

We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

6,900

Open access books available

186,000

International authors and editors

200M

Downloads

Our authors are among the

154

Countries delivered to

TOP 1%

most cited scientists

12.2%

Contributors from top 500 universities



WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.
For more information visit www.intechopen.com



Sustainable Use of Natural Resources of Dryland Regions in Controlling of Environmental Degradation and Desertification

Peter F. Ffolliott

*University of Arizona, Tucson, Arizona
USA*

1. Introduction

One-half of the world's countries have portions or all of their land areas in hyper-arid, arid, or semi-arid climatological zones. These lands together with their sub-humid margins and savannas cover nearly 45 million square kilometers or approximately 30 percent of the earth's land surface. These lands collectively comprise the dryland regions of the world where severe ecological degradation and desertification is occurring at alarming rates and threatening the livelihoods of over 900 million inhabitants (Middleton & Thomas, 1997; Mainguet, 1999; Altschul 2008). Applications of carefully planned land-use practices can often halt and eventually reverse the processes of environmental degradation and desertification on these landscapes. Importantly, the formulation and application of these interventions must be based on sound technical knowledge, the interrelationships of human, ecological, and socio-economic factors, and responsive policy options. One problem, however, is that many planners, managers, and policy-makers have often considered the drylands regions as wastelands and, therefore, do not appreciate their critical environmental role and potential contributions to the welfare of people.

The chapter reviews the land-use issues, assesses the weaknesses, and reviews the options available for the conservation and sustainable use of natural resources in the dryland regions of the world. The information presented is based largely on publications and office reports of the past 35 years. After the general features of dryland environments and how people use their natural resources are discussed, challenges to the sustainable use of natural resources are considered. The close correlation between the dryland regions of the world and the occurrence of environmental degradation and desertification is then indicated. Finally, policies necessary to sustain the use of land and natural resources while controlling environmental degradation and desertification including strategies for policy implementation are described.

2. General features of dryland environments

Dryland environments are characterized by wide differences in temperatures, inadequate and unreliable rainfall events, seasons when rain falls, and frequent conditions of aridity. Some of these environments have excessive heat while others are cold and dry areas.

Extremes in temperature ranging from lows approaching 0°C to highs exceeding 50°C at times are characteristic of these environments ((Middleton & Thomas, 1997; Mainguet, 1999; Altschul 2008). The limited rainfall amounts are compounded by high evapotranspiration rates that cause water shortages in many dryland regions. Varying degrees of aridity is a climatic condition that can be expected. Unexpected but recurring droughts add uncertainty to the lives of people as a consequence.

2.1 Geomorphic features and soils

Mountain massifs, plains, pediments, and incised ravines and drainage patterns result in sharp changes in slope and topography and a high degree of angularity. Rivers generally traverse wide floodplains at lower elevations and at times are subject to dramatic changes in drainage patterns. Many landforms in the more arid climates are partially covered by unstable sand dunes or sand sheets that can impact livestock grazing lands, agricultural crops, and cities and villages. Other geomorphic features influence the formation and characteristics of the soils including the distributions of coarse and fine soil fractions from transportation processes, reworking and disposition by wind and water, and periodic inundation of floodplains (Middleton & Thomas, 1997; Mainguet, 1999; Altschul 2008)). Among the beneficial effects of these influences, however, are a replenishment of soil nutrients and leaching of accumulated salts in the soil. Of primary importance of the soils is their water-holding capacity and ability to supply nutrients. Depth of the soil governs the amount of water stored in a profile. Depth of the soils is often limited by a hardpan layer, however, restricting water-holding capacities. Many soils are characterized by the leaching of nutrients and intensive weathering of minerals. Soil fertility, therefore, is low.

2.2 Water

Most of the water is found in large rivers that originate in higher elevations. These river systems include the Nile in the Sudan and Egypt and the Tigris, Indus, Ganges, Senegal, and Niger. Tributaries to these rivers are likely to be intermittent or ephemeral in contrast to the perennial flows of smaller streams in other temperate and moist tropical regions. The flow of intermittent or ephemeral streams is almost exclusively dependent on precipitation events that determined the duration and amount of channel flow. The tendency for the channel beds to reside above a groundwater table so that channel flows lose water to the groundwater is another reason for the intermittent or ephemeral flows of streams (Middleton & Thomas, 1997; Mainguet, 1999; Altschul 2008). Evapotranspiration processes and the infiltration of the flowing water into the channel beds can diminish the volume of water in the streams as they flow to lower elevations.

Local but limited groundwater is often available to support the ecological development of relatively small areas. However, the recharge of groundwater resources is dependent on the amount, intensity, and duration of the infrequent rainfall and soil properties including infiltrations capacities and water-holding characteristics of the soils that also influence the amount of surface runoff on an area (Altschul 2008). Construction of wells is necessary to have access the groundwater resources.

Water available for people's use in many dryland regions can be affected to varying magnitudes by salinity (Mainguet, 1999). Problems of salinity are more widespread and acute in the drylands than in other temperate and moist tropical regions.

2.3 Plants

Most plants possess adaptations that enable them to successfully reproduce, sustain their growth, and survive in some of the harshest environments in the world. Some plants have evolved special root systems while others have unique leaf characteristics that allow them to withstand prolonged periods of drought. Other plants lose their leaves when soil moisture conditions become too dry to support their survival. Ephemeral annuals, succulent perennials, and non-succulent perennials are found throughout dryland environments (Middleton & Thomas, 1997; Mainguet, 1999; Altschul 2008). Ephemeral annuals appear after rains, complete their life cycle in a short growing season and at times form dense stands to provide limited forage for livestock. Succulent perennials store water through the enlargement of parenchymal tissue and their low rates of transpiration. Cacti are typical of the succulent perennials. Non-succulent perennials that withstand the stress of dryland environments are the majority of plants in these regions. Three forms of non-succulent perennials are found. Evergreen plants are active biologically throughout the year, drought-deciduous plants are dormant in the dry season, and cold-deciduous plants are dormant in the cold season.

2.4 People

Almost 40 percent of the world's people live in the dryland regions of the world (Altschul, 2008). These people are grouped broadly into nomadic, semi-nomadic, transhumant, and sedentary populations (Child et al. , 1987; Squires & Sidahmed, 1998; Tunstall et al. , 2002). Nomadic people are pastoral groups that depend mostly on livestock for subsistence with small-scale rain-fed farming when possible as a supplement. Nomads migrate in patterns determined by available forage conditions, water availability, and access rules worked out with other pastoral or sedentary groups of people. Semi-nomadic people are also found in pastoral groups that depend mostly on livestock for their livelihood. However, this group of people might also practice agricultural cultivation at base camps where they return for varying periods of time. Transhumant populations combine farming and livestock production during favorable seasons but seasonally migrate along regular routes when grazing diminishes near their farming area. Sedentary farmers practice rain-fed or irrigated agriculture. Land uses are often a combination of agricultural crop, livestock, and occasional wood production.

3. How people use their natural resources

Demands are increasing greatly for food, water, and other natural resources found in the dryland regions as a result of the increasing populations of people. Shortages in these critical resources continue as witnessed by widespread food shortages, lack of potable water, and a loss of livestock grazing lands and deficiency of firewood in many countries. In responding to these increasing demands, people are frequently forced to intensify their use of these limited natural resources and, as a consequence, degrade the impacted ecosystems in doing so. Such actions are a leading cause of environmental degradation and desertification. It is unfortunate that the ways in which people use the natural resources of dryland regions are not normally well defined and often based on historical but inappropriate cultural practices. How people use the resources available to them are generally centered on pastoralism, small-scale agricultural crop production, forestry-related activities, agroforestry practices, and wildlife.

3.1 Pastoralism

Unconfined livestock production has been widespread in the dryland regions of many countries and undoubtedly will continue as such into the future. However, severe environmental degradation and desertification can be accelerated where excessive consumption of the sparse forage resources of often low nutritive value occurs. Changes in the livestock grazing practices on the degraded lands have been and continue to be recommended by technical personnel (Pratt & Gwynne, 1977; Walker, 1979; Child et al. , 1987; Squires & Sidahmed, 1998). However, these suggested changes must be acceptable to the herdsman's way of life. It is also important that the livestock grazing practices are compatible with other land uses such as agricultural crop production and the use of wood for local needs.

Systems of livestock management practiced in the dryland regions include sedentary, transhumance, and nomadic (Child et al. , 1987; Squires & Sidahmed, 1998). Livestock are kept at a permanent site throughout the year with a sedentary system of grazing. The number of animals is limited to the capacity of the site to support the livestock when the dry season occurs. Should this number be exceeded, the surplus livestock are often placed in the care of a migratory herdsman of the owner's family or a nomadic tribe. The transhumance system also has a permanent base but the number of livestock and environmental conditions are such that a portion of the annual forage requirement is likely to be obtained elsewhere. There are no permanent settlements in the nomadic system because the herdsman move freely in search of available forage for their livestock. Changing environmental conditions of a locale can induce the individual herdsman to change from one management system to another for the short-term.

3.2 Small-scale agricultural crop production

Small-scale rain-fed agricultural crop production is practiced on the sites favorable to this type of land use. Exceptions occur where irrigation is possible in which case larger-scale and more intensive agriculture is practiced. Cereals, legumes, and roots are grown as a source of food for people. Annual and perennial grasses and other forage plants for livestock are also grown as agricultural crops but their production is not as commonly stressed as the food for people (Spedding, 1988; Okigbo, 1991; Seckler, 1993). Sedentary agriculture is practiced where soil fertility and precipitation and temperature regimes allow crops to be grown in place. Otherwise, shifting cultivation is practiced where a farmer shifts to other pieces of land once the potentials of the soil to produce agricultural crops on the original land have been lost.

Subsistence and occasionally commercial farming is found in dryland environments. With subsistence farming, most of the crops are produced to meet the immediate needs of families. When a surplus becomes available, the farmers often enter markets to obtain additional incomes. Commercial farming requires infrastructures of roads and vehicles for transportation and the presence of structured marketplaces. Large-scale commercial farming is rarely possible in dryland regions without large irrigations systems.

3.3 Forestry-related activities

Implementation of traditional forestry practices is not generally feasible in the dryland regions of the world with the exception of establishing energy plantations to alleviate the frequently encountered and continuing shortages of firewood in many countries. Implementation of

other forestry-related activities in these countries differs in many ways from forestry as it is practiced in more humid ecosystems (Salem, 1988; Wiersum, 1988; Sharma, 1992; Ffolliott et al., 1995a). The applications of forestry-related activities in the dryland regions are broader in scope including producing wood for fuel, poles, and local housing materials; practicing horticulture for a wide range of commercial and subsistence products; managing trees and shrubs as fodder for livestock production; implementing practices that modify microclimates to increase agricultural crop production such as windbreak plantings; and protecting of lands that are susceptible to water and wind erosion.

People often combine their uses of trees and shrubs into combinations of land and natural resources use that are linked to their needs and social values. Therefore, what is commonly called "Dryland Forestry" is more generally defined as the management of trees and shrubs to improve the livelihood and quality of life of people living in dryland environments (Salem, 1988; Ffolliott et al. , 1995a; Hoekstra & Shachak, 1999).

3.4 Agroforestry

While intensive forestry practices are not commonly implemented in dryland regions, agroforestry is practiced widely to sustain the livelihood of rural people. Agroforestry practices involve the deliberate association of trees and shrubs with the production of agricultural crops, livestock grazing, or other components of a land-use system in varying combinations (Nair, 1989; MacDicken & Vergara, 1990; Gordon & Newman, 1997). The general types of agroforestry found in dryland regions are agrosilvicultural practices in which agricultural crop production is combined with forestry-related activities; silvopastoral practices consisting of combinations of forestry-related activities and livestock production; and agrosilvopastoral practices involving varying combinations of agricultural crop production, forestry-related activities, and livestock production.

Regardless of how it is practiced, however, the purpose of agroforestry is to increase the yields and qualities of food production; attain ecological stability on the landscape; obtain more efficient use of natural resources such as utilizing solar radiation inputs more efficiently by the several vegetative layers of most practices and increasing the cycling of nutrients by different depths of rooting systems of the plants.

However, there are limitations to overcome for agroforestry practices to be successful. For example, there can be competition of trees and shrubs with food crops and forage species for sunlight, soil moisture, and nutrients that can reduce the yields of the food crops or forage species (Nair, 1989; Gordon & Newman, 1997). A possibility of the trees and shrubs becoming hosts for insects and diseases harmful to food crops and forage species can be a concern. Perhaps the greatest limitation to agroforestry is the often encountered resistance by farmers to displacing food crops and forage resources with trees and shrubs where land is scarce.

3.5 Wildlife

Wildlife species are often vital to the well-being of many people because they provide meat, skins, and other values. Some of wildlife species are superior to domesticated livestock in their adaptive physiological character, resistance to disease, and general capabilities to survive on marginal diets. In addition, many wildlife species are exploited commercially in

a variety of ways (Pratt & Gwynne, 1977; Child et al. , 1987; Hoekstra & Shachak 1999). It is also true that some of these species contribute little to people's substances. To the extent possible, therefore, it is necessary to reconcile the conflicting values of wildlife and the development of more holistic land-use strategies.

Wildlife ranching has become a profitable enterprise in many dryland regions of the world. Wildlife ranching typically involves fee hunting for sport or raising indigenous species for the production of meat and other products (Pratt & Gwynne, 1977; Hopcraft, 1990). The economic returns from hunting can exceed those from solely livestock production in some localities. Mixed wildlife and livestock ranching has also been profitable in the countries of eastern Africa.

4. Challenges to sustainable use of natural resources

Achieving the sustainable use of natural resources is a challenge to planners, managers, and policy-makers because of the inherent scarcity of water, the fragile nature of the ecosystems, and the increasing pressures of enlarging human and livestock populations in many dryland regions of the world. Recognition of these limitations is a first step in creating a policy framework that will lead to the sustained uses of natural resources and while controlling the process of environmental degradation of these ecosystems. These limitations generally manifest themselves in terms of water scarcity, continuing land degradation and desertification, and socio-economic and demographic changes.

4.1 Water scarcity

Availability of reliable water sources is always problematic in dryland environments and, furthermore, its sustainability continues to be jeopardized by the demands for potable water increasing at alarming rates over large areas. The stability of available water resources is also crucial to the control degradation and combat desertification. While water scarcity is caused largely by its unequal distribution, it also results from its pollution that makes available water supplies unusable. However, many efforts to develop water resources have focused on increasing available supplies and solving the problem of distribution (Thomas et al. , 1993; Postel, 1997; Grey & Sadoff, 2006; Gregersen et al. , 2007). Unfortunately, this orientation has resulted in unwanted side effects that have economic, social, political, and environmental implications in many instances. For example, the applications of innovated technologies such as desalination are energy intensive that has both economic and environmental impacts. As a consequence, water resource problems and some of the solutions to these problems have adversely affected the health and wealth of people with the greatest threats occurring in the poorest of countries.

Because agriculture is the major user of freshwater resources worldwide, intensified efforts need to be directed toward reducing the agricultural uses of water (Thomas et al. , 1993; Gregersen et al. , 2007). Providing reliable supplies of water for uses other than agriculture, therefore, can be essential to people's well-being. Securing water supplies and protecting them from contamination are not simply technical problems to be solved with technical solutions but also institutional and political issues. However, effective institutional and political resources for managing water resources are frequently limited. As a consequence, the water resources in many countries with dryland environments continue to be

administered in a mode of crisis with governments reacting only when droughts, water pollution, or flooding occur.

4.2 Continuing land degradation and desertification

Rapidly spreading environmental degradation and desertification of dryland ecosystems is a problem of worldwide dimensions. To illustrate this point, a study by the United Nations Environment Programme found that an area the size of the People's Republic of China and India combined had suffered moderate to extreme soil degradation caused mainly by inappropriate agricultural practices, on-going deforestation activities, and overgrazing of livestock by the early 1990s (World Resources Institute, 1992). This degradation represented 1.2 billion hectares or almost 12 percent of the earth surface. Soil degradation in Africa and Asia is also caused by nutrient losses on land that is used for low-input agriculture and the effects of salinization resulting from poor management of irrigation systems (Chandra & Bhatia, 2000). Continuing losses of limited soil resources by wind erosion are also widespread throughout the dryland regions of the world.

The continuing loss of forests, woodlands, and rangelands also contributes to environmental degradation and desertification processes of already fragile watershed landscapes as the hydrologic functions of these landscapes are diminished or even destroyed. A consequence of the losses of these ecosystems can lead to downstream flooding and the transport of excessive sediment loads and other pollutants into reservoirs. These impacts can be felt within a river basin, throughout a country, and even in neighboring countries sharing a common river basin (Sharma, 1992; Brooks et al. , 2003; Gregersen et al. , 2007).

Establishment of introduced or invasive species caused by the ecosystem alterations resulting from environmental degradation and desertification is also common. These often unwanted species can lead to a decrease in the biological diversity of flora and fauna that further weakens the ability of marginal lands to maintain the capacity of natural resources (McNeely et al. , 1990; Hoekstra & Shachak, 1999). While tropical rainforests receive more international attention with respect to the loss of species richness, dryland regions also have high levels of endemism of plant and animal species and, therefore, are often in more urgent need of protection and conservation. All of these causes of degradation are likely to increase in importance in the future because of population increases.

Environmental degradation and desertification are likely to take place in ecosystems that are less able to recover from environmental stresses than other temperate and moist tropical ecosystems. Many of these landscapes are already severely degraded to point of desertification or threatened by desertification processes. India, Pakistan, Bangladesh, Ethiopia, Kenya, and the Sahelian-Sudanian regions of West Africa have large areas of already severely degraded or desertified with significant areas moving in that direction (Dregne, 1998; United Nations Environment Programme, 1992; Hoekstra & Shachak 1999).

4.3 Socio-economic and demographic changes

Understanding the socio-economic issues unique to the dryland regions is fundamental to planning and implementing land-use strategies and management practices and formulating effective policies that promote the sustainable use of natural resources on lands threatened by degradation and desertification. As dryland ecosystems are inherently marginal in their

natural character, the socio-economic and demographic status of the inhabitants of these ecosystems differs from that of people living other regions of the world with richer and more abundant endowments of natural resources (Whitehead et al. , 1988; Hoekstra & Shachak, 1999). People living in dryland regions face constant risks to their well-being due to the harsh environment conditions that they continually confront. These prevailing conditions can limit income generation and employment opportunities.

Many inhabitants are dependent on traditional subsistence practices that are often centered on raising livestock. These pastoral economies are closely adapted to their environments (Child et al. 1987; Squires & Sidahmed, 1998). For example, there is often a high economic dependence on the exchange of livestock and livestock products (milk, ghee, hides, horns) that are supplemented by agriculture produce wherever possible and the exchange of minor tree products (incense, gums, resins, beeswax) and minerals and gems (amber, crystals, mica).

Low population densities, low land-to-human ratios, and the high mobility of rural people and their livestock are also characteristic of the dryland regions of the world. These population characteristics and the mobility of people make it difficult for central governments to effectively provide education, extension services, or health care; or collect taxes, combat crime, or enforce policies and regulations affecting the use of land and natural resources. To compound these difficulties, rural people are often discriminated against because of their marginalized economic, ethnic, or cultural differences.

Many of these rural people are organized into societies within historical systems of trade, tenure relations, and social exchange. However, for example, the established rules of access to livestock water sources can be exceedingly complex and are typically supported by traditional systems for resource management and conflict resolution (Squires & Sidahmed, 1998). This complexity is not surprising because of the high degree of competition among social groups for the same resources of land and water. The traditional rights to water and forage resources in some countries are based on Ottoman or Islamic laws that in the eyes of the affected people take precedence over national laws. These traditional systems are currently breaking down in many areas due to increased population growth and increased commercialization of traditional grazing lands and the herding of livestock in some countries.

5. Environmental degradation and desertification

Many authorities agree that environmental degradation and desertification are attributed to overgrazing by livestock, improper cultivation of agricultural crops, deforestation, or combinations of these and other causes (Anderson & Fishwick, 1984; Repetto, 1988; Whitehead et al. , 1988; Food and Agriculture Organization of the United Nations, 1989; Weber, 1989; El-Baz, 1991; Mouat & Hutchinson, 1995; Hoekstra & Shachak, 1999). Desertification is a special issue of critical concern in the dryland regions of the world. The United Nations Environment Programme has estimated that approximately 35 million square kilometers of the dryland regions of the world, an area approximately the size of both North and South America, are already desertified or affected by desertification processes. Equally important is the fact that nearly 30,000 square kilometers of land are reduced to a state of uselessness every year.

A map of the dryland regions of the world (Dregne, 1983), when compared to a world map of desertification (United Nations Environment Programme, 1992), shows close correlation between dryland ecosystems and the location of areas that are likely to be threatened by desertification. This correlation is not surprising, however, when the fragile nature of dryland environments is coupled with the impacts of population growth and improper land-use practices on marginal lands. Added to this dire situation is the harshness of the climate itself, which places a persisting stress on both soil and vegetation. As a result, only a relatively little disturbance is necessary to cause ecological instability and imbalance of many and, as a result, lead to environmental degradation and desertification.

Limitations in the sustainable use of natural resources because of severe environmental degradation and desertification are expressed generally by a major breakdown in energy, water, and nutrient cycles; a loss of biological diversity; increases in human stress on the environment associated with increases in both populations and resource consumption per capita.

It is impossible to isolate these limitations from each other (Ffolliott et al. , 1995b, Gregersen et al. 2007). Their impacts on the welfare and livelihood of the inhabitants of dryland regions are closely intertwined.

6. Polices and the policy process

Sustaining the use of natural resources in dryland regions and controlling environmental degradation and desertification in these regions are both intrinsically linked to policies and the policy process (Ffolliott et al. , 1995b; Gregersen et al. , 2007). It is important, therefore, that policies related to sustainable use of these resources be identified and thoroughly analyzed initially in the context of established polices. Environmental degradation and desertification are global issues with their resolution through the policy process depending largely on local actions at the land-use level. Solutions, therefore, are often unique to a particular area.

Assessing the effectiveness of established policies, identifying ineffective polices when they occur, and formulating more effective policies when necessary is the general sequence of steps in a process to evaluate the status of current policies. This process is not original and in a sense that is its strength. It is a time tested and accepted process that provides information for the complex and often unpredictable process of policy resolution (Gregersen et al. , 1994). However, the process only works well when the responsible policy-makers, the users and managers of the land and natural resources, and the involved stakeholder groups participate together in the process.

6.1 Assessing the effectiveness of established policies

Policies throughout much the world have been oriented largely toward the delineation and maintenance of large domains of land and natural resources. This orientation is a traditional characteristic of commercial enterprises. Central governments often control far more land than they can manage effectively in many instances. Such an orientation might have been justified in the past. However, it frequently forced the governments to take on the responsibilities of managing large and often unproductive tracts of land or blocks of natural resources through largely restrictive measures and little positive actions.

Many policies focus on optimizing agricultural, livestock, or wood production rather than on the more general purpose of meeting the diverse needs of people. In many cases, policies have included attempts to modify technologies imported from other temperate and moist tropical regions for applications to local conditions. However, land-use strategies and natural resources management practices imported from these other regions were likely developed in countries with relatively settled land use and land tenure policies and where distinctions as to what constitutes livestock grazing, agricultural crop production, and forestry are possible. These distinctions do not necessarily prevail in many of the countries in dryland regions.

Among the key factors to consider in assessing the effectiveness of established policies or alternatively for formulating new policies when it becomes necessary to sustain the use of natural resources while controlling environmental degradation and combating desertification of dryland ecosystems are:

- i. Livestock production should be recognized as a de facto component of land and natural resource use. Policies need to reconcile this fact within the overall management of land and natural resources rather than treating it a category to be suppressed or eliminated.
- ii. Agricultural crop and livestock production, soil and water conservation measures, obtaining firewood and other wood products, and income generation and local employment should be supported whenever feasible and appropriate.
- iii. Wood production need not be the primary objective of forestry-related activities. On the other hand, wood production can be a by-product of forestry-related protection and amenity practices in windbreak plantings, soil stabilization measures, or green belts around urban areas.
- iv. Sustainable not short-term practices for the use of land and natural resources should be encouraged in view of the slow rate at which fragile dryland environments respond to improvement interventions.
- v. Fairness and equity should be incorporated into policy language to ensure the support of rural populations, which is a necessity for sustaining developmental projects after initial phases of the projects have terminated. This incorporation has not always been the case in the past and, as a consequence, has led to misuse of land and natural resources in many dryland regions.

Existing governmental legislation should also be analyzed for weaknesses and improved on when weaknesses are found (Bromley & Cernea, 1989; Gregersen et al. , 1994; Cortner & Moote 1999). Legislative actions are a means for encouraging the social behavior favorable to land and natural resources policies. For this to happen, however, requires that all people understand and agree to the objectives of land and natural resources legislation. It is also necessary that people perceive provisions of the legislation as equitable and legitimate in relation to their interests, traditions, and moral standards. It is often suggested that the resources of administrative institutions be concentrated on the most relevant and feasible activities that are conducive to applying policies. It might be necessary, therefore, to modify current legislation to reflect the socio-economic conditions and natural resource capacities of a country, keeping in mind regional differences, and the nature and limitations of the administrations that apply them.

6.2 Ineffective policies

Policies are ineffective for a combination of reasons that are easier to explain than to rectify. Policies related to land and natural resources are ineffective when they fail to meet their intended purpose or they are not or cannot be enforced (Gregersen et al. , 1994; Cortner & Moote, 1999). The causes for their ineffectiveness have often been attributed to varying combinations of inadequate knowledge of the proper management practices, low levels of investment, and resources tenure considerations.

6.2.1 Inadequate knowledge of proper management practices

People living in the dryland regions of the world are well-adapted to living in marginal areas. It should not be surprising, therefore, that there is a wealth of indigenous knowledge stored by pastoralists, farmers, traditional healers, and importantly women who are often responsible for the family's survival in periods of environment or socio-economic stress. However, many of these people are impacted by increasing population growth and privatization of common property resources. These dual pressures can force people into shorter-termed practices that are not always sustainable (Cortner & Moote, 1999; Gregersen et al. , 2007). In addition, new comers to a dryland region often bring with them land-use activities from their area of origin that are not necessarily appropriate in dryland environments. Furthermore, improved management practices emerging from research efforts are often beyond the reach of pastoralists and farmers in isolated areas where there is little contact with extension personnel.

Rural people are frequently confronted by technical problems in attempting to implement improved strategies for the use of land and natural resources in the dryland regions of the world because of inadequate knowledge or experience with these practices. Inadequate knowledge of these strategies and management practices generally results from inadequate technical reference, incompetent extensive services, or ineffective communication among technical personnel and the users of the land and natural resources. In turn, it becomes difficult to inform planners, managers, and rural people on the appropriate managerial efforts in dryland ecosystems (Schechter, 1988; Gregersen et al. , 2007). While this problem has been alleviated to some extent by improved educational and training programs for professionals it frequently remains the case for rural people.

6.2.2 Low levels of investment

People living in the dryland regions of the world are often confronted with a vicious cycle of low productivity, low levels of investment, and as a frequent result endemic poverty. Central governments often believe that these people are too marginal to be worth investments. Investments, apart from those made for irrigated agricultural production, have been and remain relatively low (Marples, 1986; Ffolliott et al. , 1995b; Gregersen et al. 2007). Private investments by farmers in rain-fed agriculture are also minimal largely because of the higher risk of erratic rainfall. Lack of investment has exacerbated the gap in agricultural-related productivity of which livestock grazing, forestry-related activities, and other forms of land and natural resources management are often integral components between rain-fed lands and irrigated or wetter rain-fed areas.

The poverty and hunger that are prevalent in sub-Saharan and the Horn of Africa is the most poignant example. However, critical conditions also are found elsewhere (The World Bank, 2005). Improving this situation requires that a variety of technical and institutional problems be solved. Increasing the levels of investment in agricultural, forestry-related activities, and agroforestry interventions is one of the main problems. Its solution includes increased investments in research and extension infrastructures oriented towards building institutional capacity and monitoring the effectiveness of policies and programs. Strategies for risk management need to be developed and programs implemented that lead to equitable distribution of land and income.

6.2.3 Tenure considerations

Systems of tenure are complex in the dryland regions of the world. Codified laws are often underlain with centuries of customary or religious laws that continue to influence rural resource use. For example, Islamic sharia law governs the transfer of title to land and water sources and the access to water and pastures in many dryland areas of Africa, Asia, and in the Middle East even though different and more recent codified laws exist (Raintree, 1987; The World Bank, 2003). There are often separate rules for land, trees, water sources, and traditionally sacred areas. Small watersheds and groves of trees that are conserved carefully and protected by people often constitute the last remaining fragments of indigenous forests and woodlands in many countries and dryland areas including Ghana, Tanzania, Kenya, and Lesotho.

Of particular concern are the relationships between tenure and landless people. A large group of the dryland dwellers are landless refugees who do not have legal access to land or natural resources (Mukhoti, 1986; Fortmann, 1987; Gregersen et al. 2007). As a result, these people cannot participate effectively in developmental projects except when they might be hired temporarily for the planting of trees and shrubs or other short-term tasks. However, sustained involvement in these projects cannot be secured through temporary employment. In country after country, landless people have not received commensurate benefits obtained from developmental projects because of their lack of access to land and natural resources. This access can be provided only through ownership of land or security of land tenure in principle. In reality, granting ownership of lands or natural resources ensuring the security of tenure to landless people is difficult politically if not impossible.

Policies relating to tenure considerations have worked up to a point in some countries. When human population pressures continue to increase, however, many of these policies have to be revised or even abandoned. For example, the demarcation of the "Northern Limit of Cultivation" in the Sahelian Region of West Africa originally set by colonial rulers and later adopted by Sahelian governments had to be abandoned eventually in view of increasing the needs to produce more food (Weber, 1989).

6.3 Formulating more effective policies

It is necessary to encourage the modification of established policies or the formation of new policies in situations where the established policies are ineffective or where inconsistent or conflicting policies have unintended, unanticipated, and negative impacts on one or more

groups of people (Gregersen et al. , 1994; Ffolliott et al. , 1995b; Cortner & Moote, 1999). Among the factors that should be considered in formulating more effective policies are:

- i. Identifying areas that are at risk of environmental degradations and desertification - A key to the sustaining the use of natural resources is increasing the use of these resources in productive years and then decreasing use in years of environmental stress.
- ii. Avoiding the tragedy of the commons - The use of land and natural resources should be allocated to individual or organizational entities for responsibility rather than have open access lands available to everyone.
- iii. Avoiding incentives that encourage overutilization of natural resources - For example, incentives to increase agricultural crop production can led to increased soil erosion and, as a result, contributed to environmental degradations and desertification.
- iv. Encouraging the development of new and appropriate technologies including indigenous technologies - Mechanisms need to be found for the communication and interchange of this information starting at the local level and progressing to higher levels of management and decision-making.
- v. Facilitating local level involvement in formulating more effective policies - The most important factor in this regard is insuring that local people have a level of ownership in the policy process.
- vi. Encouraging people to work together to share their collective experiences and indigenous knowledge - People also need to be provided with the knowledge and means for sustaining their use of natural resources and controlling environmental degradation and desertification and, furthermore, government officials must be made aware that piecemeal solutions will not surmount the problem.

Policies that foster more efficient use of natural resources and reduce the threat of continuing environmental degradation and desertification are likely to incorporate one or more of the following policy instruments in their formulation and compliance: regulatory tools, that is, regulations, controls, or permits; fiscal tools such as prices, taxes, and fines; and public investments and management, for example, technical assistance, educational opportunities, research endeavors, or installation of structures and infrastructures.

7. Appropriate strategies for policy implementation

Appropriate strategies for the implementation of responsive policies are necessary to the conservation and sustainable use of natural resources in the dryland regions of the world. Unfortunately, a common set of strategies for implementing land and natural resource policies that have been successful are few in number. While some notable successes have been achieved, most of them took place in other temperate and moist tropical regions as opposed to the dryland regions.

Varying combinations of policies relating to the conservation and sustained use of soil, water, and vegetation have been formulated and implemented on massive scales with positive results obtained in the dryland regions of the world (Armitage, 1985; Gregg, 1988; The World Bank, 1993; Gregersen et al. , 2007). In each case, however, the strategies followed have been different as far as the modes of implementation are concerned. Nevertheless, general strategies for the establishment of energy plantations, water resources management, and other issues related to the sustainable use of natural resources in the dryland regions are suggested below:

- i. Political commitments to responsible policies must be strengthened.
- ii. Efforts to resettle rural people when necessary and limiting their use of the resources of an area must be preceded by feasibility studies and followed by appropriate compensation.
- iii. Efforts in controlling environmental degradation and combating desertification must be based largely on local participation. This participation should be structured on both the immediate and long-term interests of the people who are likely to be united in groups with common economic and social interests.
- iv. Establishment of new socio-ecological balances because of the need to resettle rural people should not be pursued in isolation but rather in connection with the security in food, water, and energy production.
- v. Small-scale interventions are successful only within a favorable political, economic, and social framework.

Other approaches have been applied elsewhere. For example, trees and shrubs in the dryland regions of the Dominican Republic were nationalized and the wood processing mills were closed in attempting to preserve forest resources. Whatever negative economic and social impacts this action had on people in the Dominican Republic, a striking difference from the barren hills of neighboring Haiti exists (White, 1993; White & Gregersen, 1993). Still other cases are found where massive and in many instances grass-roots conservation of soil and water resources involving the construction of benches or terraces, gully control conservation measures, and building of small dams to control water flows have been encouraged by governments and undertaken by rural people. Examples of these efforts are dispersed in Kenya, Cape Verde, and Tunisia to name only a few countries (Weber, 1989; Hoekstra & Shachak, 1999; Gregersen et al. , 2007). Elsewhere, the emphasis has been placed on planting of trees and shrubs in forests or woodlands or incorporating these planting into on-farm landscapes or land not used for agricultural cropping.

Several countries including Senegal, India, Tanzania, and Botswana have embarked on long-range, nationwide reorientations of their local administrative structures in an attempt to improve efficiencies of their policy and management operations (Bromley & Cernea, 1989). New rural communities have often been created in the process. Local participation in planning and decision-making in relation to land and natural resource use has been incorporated into a more balanced way of collectively deciding which of the resources are to be used under what managerial concepts and by whom. This general approach holds promise in the long-run. As with any effort at redistributions of resources, however, some parts of a population of people end up with less than they had before, and effects of social or economic equity is a matter of who is looking at it.

Strategies for policy implementation vary from one country to another. However, where the efforts are placed in a context that makes sense to the people, the implementing the resultant policies becomes relatively successful. In many instances, however, it has become necessary for governments to shift from only top-down, nationally-focused policies and viewpoints that include motivations or incentives for people in the form of guaranteeing the benefits of their use of the natural resources (Gregersen et al. , 1994; Cortner & Moote, 1999). This approach can be ineffective, though, if not carefully planned and managed.

8. Conclusions

A case can be made that there are gaps in the knowledge necessary for effective policy-making for conservation and the sustainable use of dryland ecosystems. Much of this problem rests with central governments not always knowing or appreciating what makes sense to rural populations and what does not. However, policies, laws, rules, and regulations will all be for naught unless people themselves change their ways of using available land and natural resources. Each country and each area within a country has its own set of interrelationships between people and the land they are living on and natural resources they are dependent on.

Policies are formulated relatively easily but the art is to establish a set of policies that work. While governments often struggle with finding methods to control environmental degradation and combat desertification, rural people are setting fire to plantations of trees that were established to halt degradation and desertification to increase the land available for agriculture. In such cases, governments are often advised to review their land and natural resource policies and the way in which they are carried out. This review also means that it is necessary to understand the attitudes and motivations of those responsible for implementation of a policy once it has been formulated. What is needed for central governments from top to bottom, therefore, is a change in their attitudes and approaches vis-a-vis rural populations of people to attain more effective responses from those who ultimately can make or destroy the best intentioned policy plans.

Policy-makers must understand the marginal and fragile nature of dryland environments and the often marginalized nature of the livelihoods that inhabitants of these environments. The challenge, therefore, is to reduce risks, improve the productivity, and enhance the quality of life for people while conserving the land and natural resource base. Good policy assessment requires that policy-makers take the time to become familiar with the complex socio-economic and environmental interactions characteristic of dryland ecosystems.

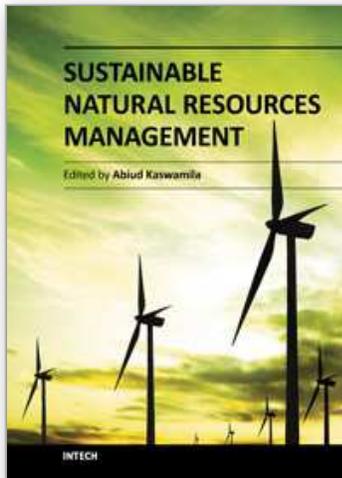
9. References

- Altschul, D. R. 2008. Arid and Semiarid Lands of the World. In *Natural Environments of Arizona: From Deserts to Mountains*, Ffolliott, P. F. & O. K. Davis, editors, pp. 9-25, University of Arizona Press, ISBN 978-0-8165-2696-3, Tucson, Arizona, USA.
- Anderson, D. & R. Fishwick. 1984. *Fuelwood Consumption and Deforestation in Developing Countries*. The World Bank, Working Paper 704, Washington, DC, USA.
- Armitage, F. B. 1985. *Irrigated Forestry in Arid and Semi-Arid Lands: A Synthesis*. International Development Research Centre, ISBN 0-88936-432-X, Ottawa, Canada.
- Bromley, D. W. & M. M. Cernea. 1989. *The Management of Common Property Natural Resources: Some Conceptual and Operational Fallacies*. The World Bank, Discussion Paper 57, Washington, DC, USA.
- Brooks, K. N. , P. F. Ffolliott, H. M. Gregersen & L. F. DeBano. 2003. *Hydrology and the Management of Watersheds*, Iowa State Press, ISBN 0-8138-2985-2, Ames, Iowa, USA.
- Chandra, S. & K. K. S. Bhatia. 2000. Water and Watershed Management in India: Policy Issues and Priority Areas for Research. In *Land Stewardship in the 21st Century: The Contributions of Watershed Management*, Ffolliott, P. F. , M. B. Baker, Jr. , C. B.

- Edminster, M. C. Dillion, & K. L. Mora, technical coordinators, pp. 158-165, USDA Forest Service, Proceedings RMRS-P-13. Fort Collins, Colorado, USA.
- Child, R. D. , H. F. Heady, R. A. Petersen, R. D. Pieper & C. E. Poulton. 1987. *Arid and Semiarid Rangelands: Guidelines for Development*. Winrock International, ISBN 0-933595-08-5, Morrilton, Arkansas, USA.
- Cortner, H. J. & M. A. Moote. 1999. *The Politics of Ecosystem Management*. Island Press, ISBN 1-55963-671-8, Washington, DC, USA.
- Dregne, H. E. 1983. *Desertification in Arid Lands*. Harwood Academic Publishers, ISBN 3-718-60168-0, New York, New York, USA.
- El-Baz, F. 1991. Desertification. *Geotimes* 36(2):52-54.
- Falloux, F. , & A. Mukendi. 1987. *Desertification Control and Renewable Resource Management in the Sahelian and Sudanian Zones of West Africa*. The World Bank, Technical Paper 70, ISBN 0-8213-0948-X, Washington, DC, USA.
- Ffolliott, P. F. , H. M. Gregersen & K. N. Brooks. 1995b. *Land Degradation and Desertification: A Policy Perspective on Issues and Their Resolution*. EPAT/MUCIA/USAID Draft Policy Brief, University of Minnesota, St. Paul, Minnesota, USA.
- Ffolliott, P. F. , K. N. Brooks, H. M. Gregersen & A. L. Lundgren. 1995a. *Dryland Forestry: Planning and Management*. John Wiley & Sons, Inc. , ISBN 0-471-54800-6, New York, New York, USA.
- Food and Agriculture Organization of the United Nations. 1989. *The Role of Forestry in Combating Desertification*. Food and Agriculture Organization of the United Nations, FAO Conservation Guide 21, ISBN 92-5-102806-8, Rome, Italy.
- Fortmann, L. 1987. Tree Tenure: An Analytical Framework for Agroforestry Practices. In *Land, Trees and Tenure*, Raintree, J. B. , editor, pp. 17-33, University of Wisconsin, Land Tenure Center, ISBN 0-934-519-01-3, Madison, Wisconsin, USA.
- Gregersen, H. M. , P. F. Ffolliott & K. N. Brooks. 2007. *Integrated Watershed Management: Connecting People to Their Land and Water*. CAB International, ISBN 978-1-84593-281-7, Oxfordshire, United Kingdom.
- Gregersen, H. , K. Brooks, P. Ffolliott, A. Lundgren, B. Belcher, K. Eckman, R. Quinn, D. Ward, T. White, S. Josiah, Z. Xu & D. Robinson. 1994. *Assessing Natural Resources Policy Issues*. EPAT/MUCIA/USAID Draft Policy Brief, University of Minnesota, St. Paul, Minnesota, USA.
- Gregg, F. 1988. Observations on Policy and Professionalism in Arid Lands. In *Arid Lands: Today and Tomorrow*, Whitehead, E. E. , C. F. Hutchinson, B. N. Timmermann & R. C. Varady, editors, pp. 583-590, Westview Press, ISBN 1-08133-7536-3, Boulder, Colorado, USA.
- Grey, D. & C. W. Sadoff. 2006. *Water, Wealth, and Poverty*. The World Bank, ISBN 0-8213-6739-0, Washington, DC, USA.
- Gordon, A. M. & S. M. Newman. 1997. *Temperate Agroforestry Systems*. CAB International, ISBN 0-85199-147-5, Wallingford, Oxfordshire, United Kingdom.
- Hoekstra, T. W. & M. Shachak, technical editors. 1999. *Arid Lands Management: Toward Ecological Sustainability*. University of Illinois Press, ISBN 0-252-06717-7, Urbana, Illinois, USA.
- Hopcraft, D. 1990. Wildlife Land Use at the Athi River, Kenya. In *The Improvement of Tropical and Subtropical Rangelands*, National Research Council, editor, pp. 332-340, National Academy Press, ISBN 0-309-04261-5, Washington, DC, USA.

- MacDicken, K. G. & N. T. Vergara, editors. 1990. *Agroforestry: Classification and Management*. John Wiley & Sons, Inc. , ISBN 0-471-83781-4, New York, New York, USA.
- Manguet, M. 1999. *Aridity: Droughts and Human Development*. Springer-Verlag. ISBN 978-3-540-63342-6, New York, New York, USA.
- Marples, S. 1986. Production and Investment in Marginal Areas. In *Development of Rainfed Agriculture Under Arid and Semiarid Conditions*, Davis, T. J. , editor, p. 87, The World Bank, ISBN 0-821-30817-2, Washington, DC, USA.
- McNeely, J. A. , K. R. Miller, W. Reid, R. Mittermeier & T. B. Werner. 1990. *Conserving the World's Biological Diversity*. The World Resources Institute, The World Wildlife Fund, and The World Bank, ISBN 0-915825-42-2, Washington DC, USA.
- Middleton, N. & D. Thomas, editors. 1997. *World Atlas of Desertification*. United Nations Environment Programme and A. Holden Arnold Publications, ISBN 0-340-69166-3, London, England.
- Mouat, D. A. & C. F. Hutchinson. 1995. *Desertification in Developed Countries*. Kluwer Academic Publishers, ISBN 0-7923-3919-3, AH Dordrecht, The Netherlands.
- Mukhoti, B. 1986. Forestry Projects and Landless Farmers - A View of Issues from Within a Donor Agency. *Bulletin of the Culture and Agriculture Group* 30:7-12.
- Nair, P. K. R. , editor. 1989. *Agroforestry Systems in the Tropics*. Kluwer Academic Publishers, ISBN 90-247-3790-7, AH Dordrecht, The Netherlands.
- Okigbo, B. N. 1991. *Development of Sustainable Agricultural Production Systems in Africa*. International Institute of Tropical Agriculture, Ibadan, Nigeria.
- Postel, S. 1997. *Last Oasis: Facing Water Scarcity*. W. W. Norton Company, ISBN 0-393-31744-2, New York, New York, USA.
- Pratt, D. J. & M. D. Gwynne, editors. 1977. *Rangeland Management and Ecology in East Africa*. Robert E. Krieger Publishing Company, ISBN 0-88275-525-0, Huntington, New York, USA.
- Raintree, J. B. , editor. 1887. *Land, Trees and Tenure*, University of Wisconsin, Land Tenure Center, ISBN 0-934519-01-3, Madison, Wisconsin, USA.
- Repetto, R. 1988. *The Forest for the Trees: Government Policies and the Misuse of Forest Resources*. : World Resources Institute, ISBN 978-0-915-82528-7, Washington, DC, USA.
- Salem, B. B. 1988. A Strategy on the Role of Forestry in Combating Desertification. In *Arid Lands: Today and Tomorrow*, Whitehead, E. E. , C. F. Hutchinson, B. N. Timmermann & R. G. Varady, editors, pp. 841-869, Westview Press, ISBN 0-8133-7536-3, Boulder, Colorado, USA.
- Schechter, J. 1988. Obstacles to the Transfer of Agricultural Technology Due to Inadequate Farming Systems in Developing Countries. In *Arid Lands: Today and Tomorrow*, Whitehead, E. E. , C. F. Hutchinson, B. N. Timmermann & R. G. Varady, editors, pp. 1255-1267, ISBN 0-8133-7536-3, Westview Press, Boulder, Colorado, USA.
- Seckler, editor. 1993. *Agricultural Transformation in Africa*. Winrock International Institute for Agricultural Development, ISBN 0-933595-77-8, Arlington, Virginia, USA.
- Sharma, N. P. , editor. 1992. *Managing the World's Forests*. Kendall Hunt Publishing Company, ISBN 0-8403-7885-8, Dubuque, Iowa, USA.
- Spedding, C. R. W. 1988. *An Introduction to Agricultural Systems*. Elsevier Applied Science, ISBN 1-85166-191-3, New York, New York, USA.

- Squires, V. R. & A. E. Sidahmed, editors, 1998. *Drylands: Sustainable Use of Rangelands into the Twenty-First Century*. International Fund for Agricultural Development, ISBN 92-9072-006-9, Rome, Italy.
- The World Bank. 1993. *Water Resources Management*. The World Bank, ISBN 0-8213-2636-8, Washington, DC, USA.
- The World Bank. 2003. *Land Policies for Growth and Poverty Reduction*. The World Bank, ISBN 0-8213-5071-4, Washington, DC, USA.
- The World Bank. 2005. *Agriculture Investment Sourcebook*. The World Bank, ISBN 0-8213-6085-X, Washington, DC, USA.
- Thomas, R. , M. Colby, R. English, W. John, B. Rassas & P. Reiss. 1993. *Water Resources Policy and Planning: Toward Environmental Sustainability*. U. S. Agency for International Development, Irrigation Support Project for Asia and the Near East, Washington, DC, USA.
- Tunstall, D. , N. Henninger & R. P. White. 2002. *An Ecosystem Approach to Drylands: Building Support for New Development Policies*. World Resources Institute, ISBN 1-56973-499-2, Washington, DC, USA.
- United Nations Environment Programme. 1992. *World Atlas of Desertification*. Edward Arnold, ISBN 0-3405-5512-2, London, England.
- Walker, B. H. , editor. 1979. *Management of Semi-Arid Ecosystems*. Elsevier Scientific Publishing Company, ISBN 0-444-41759-1, AH Dordrecht, The Netherlands.
- Weber, F. R. 1989. Policy Relating Arid-Zone Forestry to Rural Development and Desertification Control. In *The Role of Forestry in Combating Desertification*, Food and Agriculture Organization of the United Nations, editor, pp. 82-90, Food and Agriculture Organization of the United Nations, Conservation Guide 21, ISBN 92-5-102806-8, Rome, Italy.
- White, T. A. 1993. *Development of Rural Haiti: Policy Lessons from Natural Resources Projects*. EPAT/MUCIA/USAID Draft Working Paper, University of Minnesota, St. Paul, Minnesota, USA.
- White, T. A. & H. M. Gregersen. 1993. *Priorities for Programs in Rural Haiti: Policy Lessons from Natural Resources Projects*. EPAT/MUCIA/USAID Draft Policy Brief, University of Minnesota, St. Paul, Minnesota, USA.
- Whitehead, E. E. , C. F. Hutchinson, B. N. Timmermann & R. G. Varady, editors. 1988. In *Arid Lands: Today and Tomorrow*, Westview Press, ISBN 0-8133-7536-3, Boulder, Colorado, USA.
- Wiersum, K. F. 1988. Outline of the Agroforestry Concept. In Wiersum, K. K. , editor. *Viewpoints on Agroforestry*, pp. 1-26, Agricultural University Wageningen, Wageningen, The Netherlands.
- World Resources Institute. 1992. *World Resources 1992-93*. Oxford University Press, ISBN 0-19-506230-2, New York, New York, USA.



Sustainable Natural Resources Management

Edited by Dr. Abiud Kaswamila

ISBN 978-953-307-670-6

Hard cover, 166 pages

Publisher InTech

Published online 13, January, 2012

Published in print edition January, 2012

Natural resources conservation is one of the dilemmas currently facing mankind in both developed and the developing world. The topic is of particular importance for the latter, where the majority depend on terrestrial ecosystems for livelihood; more than one billion people live in abject poverty earning less than a dollar per day; more than 3.7 billion suffer from micronutrient deficiency and more than 800 million suffer from chronic hunger. Population increase, resource use conflicts, technological advancements, climate change, political doldrums, and unsustainable use and harvesting of resources have all put more pressure on natural resources leading to land degradation and poverty. To achieve a win-win situation, we need to change our mindset by thinking outside the box through advocating integrated and holistic approaches in managing our natural resources. This book presents a variety of sustainable strategies and/or approaches including use of GIS and Remote Sensing technologies, decision support system models, involvement of stakeholders in major decisions regarding use of natural resources, community level initiatives, and use of surveillance and monitoring mechanisms.

How to reference

In order to correctly reference this scholarly work, feel free to copy and paste the following:

Peter F. Ffolliott (2012). Sustainable Use of Natural Resources of Dryland Regions in Controlling of Environmental Degradation and Desertification, Sustainable Natural Resources Management, Dr. Abiud Kaswamila (Ed.), ISBN: 978-953-307-670-6, InTech, Available from:
<http://www.intechopen.com/books/sustainable-natural-resources-management/sustainable-use-of-natural-resources-of-dryland-regions-in-controlling-of-environmental-degradation->

INTECH
open science | open minds

InTech Europe

University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
Fax: +385 (51) 686 166
www.intechopen.com

InTech China

Unit 405, Office Block, Hotel Equatorial Shanghai
No.65, Yan An Road (West), Shanghai, 200040, China
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821

© 2012 The Author(s). Licensee IntechOpen. This is an open access article distributed under the terms of the [Creative Commons Attribution 3.0 License](#), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

IntechOpen

IntechOpen