (Parish and Funnell 1999). Mountainous regions of Morocco, showing a 5 % rainfall reduction, 30 % in the southern regions, and rising temperatures of 1.2 °C, are ultimately undergoing drier conditions. These warming patterns and fluctuations are more likely to impact the Atlas Mountains than the coastal parts of the Atlantic Ocean and the Mediterranean Sea (Schilling et al. 2012; Knippertz et al. 2003). Subsequently, rural populations, particularly those who depend heavily on natural resources for subsistence, and to a lesser extent those living in lower plains, are most likely to be affected by these changes particularly in agricultural activities, fisheries and other resource domains (Price and Funnell 1999).

What is more, as the country increasingly experiences drier spells, the needs for water are estimated to reach 16.2 billion m³ by 2020. However, the provision of 17 billion m³, theoretically available from 2020, would require the construction of further dams and deep wells. While these constructions are thought to meet up to 60 % of the drinkable water for the major urban areas, and supply for irrigation of large agriculture settings and power generation for the national power grid (Jellali 1999; Nusser 2003), it does not necessarily imply that water is equally distributed, and in fact, it may increase deficiencies and inadequate performance, impact on ecological systems, exacerbate natural resource degradation, displace local inhabitants, and disrupt the social, cultural, and economic life of communities living within the proximity of these structures (Minoia and Brusarosco 2006; Tilt et al. 2009).

3 The High Atlas Mountains: Geographic Situation

Morocco possesses the largest mountain area in North Africa, broadly divisible into three parts with the following characteristics:

- A. The Middle Atlas, which rises to 3,000 m with an annual precipitation of 600–1000 mm per year on the west side but decreasing to 300–500 mm a year in the east. These mountains form a major barrier between Mediterranean and Atlantic Morocco and the Sahara (Fig. 1), and are the location of some of the highest North African peaks, ranging from 700 m above the permanent snowline at 3,300 m. Season, altitude and rain precipitation largely determine the climate and can vary significantly in some valleys.
- B. The Anti-Atlas, a plateau characterised by dissection, and situated south of the High Atlas, with an altitude ranging between 500 and 1,500 m, and displaying a complex climate, with precipitation of 120–650 mm per year. The Anti-Atlas landscapes play a fundamental role in the Moroccan environmental system, protecting the country from dry, hot Saharan air, and collecting rain, which in turn feeds most of the streams, and main land water, which lowland and agriculture depend upon. Further, the Anti-Atlas provides much of the food grain, fibre and meat consumed in the country.

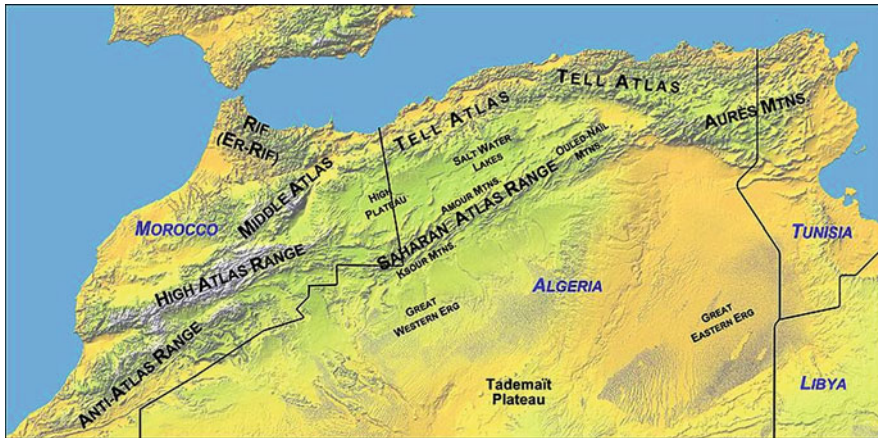


Fig. 1 The range of the Atlas Mountains in Morocco. Source <http://en.academic.ru/dic.nsf/enwiki/762566>

C. The High Atlas rises in the West towards the Atlantic Ocean and extends in an eastern direction as far as the Moroccan–Algerian border. An abrupt drop from the Atlantic to the southwest marks an impressive transition right up to the coast and the Anti-Atlas range. The Jbel Toubkal at 4,167 m is the highest mountain included in this range and hosts the Toubkal National Park. The High Atlas is an important barrier in the Moroccan weather system, preventing the pronounced Saharan conditions, particularly in the summer from influencing the Mediterranean climate to the north. This results in dramatic changes in temperature across the range. Snow falls regularly in the highest elevations of the range, which permits winter sports. Snow can last until late spring and is present mostly on the northern faces of the range. In this respect, the High Atlas represents the backbone of Morocco. An estimated 800,000 ha of irrigated land are in the mountain regions, which can in turn support 30 % of the population. In the High Atlas, traditional irrigated terraced agriculture can support up to 28 persons per square kilometres (Downs 2003; Barrow and Hicham 2000).

4 Mountains: A Complex Socio-Political Environment

Mountain environments present unique political, economic and cultural features. Geographically, they often form ‘natural’ borders and frontiers between territories, and define political divisions between states and regions and between political units within a state. While geographical access, slow and precarious systems of transportation remain problematic, physical and political remoteness from central power and authority contribute to these communities’ disproportionate political

representation. Culturally, they stand apart from the lowlands, physical environment accentuating the boundaries between cultural groups. Mountain environments are difficult and complex areas to live in and often perceived as marginal by outsiders. These marginal social groups have limited options, which further encourage them to depend on local resources, leading to landscape degradation, and limited accessibility and isolation increases the community's crucial dependence on natural resources (Jodha 2007; Collins 2008). Marginality, therefore, both in a physical and socio-political sense, exacerbates poverty in these difficult zones and accentuates the importance of cohesion for collective self-help and reliance.

The High Atlas Mountains in Morocco serve not only as a border between Morocco and Algeria but also to separate traditional Berber communities from the rest of Moroccan society. Indeed, they represent a very important refuge for these communities. These mountain areas which offer significant untapped human and natural development potential abound in natural resources, particularly aromatic and medicinal plants. The people and the landscapes have always been changing, shifting, and self-regenerating. Because these regions face strong environmental constraints, the populations are called to manage their environment, something that they do generally well, contrary to the widespread current belief that local people mismanage their resources (Ostrom 1990; Scoones 1994; Pretty and Pimbert 1995; Pretty and Shab 1997; Ghimire and Pimbert 1997).

5 El Maghzen in the Agoundis Valley, High Atlas Mountains

El Maghzen is a Berber village in the Agoundis valley, about 100 km from Marrakech. It is part of the Talat n'Yakoub circle¹ in Al Haouz province and is close to the Toubkal National Park, a biodiversity 'hot-spot'. The disparity between the cities and these areas is considerable, mostly because the populations are poor, marginalised, and lack the basic infrastructures for development. The inhabitants represent one of the poorest segments of Moroccan society in terms of literacy, infant mortality, availability of potable water, electrification and other development indicators (Russell 2004). Although the environment is biologically rich, especially in aromatic and medicinal plants, the region's natural resources overall are declining owing to over-harvesting in the face of the increasing demand for phyto-aromatic products and the needs of a growing population. Local people harvest plants during the summer months, for both herbal medicine and for trade, the most important being thyme (*Thymus satureioides*), although sage (*Salvia aucheri*) and a species of lavender (*Lavandula dentata*) are also collected. These

¹ A circle or 'cercle' in French was the smallest administrative unit of the French colonies in Africa. A circle was usually composed of districts, and these composed of several villages (Personal communication, Alifriqui 2008).

plants are one of the few sources of cash income. The plants are traded down the valley via several middlemen to urban markets in Marrakech and beyond. The trade follows two commodity chains, one official and the other informal and illegal (Montanari 2004). Although this income varies in terms of the amount of plant material collected, it nevertheless represents an important contribution to the household economy.

In the past, the inhabitants of the villages in the Agoundis valley had collective rights of access to the land for their subsistence needs, e.g. harvesting medicinal plants and collecting wood for fuel and building material. An autonomous system of Berber customary law, known as *jama'a*, regulated rights of access to land for grazing, forests and water. This traditional law, never codified, was rather flexibly applied for solving problems of resource use. It regulated not only individual access but also collective access, and was integrated into the cultural and political life of the community (Id Balkassm 2002). In 1917, during the French colonial period, the national government claimed to own the land and the Department of Water and Forestry was assigned the task of control. Since then, village residents have had limited access to their traditional lands, and only for the collection of dead wood and medicinal plants. In times of conflict and confusion over land access, during the Protectorate and at the present time, people have fallen back on customary law to access the resources. Currently, local people can only collect plants for personal use. If caught collecting for trade, they are fined by the Department's representative.

6 The Socio-Economic Characteristics in the Agoundis Valley

The High Atlas communities demonstrate many of the 'poverty and livelihood' characteristics found among mountain communities. Households living under the poverty line represent 31.6 % of the total and the number of households considered vulnerable represents 25.4 % of all inhabitants. In these terms, the Agoundis valley is one of the poorest segments of the Moroccan areas and this is reflected in literacy levels, infant mortality, availability of potable water and other development indicators (Russell 2004). With its relative inaccessibility, small population, and a subsistence economy based on mixed farming and local natural resources, villagers manage to sustain themselves, focussing on barley, almonds and walnuts in terraces of carefully irrigated fields. Forests provide wood for cooking, construction, and heating, as well as forage for animals. Water management and irrigation is both very fragile and complex (Crawford 2003; Saxena et al. 2001). During the summer season, when temperatures can reach over 45 °C and the river is dry, water is scarce, especially if rainfall has been low during the winter months. In this case, water has to be collected from the river in containers. To provide for cattle, women have to spend many hours daily collecting fodder. The winter season can be difficult as there is no food for the animals. Women will resort to gathering fallen walnut leaves. For baking the daily bread (*tanourt*, *arum*), wood

collection is essential and requires long hours spent high up in the mountains, not without any risk of accident, as people sometimes have to climb up mountainsides to cut the wood. Women predominate in agriculture and in collecting vital resources such as wood and fodder.

Household cash income is low, partly provided by outside members of the family who are in employment and live in the cities or further away. Resources such as almonds, walnuts, carob pods and aromatic plants are traded to generate income. Individual households and their family connections will often break almonds and walnuts together so that the head of the household can take the merchandise to sell at the local *souk* (market). Given that 50.63 % of men and 14.19 % of women are active in the labour market, the rate of unemployment at 6 % is low. The population is mainly young and very active. Twenty-three percent of the population has received schooling. This rate is lower for women; with only 6 % having access to education compared to 44 % for men (Benaboubou 2004). Although there are adult literacy programmes, administered by a woman from the village, illiteracy is high: 84.39 % amongst women and 50.67 % amongst men (HCP 2007). Because the local mother-tongue, Tachelhit, is not officially recognized, the lessons mainly focus on the Koran and basic arithmetic and Arabic. In the whole valley, most inhabitants speak Tachelhit and a small part of the population speaks dialectal Arabic.

While the central government has planned for the remote parts of the country to have electricity and running water by 2012, only 24 and 37 % of respectively households benefit from these commodities in the Al Haouz region. In the Agoundis valley, the main sources of light remain candles (36.5 %), gas (80.8 %) and solar panels (18.3 %). Spring water is the main source of water supply for 80.3 % of the population and village fountains for 23.8 % (HCP 2007). The Agoundis valley and its villages do not have medical facilities. From El Maghzen the nearest such facilities are 8 km away in Ijoukak and 13 km in Talat n' Yacoub.

Nowadays, families have no more than three to four children, but in the past, it was common for women to have up to ten or twelve. Some women would sometimes lose as many as five. Women still give birth at home and child mortality remains high, at 7.5 % (HCP 2007). Children are central to production in this rural environment and parents view their children as a source of wealth and power. Moreover, children cost less in the rural areas than in towns. Children may go to the local school to learn Moroccan Arabic, mathematics, and to read and write. The local commune encourages parents to send their children to school. However, very few children can make it to college for further education. From an early age, children work in agriculture, wood and water collection. The parents do not have the money to send their children to further education. Children are regarded as being more useful for their contribution to the household. Girls take care of their younger siblings, thereby relieving a mother pregnant with another child; or they may work in the fields. Boys tend to labour in the gardens or at the river. Members of Berber families work together but also divide the rewards together and the elderly rely on their adult offspring for care.

7 Traditional Ecological Knowledge and the Management of Activities

Traditional or local ecological knowledge is a complex dynamic learning process embedded within cultural forms and social institutions (Berkes et al. 2000; Davis and Wagner 2003; Ellen and Harris 2000; Ellen 2011). In many places it is vital for the maintenance of the land, water and biological resources upon which people depend, and enters into decision-making chains at every stage in production, management, distribution and consumption (Grenier 1998; Turner and Garibaldi 2004; Folkes 2004).

In El Maghzen, as in most other traditional societies, the transmission of knowledge is both *horizontal* between the members of the same generation, and *vertical* between members of different generations, stereotypically between parents and their offspring (Guglielmino et al. 1995). Both these horizontal and vertical transmission pathways contribute to the reproduction of traditional knowledge, which—though adaptable—is inherently conservative (Guglielmino et al. 1995; Eyssartier et al. 2008). This knowledge and transmission extend to all activities.

7.1 Traditional Agriculture: A Balanced Management System

Owing to its topographic and geographic position, Agoundis is one of the narrowest and enclaved valleys of the High Atlas, enclosed between abrupt forested slopes, and offering very little cultivable space. The duality of this spatial structure produces noticeable differences in the landscape and in the availability of resources. However, these harsh and fragile environments are more often than not heavily settled. The strong declivity of the slopes favours the streaming and erosion of the ground, thus necessitating the construction of terraces. Because of the altitude ranges, local families have traditionally diversified livelihood strategies according to the seasons. With the integration of terrace agriculture in the landscape, local populations have managed to subsist on diversified rotation agriculture (Barrow and Hicham 2000). Millennia of human modification have shaped the typicality and diversity of these landscapes to control erosion and to promote agriculture. The Agoundis valley has, therefore, access to a remarkable anthropic landscape (Gerbaty 2004). Farming takes place in terraced fields cut into the steep valley sides (Plate 1). For centuries, the villagers of the High Atlas have practised a mixture of subsistence cultivation and pastoralism.

Although the inhabitants of El Maghzen tend to rely heavily on local resources, they have always been self-sufficient and techniques for managing the land and other natural resources have little altered over the centuries. They have developed flexible mechanisms—terracing, irrigation, pasture management, transhumance, crop selection—that have allowed them to survive difficult (including extreme climatic) conditions using the resources at hand; villagers have adapted and shaped



Plate 1 A typical landscape of wheat terraces in the Agoundis valley. *Source* Montanari© 2007

the landscape according to their needs. Gardens, not only provide the basic crops to feed the family, but also a space for recreational and other social activity, and where, for example, women can make pre-arrangements for meetings. In the spring and summer, people will spend a considerable amount of time in the garden and have food and tea brought to them by a younger member of the family. Every household has a more or less equal number of terraces and due to the restricted space for cultivation, the gardens are well-delineated, ploughed with a mule and wooden plough. Nothing is added to the land apart from cow and chicken manure once a year.

The main crops in the gardens are wheat and barley, harvested once a year during the summer, and more recently alfalfa (*Medicago sativa*), which is collected mainly for cow fodder. In the absence of chemical pesticides, crops are often companion-planted in groups of two or three cultigens, for example tomatoes with maize and peas, broad beans, onions and egg plants. While most women are involved in garden activities such as sowing, weeding and harvesting, it is men who have the duty of ploughing. This is performed with a donkey or a mule and traditional plough (Plate 2). Harvesting wheat and barley may be undertaken both by men and women. This activity is performed during the summer (May, June) and involves cutting the wheat and barley to be carried back to the village terraces for drying. Women will often gather and go down to the terrace together, and may reap either alone or with other family members. Although men may also harvest wheat and barley from the terraces, the wheat and barley processing done by men is quite different to that undertaken by women, as they are more involved in threshing. The work is mainly undertaken using donkeys but does require control



Plate 2 Ploughing with donkey on terraces in El Maghzen. *Source* Montanari© 2008

of the animal and a certain amount of strength to push the axle of the mill. The collection of wood is either a female or male activity, in which a group of young children team up for the task, loading the donkeys and mules with chopped wood before returning to the village at dusk.

Although female outdoor activities reflect the harshness of daily existence, many activities are collective and group cohesion is very important in the community. For instance, cow fodder collection also occurs in the mountains and groups of between two and four women may collect together. It requires traipsing long distances over the mountain slopes and carrying the fodder back to the village. Cattle fodder collection also occurs from the gardens, and while these are closer to the village, it still requires carrying bales of fodder on the back. The feeding of animals is undertaken within the village which is close to home. It usually takes place early in the morning or later in the afternoon (Plate 3).

7.2 Other Traditional Edible Crops

In addition to the main field crops, there is a range of non-field edible resources, which are regularly consumed by the community and often exchanged and sold for cash, making an important contribution to people's livelihood.



Plate 3 Cattle fodder collected from the terraces in El Maghzen. *Source* Montanari© 2008

7.2.1 Almonds and Walnuts

Almonds (*Prunus amygdalus* var *dulcis*), *luz*, and walnuts (*Juglans regia*), *tarkayin* in Tachelhit, are abundant in El Maghzen. Walnut and almond trees usually belong to the same family, and are harvested in autumn. The cracking of almonds and walnuts is often a collective task and a family event in which all members participate, sometimes helped by outsiders. The almonds and walnuts are therefore cracked on a stone, an occasion to converse about village or family matters over tea. The nuts are then sold to the local *souk*, for about 60 Dh a kg. They represent an important source of income for families, particularly in times of hardship.

7.2.2 Barbary Fig Tree

The Barbary fig tree (*Opuntia megacantha*), or *aknari* in Tachelhit, has its origins in the Canary Islands but is found throughout Morocco. It is very common around the village and widely consumed by the community. It is collected mostly by men. In the village, the collection of the fruit (Plate 4) with a wooden V-shaped stick is a very delicate process as the fruits are covered with prickles. Once these have been removed, the fruit can be consumed when ripe. They can be purchased in Marrakech, sold loose on carts pulled by donkeys or mules. The fig has medicinal value in the treatment of diarrhoea although will produce the opposite effect when consumed excessively.



Plate 4 A special hand made tool for handling the prickly Barbary fig. *Source* Montanari© 2007

7.2.3 Capers

Capers (*Capparis spinosa*), or *tylilout* are widespread around the village. The young flower buds are collected in early summer and packed into plastic bottles in a mixture of salt and water that is regularly drained and changed. They are then used for culinary purposes and make an pleasant addition to omelettes and *tajine*. They have beneficial properties and are particularly used as an anti-rheumatic.

7.2.4 Carob

Carob (*Cerotonia siliqua*), or *tikidit* (*tikida* for the pods), are already much exploited. They are collected in the village once a year, and sold at 25 Dh a kg to local middlemen, who transport the merchandise to bigger collection points from where they are then exported to Europe.

7.2.5 Figs

The common fig tree (*Ficus carica*), *ukzern* in Tachelhit, belongs to the Moraceae. Trees grow up to 6 m, flower between June and September and the seeds ripen in August and September. The succulent fruits are actually not seeds or flowers at all, but a receptacle which encloses a multitude of flowers and seeds which never see

the light but still ripen perfectly. It has great nutritional value, is highly calorific and is used as a laxative and expectorant. In El Maghzen, where fig trees are abundant, fruit is collected and left in the sun to dry and consumed in a mixture of almonds and walnuts served with tea.

7.2.6 Olives

Olives from the species *Olea europea*, with its vernacular name *zaytun*, are also harvested in December and January. It is often undertaken by women and men from the same lineage. Olive oil is then produced in the village oil mill in the traditional manner, each family taking turns pressing the olives. The first operation involved in pressing the olives is conducted using a donkey. The donkey is led repeatedly around the mill to squash the olives in the millstone. Thyme (*azoukni*), and lemon are then added for flavour. Once the first press has been finished, the broken olives are placed into baskets which are piled up together. In El Maghzen, a building has been constructed around a fallen carob tree being used as the press. The olive oil so produced is usually for personal use.

7.2.7 Pomegranate

Pomegranate trees (*Punica granatum*), or *taroumant*, which belongs to the Punicaceae, are found in the village of El Maghzen and people consume the fruit. From an ethnobotanical perspective, it is the remedy par excellence for ulcers, gastrointestinal ailments and diarrhoea (Belhkadar 1996). Pomegranate juice has become very popular and consumed as a juice.

7.3 Traditional Water Management

The water distribution shows the importance of traditional water management practices. There are different types of collective water resources. These consist primarily of the Agoundis and Ait Ahmed *oued* (streams). A hydraulic unit for collective management is defined by a central *targa* (irrigation canal), fed by a water pump coming from an artificial pool or from a water catchment associated with a more recently-built cement dam. These initiatives have been funded by the Fonds International de développement de l'Agriculture (FIDA) and the Agence de développement solidaire (ADS) and replace the old traditional system. However, there are two types of water distribution system. The first is called *tawala* and supplies water on request when it is abundant, particularly during the springtime. The second is called *nouba* in which distribution is based on water rights and timed allocation according to lineage. It is the most common system. The allocated time varies from half to a whole day, depending on the accounting unit from the

artificial pool. Water originating from villages higher up the valley is diverted from the river to irrigate the terraces of lower villages through an intricate branching system. In the summer when the river is dry, most men pursue the building of river dams. It involves digging the river bed to find water before diverting it to a common pool. This involves lifting huge rocks from the river bed to facilitate terrace irrigation. The architecture of the terraces is such that irrigated water can reach every garden and in each village, the sluices are opened in turn at precise times of the week so that everyone gets a share. Men tend to undertake heavier and more complex structural tasks, such as maintaining the main elements of the irrigation system which may involve some digging. With current fears regarding climate change, there are concerns not only in terms of irrigation but also of drinkable water for the village. As shortage of water is an issue during the summer months, maintenance of the waterworks is vital to ensure that the river flow can reach the lower terraces.

7.4 The *Agdal*

In the High Atlas, the *agdal* designates a method of appropriation and management of the land, a status resulting from customary rights. Although nomadic seasonal transhumance was very common up to the 1950s between natural low and highland pastures, herding is now mainly sedentary, involving small flock of grazing goats or sheep. It takes place during particular periods, especially in the higher pastures of the valley, and is often supplemented by the addition of fodder harvested from the garden or the mountains, or even with hay when villagers can afford it (Bourbouze 1999). In part of the High Atlas where transhumance still occurs, another type of resource management institution known as the *agdal* system functions at a larger territorial level than that of the fraction and tribe (Dominguez et al. 2012; Genin and Simenel 2011). This method of managing common resources is implemented by the *jama'a* which regulates access to a lineage territory and its resources. It is a geographical and agro-ecological space characterised by the physical environment and specific biotic resources (trees, pasture, and agriculture). Rigid opening and closing dates for usage of specific-collective pastures regulates and sustains these grazing practices. *Agdal* are typically found in high mountain pastures and are the most widespread and formalised system of transhumance where good pastureland and water can be found after the winter snow and during the dry summer months. This system is important because traditionally Berber pastoralists followed a pattern of seasonal migration, grazing herds at low altitudes during the winter and at higher altitudes in summer, allowing for the regeneration of pastureland during the months when the *agdal* were closed (Mahdi 1999; Auclair 1996).



Plate 5 Azoukni (*Thymus satureioides*). Source Montanari© 2008

7.5 The Collection of Thyme and its Economic Contribution

In El Maghzen, local people collect aromatic plants which represent a considerable income for the households. Although Thyme, (*azoukni*), does not quite fall into the category of an ecological or cultural key stone species (Paine 1995; Turner and Garibaldi 2004), nor is it employed in religious ritual in El Maghzen, it has a high social profile because of its wide use in the community, particularly as a medicine and as an important source of cash income (Christancho and Vinning 2004).

Thyme (*Thymus satureioides*), typically referred to as *azoukni* in Tachelhit (Plate 5) is collected during the harvest season (mid May to mid July). This vernacular name is used for the male plant characterised by its purple flowers, as opposed to the female plant that is called *tazouknit* (*Thymus pallidus*) which has white flowers. Although collectors are paid on average only 1 Dh/kg, the thyme harvest is important for both women and men as there is no other comparable income generating activities in the valley. It is a valuable contribution to the household economy that ranges from 5481 Dh² for men and 4352 Dh for women over the 2 months period. Intermediaries with trucks usually collect in the most remote villages to sell to other intermediaries at the local *souk* and then transport the product to bigger towns such as Marrakech or Casablanca, especially for essential oil distillation (Montanari 2004, 2012).

² 1 Dirham (Dh, MAD) is equal to £ 0.73 and € 0.090 (May 2012).

Table 1 Women's and men's agreement responses to questions on thyme harvesting methods in El Maghzen

	Women (%)	Men (%)
If entire plant is removed there will be no harvest the following year	24	38
If the tops are cut this will ensure that the plant grows back the next year	73	59
Removal of the entire plant will maximize my income	3	3
Removal of the entire plant is forbidden	0	0
If entire plant is removed middlemen will not want to buy	0	0
If Water and Forestry see that entire plants have been harvested they will fine us	0	0

From an ethnobotanical perspective, *Azoukni* is taken regularly, that is more or less on a daily basis, as a fresh herbal tea infusion or in the dried herb form. In the absence of other form of conventional treatment, the dried herb is powdered and taken regularly by women for painful menses, to relieve gastric disorders (stomach ache, bile complaints, indigestion, intestinal trouble), and respiratory disorders such as colds, coughs, chills and headache because of its warming character.

7.6 Thyme Sustainability

While women tend to harvest on the mountains within the vicinity of the village, men tend to collect bigger quantities on the higher mountain summits. The villagers, however, showed a strong concern about climatic conditions affecting thyme availability because they tend to collect the bulk of the harvest at higher altitudes.

A study conducted by Khadouri (2007) shows that the harvest needs to take place at strategic points on the mountains, and particularly at higher altitudes (2000 m), where the plants can reach up to 60 cm in height because of the climatic conditions affecting its regenerative abilities. In El Maghzen, the harvesters were well aware of the harvesting-extraction procedure and the ensuing problem of thyme sustainability. Most people stated that they did not extract whole plants, and that they were only cutting the tops and that roots should be left in the ground to allow the plant's regeneration for the following year. A handful of adults in El Maghzen admitted that they removed the whole plant to maximise production. The harvesting thyme being economically important for the villagers, there is a genuine concern about the plant sustainability and harvest occurs in a way to maintain availability rather than succumbing to pressure from the forestry authorities (Table 1).

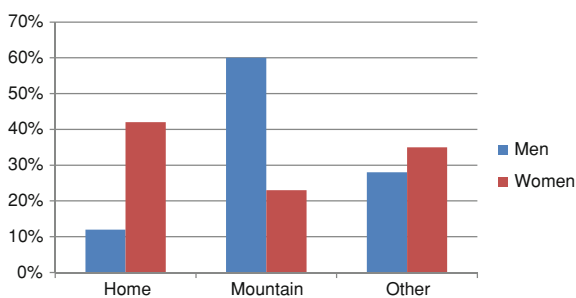
8 Plant Knowledge as an Indicator of Traditional Ecological Knowledge Transmission

Both women and men in El Maghzen share a common knowledge of plants and the distribution of this knowledge follows different patterns. Children, for instance, who usually accompany their parents to the terraced gardens and take part in the various activities there, absorb plant and other knowledge while weeding and preparing the terraces, or when gathering cow fodder or wood with their parents on the nearby mountains. These are important locations also for practical knowledge transmission.

The transmission of plant knowledge through women is entirely within the community. Within families, parents are a strong vector and girls learn particularly from their mother (41 %). However, plant knowledge is also acquired from the grandparents (11 %) and to a great extent, girls learn by themselves (19 %). They acquire this either by watching other women preparing medicine in the house and when collecting medicinal plants in the garden, at the river or in the mountains. There seems to be a combination of these transmission pathways, though the data shed an interesting light on people's own assumptions about how they acquire knowledge. Overall, the pattern shows the importance of the family group. Other means of learning for women are through friends, from the elderly people of the village, and for older women from the herbalist (8 %). Men's knowledge on the other hand, is acquired from their mother but to a lesser extent (26 %). They also acquire knowledge from their grand-parents (6 %). As with women, transmission occurs mainly within the family, defined as parents, sisters, paternal aunt and uncle and the transmission from these combined is greater than with women (38 %). Many men claimed to learn by themselves (12 %), but also from friends and acquaintances in the village (18 %), and to a lesser extent from their fathers.

Men are more likely to have acquired their knowledge while harvesting on the mountainside compared with women (60 % for men and 23 % for women), while women are more likely to have acquired their knowledge in the home than men (42 % for women and 12 % for men). However, knowledge is also acquired in other contexts (35 % for women and 28 % for men), such as the gardens and at the river, although gardens are more important for women than for men. On the other hand, men claim to acquire more knowledge and skills in the setting of the river, and to a lesser extent in the gardens, than women, as they tend to concentrate their activities in these locations (Fig. 2). Some transmission occurs also in the village and this tends to affect women more than men. This is explained by the fact that women tend to spend more time in the village, despite visits to the mountains, river or garden.

Fig. 2 Response by men and women to the question 'Where did you learn about plants?'



9 Discussion

This chapter has demonstrated the importance of traditional practices in the village for economic well-being, how knowledge about them is distributed and how these practices are valued. In the Agoundis valley, the management of the natural resources is a crucial component of local traditional knowledge that had sustained subsistence for centuries. The transmission of plant knowledge for instance, is intricately woven into the fabric of the community's traditional ecological knowledge. For the communities these forms of management are part of their cultural heritage, and attachment to the land and the services they render are strong. The inhabitants of the Agoundis valley have always been self-sufficient. They have managed agricultural, water and pasture resources, not only in a way that addresses appropriately the problems associated with living at high altitudes and limited space, but in a way that also buffers extreme climatic conditions through traditional customary law, the *jama'a*. As Parish and Funnell (1999) pointed out, one could anticipate that in the face of climate change, the community has already altered its management practices to accommodate climatic changes. Indeed, local knowledge, skills and capacities have been constantly shaped and reshaped, to respond to particular local problems and situations, in order to achieve and maintain specific survival objectives (Sillitoe 2004).

The villagers for instance, were aware of their dependence on the resources for their subsistence. As an economic practice, thyme harvesting relies on the same traditional skills traditionally sustained the resource. Thyme, as with other resources, is essential for the communities to ensure cash income. The traditional skills applied to the harvest of thyme have been modified to ensure the continuity of the resource on which economic subsistence depends. The way the villagers harvest, is not systemically unsustainable. For the harvesters, a main indication that a change is occurring and likely to affect the availability of thyme is reflected in the lack of rain. They have witnessed this increasingly in the shortage of water and the associated problems for irrigating gardens and this confirms their suspicion that it may also be affecting thyme availability. This observation is based on a locality shaped by past and present experiences, and interpreted in relation to the

physical and social environment. For the inhabitants of the Agoundis valley, the threat to thyme sustainability is perceived through changes in weather patterns that they cannot measure in technical terms. The communities, however, lack the technical skills to enhance their long-term sustainability and conservation, particularly in relation to a marginal natural environment.

As the country is adopting the Green Morocco Plan (2010–2020) to counteract the problems of climate change and water scarcity, there is an urgent need to accommodate traditional practices with new development initiatives. Such improvements may be achieved through interdisciplinary work, a hybridisation of knowledge, where technical and scientific skills are combined with traditional knowledge (Sillitoe 2004, 2009; Sillitoe and Bicker 2004; Sillitoe and Marzano 2009).

9.1 Forecast

Given the predicted climate change described above, thyme sustainability is likely to become increasingly unsustainable and there is an urgent need to apply appropriate solutions to conserve the species in El Maghzen. While cultivation seems an obvious solution, it does not stand as a viable option at village level, mainly due to land availability being inadequate. Although thyme regeneration is more profuse on higher mountain summits than at lower levels, the topographic environment remains difficult and cultivating plants at such altitudes remains problematic. It may even jeopardise women's harvesting, given that they tend to collect more locally. What is more, it is difficult at present to predict if land access and thyme harvesting will be further restricted by the Department of Water and Forestry Authorities. However, measures to do so will not prevent the population from harvesting thyme because of its important economic contribution to the household. The Green Moroccan Plan to implement massive agricultural production could therefore prove to be challenging in the mountainous regions of the country. As globalisation is gradually gaining ground, even in the more remote mountain areas, people are becoming increasingly exposed to new commodities and new technologies. Whilst the traditional agriculture could benefit from some technological input, a major threat to the conservative agricultural management is the overuse of pesticides and other chemical growth enhancers. This may further encourage a strong reliance and dependence on these substances, jeopardising not only the traditional agricultural management but also endangering the traditional Berber way of life of the Agoundis valley.

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