Chapter 9
Desertification Risk Reduction Approaches in Pakistan

Amir Nawaz Khan and Amjad Ali

Abstract Desertification is a serious global problem and more acute in the case of Pakistan. In Pakistan almost 3/4th of the land is either already affected or likely to be affected by it. Desertification process has been active since historical times in areas now-a-days constituting Pakistan. Amongst the factors affecting desertification in Pakistan, the fundamental factor is population pressure. Other major immediate physical cause of ecological degradation includes: excessive felling of trees, inadequate reforestation activities, inappropriate cultivation practices in hilly and rain fed farming area, uncontrolled and excessive livestock grazing in forest and rangeland. Inadequate efforts with regard to watershed protection and management in the catchments areas of reservoirs lead to sever soil erosion. Irrational irrigation practices also enhance land degradation. As a result of such activities vegetation cover is destroyed, and it also leads to prevent regeneration of grasses and trees etc.

The Desertification occur in both rain fed as well as irrigated lands. Pakistan is mainly a dryland country, where 80 % of its land is arid and semi-arid. Two-third of its human population depends on these drylands to support their livelihood. Like many other developing countries, Pakistan is severely affected by land degradation and desertification. Unsustainable land management practices are causing enormous environmental problems, including soil erosion, loss of soil fertility, flash floods, sedimentation of canals and water courses, deforestation and associated loss of carbon sequestration capacity and biodiversity. In recent years, number of Federal and provincial agencies are engaged to combat desertification. However, the efforts made by the originations and departments along with non-government organizations hardly fill the gap between its increasing intensity and disaster risk reduction measures to control desertification.

Keywords Desertification • DRR • Land degradation • Dryland

A.N. Khan • A. Ali (✉)
Centre for Disaster Preparedness and Management, University of Peshawar, Peshawar, Pakistan
e-mail: aliswabi@upesh.edu.pk

Atta-Ur-Rahman et al. (eds.), *Disaster Risk Reduction Approaches in Pakistan*, Disaster Risk Reduction, DOI 10.1007/978-4-431-55369-4_9

9.1 Introduction

Desertification is a process or set of processes which cause diminishing of the biological potential of land which ultimately lead to desert like conditions and complete loss of production and resources. The resources include land use and land cover, crop production, forest cover, livestock, soil etc. The phenomenon of desertification is a gradual deterioration. It is therefore not easily identified with accuracy and precision. That is the reason that amounts of desertification are not easily estimated, as at least a decade may be required effort it can adequately be distinguished from drought. However, the annual loss of land is thought to be about 60,000 km^2 distributed among about 100 countries. Of these countries, 27 are in Africa, and since 1925 on the southern fringe of the Sahara more than 650,000 km^2 of land has ceased to be productive. It is estimated that 600–700 million of the world's population live in areas of threatened dry lands, whereas more than 60 million people are already affected by desertification. To a greater or lesser extent, one third of the land surface and one seventh of the population of the world are affected directly. But the rest of the global population must bear the indirect effects of diminished food production and increased suffering which must be alleviated by international aid. As the phenomenon is one of gradual deterioration, it is vital that it be monitored effectively in order to detect serious changes as they occur. Sequential satellite image can help to do this. Agriculture production figures are also useful for determining the location and severity of desertification. It is estimated that desertification costs the world economy at least 26,000 million dollars each year. It is also estimated that it could cost 90,000 million dollars to halt current towards ever greater loses of land productivity. It has also been observed that each incidence of desertification needs as individual strategy to ameliorate it. In much degraded dry lands, retrenchment may be the only solution and recovery may be out of the question in the short term. In less damaged ecosystems rotational cropping, redistribution of ownership rights, fallowing, careful ploughing or the establishment of irrigation may be appropriate strategies. If land is so damaged that it cannot be put to productive use, then proportionately more investment will be required. Unfortunately, unless there is considerable out mitigation, the pressure of population on the land may remain the same during this period (Brown et al. 2008; Kolmannskog 2008; United Nations Decade for Deserts and Fight against Desertification [UNDDD] 2014; United Nations Environment Programme [UNEP] 2014).

The decline of Indus valley civilization with great cities of Moenjodaro and Harappa has been attributed to prolonged process of desertification. In more recent time, with all the modern technologies in land, the process has been once again activating taking heavy tolls on the economic and social life of the area. Amongst the factors affecting desertification in Pakistan, the fundamental factor is population pressure. Other major immediate physical cause of ecological degradation includes: Excessive felling of trees, and inadequate reforestation activities, uncontrolled and excessive livestock grazing in forest and rangeland. As a result of such activities vegetation cover is destroyed, and it also leads to prevent regeneration of grasses

and trees etc. Some other causes of such ecological degradation include inappropriate cultivation practices in hilly and rain fed farming area (Ahmad et al. 2004; Akbar et al. 1996; Khan 2010).

Out of 79.6 million ha total land of the country, only 20 million are suitable for agriculture (16 million for irrigated farming and 4 million for rain fed agriculture). About 5.2 % of Pakistan's land area in covered by forests, whereas both environmental and economic standards suggested that the country should have at least 20–25 % area under forests. Around 3 % of forest cover is shrinking annually and woody biomass by 5 %, further aggravating the desertification process. About 11.2 million ha mostly northern mountain regions are affected by water erosion. As a result, 40 million tons of sediments are brought into the Indus basin each year, which has reduced the soil productivity in the area and shortens the lifespan of major upstream reservoirs. According to an estimate, about 2 million ha are affected by water logging and around 6 million ha by salinity and sodicity. These problems are more acute in some irrigated areas of Punjab, Sindh, and Baluchistan resulting into low soil fertility, decline in crop yields, and loss of biodiversity. About 3–5 million ha of land is affected by wind erosion in arid regions of Punjab (Cholistan), Sindh (Tharparkar), and Balochistan (Chagai Desert and sand areas along the coast). Some of the areas have 0.5–4 m high moving sand dunes, posing danger to cultivation land and local infrastructure. Almost 60 % of the country is classified as rangelands. According to an estimate about 48 % of rangelands are degraded. Degradation of rangelands reduces ecosystem functions and services. It affects local livelihoods and increases poverty (Akram 2012; United Nations Combat to Desertification [UNCD] 2011; Akbar et al. 1996).

9.2 Major Causes of Desertification in Pakistan

In Pakistan, land degradation mainly encompasses deforestation and desertification, salinity and sodicity, soil erosion, water logging, depletion of soil fertility and negative nutrient balances.

9.2.1 Deforestation

Pakistan has a total forest area of about 12 million ha. Out of that, the total forest, scrub, and planted trees spread on 4.2 million ha, natural and modified coniferous scrub, riverain and mangrove forests spaced 3.5 million ha, tall tree forests encompass 2.4 million ha, scrub forest exist on 1.1 million ha, and plantations occupy 0.7 million ha. The forest area of Punjab is only less than 3 % per cent whereas in Sindh it becomes even half of that. The continuous destruction of forests is causing a substantial loss. The declining rate of woody biomass is the second highest in the world. It ranges between 4 and 6 % per year. Almost 7,000–9,000 ha are deforested every

year and this rate is especially severe in the north where the per capita consumption for fuel wood is 10 times higher due to the ruthless winters. Due to increase in population, the consumption of household firewood would probably go up to 3 % per year. Pakistan's woody biomass may be totally consumed within the next 10–15 years. The lopping of trees for commercial purposes has also greatly accelerated forest depletion. Unrestricted livestock grazing is also a severe threat. Regional case studies also portray a dismal picture. About 5.2 % (4.2 m ha) of Pakistan's total area is under forests. Pakistan is losing forests at a 3 times the rate of other South Asian countries. About 3.1 % of forest cover is being lost every year and woody biomass is disappearing at an annual rate of 5 % as the majority of households continue to use firewood for cooking and heating (Food and Agriculture Organization of the United Nations [FAO] 1989; Khan Forthcoming Nov 2014).

Illegal and excessive chopping of trees has resulted in severe soil erosion, flood damage and desertification in many areas. This activity leaves the soil exposed and less able to absorb rainfall which does occur. Water, therefore, runs off and causes soil erosion, speeding-up the process of denudation and eventually leading to desertification. The removal of top soil is also resulting in low production of forage, fodder, fuel wood, timber, cereal crops and grains and, as a result, exacerbating poverty (Atta-ur-Rahman and Khan 2013; Khan 2010).

A study of the Siran project area, Hazara, Khyber Pakhtunkhwa, shows a 52 % decline in the resource between 1967 and 1992. Similar cases are present in the Kaghan Valley and Allai Valley. The mangrove forests of the Indus Delta has halved from 2,600 km^2 in the late 1970s to 1,300 in the 1990s, due to the grazing by camels. Almost 50 % of the original riverine forests have been degenerated beyond economic viability. More than 60 % of the natural grazing areas of the country have production levels lower than one third of their biological potential. More than one-third of the country area has been classified as under risk of desertification. Deforestation, over cultivation, excessive cutting of fuel wood and incorrect irrigation practices all have a share in this problem. The data reported for a 5 years period, from 1997–1998 to 2001–2002, revealed that the extent of area afforested and regenerated is more or less stagnant as it only increased 3,900 ha from 21,400 to 25,300 ha (The United Nations Educational, Scientific and Cultural Organization (UNESCO) 2009; UNCD 2011; FAO 1989; United Nations Environment Programme [UNEP] 2014).

9.2.2 Poor Irrigation and Drainage Practices

Pakistan has one of the largest canal irrigation systems in world and this system operates on the principles of flood irrigation. The overall poor management of irrigation, both at the system and farm levels, is contributing to water logging and salinity in cultivated areas. Excessive percolation of water from the canal system builds up the ground water level. Human activities such as the obstruction of natural drainage through construction of roads, improper alignment and poor maintenance

of irrigation channels, insufficient drainage of excessive rainwater etc. all add to water logging problems. About 11 million ha of arable land in Pakistan is affected by water logging, while over 3 million ha are affected by salinity and sodicity. In majority of the soils of plains in Pakistan, the rainfall is usually low and the evapotranspiration is higher than the annual precipitation resulting in buildup of salts in the soil profile and their accumulation on the soil surface. At country level, 6.28 million ha of area is affected with salinity and sodicity. The majority of salt-affected soils are saline-sodic in nature. These salt affected soils are causing potential reduction in yield (Akram 2012; Khan 1993a; UNESCO 2009).

9.2.3 Soil Erosion

Soil erosion implies loss or removal of surface soil material through the action of moving water, wind or ice. The total area affected by water erosion is 13050.2 ha. Area affected by different types and extent of water erosion in Pakistan are 61,200 ha, 3,635,000 ha, 5,640,700 ha 3,446,500 ha with slight (sheet & rill erosion), moderate (sheet & rill erosion), severe (rill, gully and/or stream bank erosion) very severe (gully, pipe & pinnacle erosion), respectively. About 13.05 million ha of area is affected by water erosion and about 6.17 million ha is affected by soil erosion. Soil erosion is taking place at an alarming rate and is mainly due to deforestation in the north. Water erosion is prominent on steep slopes such as the Potohar track and surrounding areas, an area extensively used for cultivation. The highest recorded rate of erosion is estimated to be 150–165 tones/hectare/year. The Indus River carried the fifth largest load of sediment (4.49 t/ha) in the world in 1990. According to some estimates the Indus is adding 500,000 tons of sediment to the Tarbela Reservoir every day, reducing the life of the dam by 22 % and the capacity of reservoir by 16 %. Wind erosion has a relatively lower impact than water erosion. However, the combination of the two is more devastating. This reduces the productivity of the land by 1.5–7.5 % per year. This affects almost one-fifth of the Punjab (Shah and Arshad 2006; Bell 1999).

9.2.4 Water Logging

The total affected area by waterlogging in Pakistan is 1,427,200 ha. In cultivated areas of Pakistan, the water table depth 100–150 cm and 50–100 cm covered area is 318,300 ha and 292,800 ha, respectively. In uncultivated area with water table depth less than 150 cm the covered area is 142,700 ha. The figures are based on the surveys which were completed about 15 years ago. It appears that problem of water logging may not be as serious now as it was in the past. The problem has reduced due to prolonged drought and excessive mining of ground water (Akram 2012; Khan 2010; UNEP 2014).

9.2.5 *Depletion of Soil Fertility and Negative Nutrient Balances*

The fertility status of Pakistani soils is rapidly depleting. The data generated by the public and private organizations in the country reflect the general agreement about the deficiency of nitrogen in 100 % soils. Same is the situation with organic matter content, which is on around average 0.5 % only. In case of phosphorus, more than 90 % soils are deficient. Potassium deficiency in Pakistani soils, which was not a soil fertility problem earlier, is increasing rapidly due to the discriminate use of only nitrogenous and phosphatic fertilizers. Various public and private organizations in the country are reporting a soil potassium deficiency in the range of 20–40 %. For that reason, Nitrogen, Phosphorous, Potassium (NPK) formulations for various crops have also been introduced in Pakistan. Among micronutrients, field scale deficiencies of economic significance prevail in case of zinc, boron, and iron. The nutrient balance in Pakistani soils reflects a severe mining trend. All the provinces show negative nitrogen balance, although in Punjab the deficit is declining. Over the decade, negative phosphorus balances did not change significantly in Punjab but worsened in the other three provinces. In 1985–1986, the level of deficit was highest in Punjab. However, in 1995–1996 they were all fairly similar. Potash balances deteriorated over the decade (FAO 1989; Khan Forthcoming Nov 2014; UNCD 2011; Khan 1993b).

The estimated loss of productivity as a result of land degradation is US $ 353 million annually, and the loss to rangeland productivity is between US $ 90–160 million/year. All of the above environmental issues are summarily heading Pakistan towards more economic instability. According to a conservative estimate, the impacts of degradation and biodiversity loss on productivity and public health are in the tune of 3 % of GDP per year. It would be higher if toxic waste disposal, biodiversity, river and coastal resource depletion were taken into account. It is therefore very necessary for the sustainable economic future of Pakistan and a friendly environment to cope with land degradation problem on war-footing bases. Productive lands and healthy environment are the only gift worth passing to our next generations (Bell 1999; Khan 2010; Shah and Arshad 2006; UNISDR 2004; UNDDD 2014).

9.3 Desertification in Rain-Fed Areas

The total area under rain fed cropland in Pakistan is about 5 million ha which is about one fourth of the total cultivated area in the country of these 3.2 million ha in sub-humid regions. Over the past two decades approximately 25 % of the rain fed cultivated area has decreased due to erosion, and introduction of canal irrigation system. Soil erosion in the rain fed and hilly areas is big problem which limits the agricultural production. Due to water erosion in northern uplands, millions of tons

of fertile top soil is getting washed away, where as in southern areas, shifting of sand dunes due to wind storms, damages crops, chocks up water courses and blows away fine particles of sand leaving behind infertile sandy wastes. It is estimated that there is a total of 1.2 million ha of eroded land at present in the country (Akbar et al. 1996; Alan and Macdonald 2012).

9.4 Desertification in Irrigated Lands

The total area under irrigation in Pakistan is about 15 million ha, out of this irrigated land 9.6 million ha is arid, 3.8 million ha is semi-arid, 1.0 million ha is sub humid and the remaining 0.6 million ha is in transitional climatic zones. Desertification is affection irrigated ecosystem in the form of water logging and salinity. The extensive and continuous use of surface irrigation has altered the hydrological balance of the Indus basin by substantially raising the ground water table. The water table has risen to within 6 ft over 25 % of the basin and to within 10 ft in over 1/3 of the entire Indus plain. This is the outcome of perennial canal irrigation which was introduced to combat aridity. With perennial canals it possible to water the crops whenever the need was felt. As a consequence of seepage of water from the unlined canals and the percolation of water from the irrigation field, the water table began to rise. When the water table rose to 5 ft below the surface, the saline water reached the surface by capillary action. With a further rise of water table, water logging took place. It is estimated that 26 % of the irrigated area of Pakistan is affected by salinity, of which 8 % is severely affected. Sindh is the worst affected province where 48 % of the soil is saline, of which 18 % is strongly saline. As a whole in Pakistan more than 40,000 ha of irrigated land are lost each year to agricultural production due to water logging and salinity. They vary from season to season and year to year, depending in past on the strength of the monsoon and the spatial and temporal distribution of rainfall (Akram 2012; Asian Disaster Preparedness Center (ADPC) 2008; Shah and Arshad 2006; Government of Pakistan (GOP) 2007).

Crop damage varies according to the water and salt sensitivity of the particular plant. Now within these limitations, surveys conducted by WAPDA in 1980s revealed that about 21 million ha of land has been severely affected by water logging. The total population affected is about 3 ½ million. Salinity has also taken heavy toll by affecting about 4.2 million ha of land. According to 1980s WAPDA surveys 1.3 million ha of 4.2 million ha is very strongly saline. Pakistan cannot effort this kind of deterioration of land in the wake of fast growing population. Therefore, it is important not only check further growth of water logging and salinity of land but to reclaim the land already damaged. As a remedial measure it has been decided to bring down the salinity below the danger level and to flush away the salt from the soils. For this the country has been divided into a number of salinity control and Reclamation Project zones (SCARP). The reclamation work has been started phase-wise. The water table is lowered by pumping water out by tube wells. This plan proved a success but brought in its wake other problems. Ground water in

some areas, particularly sindh is saline. It cannot be used for irrigation; therefore, it cannot be drained into the canals. The safest way of disposal is to drain the water into the sea. This involves new engineering problems and added cost. In addition to this tube well installed began to wear out in a few years. They needed repair and in some cases installation of new tube wells was required. Furthermore installation of thousands of tube wells resulted in a heavy pressure on electricity which is already in short supply. Long spells of load shedding also create problems. Above all the whole plan involves a heavy expenditure, but the work of SCARP is continuing as no better alternative is known (GOP 2010a, b; GOP 2013; Shah and Arshad 2006; UNESCO 2009; UNISDR 2004).

Besides WAPDA the activities of the Punjab Land Utilization Authority (PLUA) also follow the same premises. PLUA is undertaking efforts to rehabilitate, or otherwise return to economic use approximately five million in most cases is crop land abundant due to water logging or salinity. The PLUA's charter does not preclude activities designed to facilitate waste land utilization for purposes other than crop agriculture. However, the forest department differs with this view. Forest officials argue that various tree species could grow on land no longer suitable for crop cultivation because of water logging and salinity. However, no serious official attempt has been made so far to assess the technical potential for, and the economics of, farm forestry on such land, and to weigh this against the cost and benefits of further capital intensive reclamation for crop cultivation. It is important to note in this context that a significant number of the owners of land reclaimed under PLUA projects have in fact, for technical as well as economic reasons, switched from wheat cultivation to various farm forestry and orchard operations, including the bamboos and the establishment of tree nurseries. It might, therefore, be worthwhile to try same in other areas as well (Akbar et al. 1996; Khan 2010; Khan 1993a, b).

9.5 Desertification in Rangeland

There has been an adverse effect on rangeland due to overgrazing. The ecological system throughout the rangeland has a very fragile set of relationships which can be easily disturbed. Since generations Man's livestock in the area through overgrazing have reduced some species of plants. As a result recovery is no longer possible in the short run and desertification is imminent. It has been suggested that the area most seriously affected by this process are those closest to watering points, because livestock must come regularly to drink water, especially during the hot season (Johnson 1979). Unfortunately in the arid zone, man's technological skill has sometimes outrun his ability to consider the consequences of his actions. After, about 40 years of experimentation and reviews, there still is no effective leadership for managing the country ranges and natural pastures and very little effective activity in this respect. A number of range management and improvement projects were initiated in the 1950s and early 1960s. But by the end of 1960s almost all projects had ended in virtual failure in large parts. The failure was because of the fact that these projects were over ambitious,

lacked clear objectives, and paid inadequate attention to prevailing socio-economic constraints. The single most important cause of failure was, in fact, sociological rather than technical: i.e. inability to deal effectively with the human population of the ranges, rather than the absence of, or inability to apply, technical solutions. In May, 1973, a National Range Management Committee issued a comprehensive report, containing wide-ranging recommendations for both the short and long-term:

(i) Promulgation of a comprehensive National Range Policy and Provincial Range Management Acts,
(ii) Creation of provincial Range Management Agencies
(iii) Assignment of co-coordinative lead function to I.G. forest, and creation of a Directorate of Range Management in the I.G. forest's office.
(iv) Establishment of a Federal Range Management Fund for preparation and implementation of range management schemes.
(v) Formation of grazing associations to facilitate effective range management.
(vi) Effective training, education and research in the range management.
(vii) Effort to reduce unproductive live stock.
(viii) Improvements in livestock and livestock products marketing
(ix) And establishment of a livestock feed industry and livestock feedlots.

Although some steps were taken to implement a few of these proposals, most of the major recommendations have never been implemented. There is no effective co-ordination among the various agencies involved. Funding for range management and improvement remains extremely limited, Livestock numbers have increased further and the sector's productivity and contribution to national income has declined further (Akbar et al. 1996; Collins 2009; Khan Forthcoming Nov 2014; Shah and Arshad 2006).

9.6 Rolling Sandy Areas in Pakistan

A considerable part of Pakistan is occupied by wind reworked sand. The notable rolling sandy areas are: Cholistan (1.8 million ha) Punjab Province; Thal Doab (2.3 million ha) Punjab Province; and Thar (2.8 million ha) Sindh Province. Other similar desert patches are D.I. khan in Khyber Pakhtunkhwa and the Kharan dessert in Baluchistan. The surface relief of these areas generally comprises of variety of sand dunes. The sub-soil water over most of the area is brackish and is unfit for agriculture and for human or livestock consumption. The average annual rainfall varies from about 80 to 200 mm. The rainfall is mostly collected in ponds to sustain livestock for a short period and on its drying the livestock is moved to settle areas. The people in these areas live in small hamlets and their main profession is livestock grazing. The potential of rangeland and other development in these areas is very low because of the moving nature of the sand dunes. Moving sand dunes are a major threat to settlements, agriculture land and physical infrastructure facilities in Pakistan (Ahmad et al. 2004; Akbar et al. 1996; Shah and Arshad 2006).

In a number of locations, successful efforts have been made to stabilize shifting dunes by planting suitable species of shrubs and grasses in the inter-dunal spaces, on the leeward and windward dune slopes. The species used have demonstrated a considerable ability to withstand drought and to regenerate naturally, once they have firmly taken root. The technology developed is effective and replicable on a large scale, provided funding and labour are available. The cost/acre is not very high, but the areas still requiring treatment are extensive. Where successful work has been undertaken, the local population is convinced of its benefits, interested in further dune stabilizing, and willing to co-operate in protecting newly planted areas against grazing and firewood extraction. It would be desirable to continue further dune stabilization work. For achieving successful results however, it is necessary that firstly, a thorough evaluation should be carried out of past and ongoing projects, to search for more effective techniques under different conditions, and find the cost effectiveness of approaches alternate. Secondly dune stabilization efforts should be combined with effective efforts to introduce sand range management techniques in the adjoining range areas, where increasing desertification causes dune creation and movement, so as to permit range vegetation to regenerate naturally and provide resistance to further wind erosion. Thirdly the local population is the area to be treated should be effectively mobilized both for providing the labour needed for initial planting and for subsequent maintenance and protection of the stabilized areas and adjoining range lands (Akbar et al. 1996; UNESCO 2009; UNEP 2014; UNCD 2011; UNISDR 2010).

9.7 Measures for Combating Desertification

The Government of Pakistan has adopted medium and long term DRR measures to control desertification. Different projects have been lunched for DRR measures to control desertification by various agencies organizations and departments at Federal and provincial levels. The important organizations and departments at Federal and provincial levels involved in DRR measures to control desertification are: Pakistan Agricultural Research Council, Pakistan Council of Research in Water Resources, Water and Power Development Authority, Forest Departments, Irrigation Departments, Agriculture Departments, Sindh Arid Zone Development Authority, Cholistan Development Authority, Arid Zone Research Institute, Drainage and Reclamation Institute of Pakistan, Pakistan Desertification Monitoring Unit, Soil Conservation Departments, Agricultural Universities, Irrigation Research Institute, Center of Excellence in Water and Resources Engineering, National Institute of Agricultural Botany etc. These measures of DRR for desertification can be summarized as afforestation; soil and water conservation; reclamation of salt affected and waterlogged areas; and range development and sand dune stabilization (GOP 2010a, b, 2007, 2013; Shah and Arshad 2006; Bokhari 2014; Khan 1993a, b; UNISDR 2010). Some of the examples of these DRR measures for desertification are discussed as below:

(i) Afforestation and reforestation through planting more trees that reduced the negative impacts of climate change and slowly reduce the desertification.
(ii) Watershed management for control of soil erosion in mountainous areas of Pakistan.
(iii) Combat the effects of the wind by constructing barriers and stabilizing sand dunes with local plant species
(iv) Restore and fertilize the land by preparing compost with organic matter. Composting is a simple and cheap way to fertilize and regenerate the soil.
(v) Creation of a desertification prevention culture through awareness raising and change in attitudes
(vi) Protection of vegetative cover to prevent wind and water erosion
(vii) Introduction of policies that create incentives for rehabilitation of degraded land such as capacity building, capital investment and institutional support.
(viii) Community involvement in planning and implementation of rehabilitation programs
(ix) Promotion of integrated land and water management practices
(x) Promotion of Sustainable Land Management options

9.8 Conclusion

Desertification is the persistent degradation of dryland ecosystems. It affects the livelihoods of millions of people. In 2000, drylands, which occupy 41 % of Earth's land area, were home to a third of the human population. A significant portion of drylands are already degraded, and the ongoing desertification threatens the Pakistan's poorest populations and hinders the prospects of reducing poverty. Therefore, desertification is one of the greatest environmental challenges today. It is a major barrier to meeting basic human needs in drylands and leads to losses in terms of human well-being. The causes of desertification include social, political, economic, and climatic factors that contribute to an unsustainable use of scarce natural resources. The magnitude and impacts of desertification vary greatly from place to place and change over time in Pakistan. A wide gap remain in our understanding and monitoring of desertification processes, gaps which sometimes prevent cost-effective actions in affected areas. Pakistan is blessed with diverse physiographic, climatic and cultural conditions. This situation leads to all environmental degradation agents for desertification. Although, number of organizations and departments at government as well as at non-government level working for remedial measures of desertification. However, the variety of causes and socioeconomic conditions certainly restrain the effects of these measures of DRR.

References

Ahmad S, Hussain Z, Qureshi AS, Majeed R, Saleem M (2004) Drought mitigation in Pakistan: current status and options for future strategies. IWMI, Colombo

Akbar G, Khan TN, Arshad M (1996) Cholistan desert, Pakistan. Rangelands 18(15):124–128

Akram M (2012) Management of surface and groundwater resources in Cholistan Desert of Pakistan for drinking and farm production. Pakistan Council of Research in Water Resources (PCRWR), Islamabad

Alan K, Macdonald D (2012) Indigenous people, poverty and development. Cambridge University Press, New York

Asian Disaster Preparedness Center (ADPC) (2008) 'Vulnerability and risk: Module 3, Capacity Building in Asia using Information Technology Applications (CASITA) Project', ADPC, SM Tower, 24th Floor, 979/69 Paholyothin Road, Samsen Nai, Phayathai, Bangkok 10400, Thailand, ADPC, Bangkok

Atta-ur-Rahman, Khan AN (2013) Analysis of 2010-flood causes, nature and magnitude in the Khyber Pakhtunkhwa, Pakistan. Nat Hazards 66(2):887–904

Bell FG (1999) Soil erosion and desertification. In: Geological hazards their assessment, avoidance and mitigation, 1st edn. Taylor & Francis Group, New York. http://www.crcnetbase.com/doi/abs/10.4324/9780203014660.ch9

Bokhari IM (2014) UNISDR. Viewed 15 June 2014, http://www.preventionweb.net/english/professional/policies/v.php?id=38542

Brown D, Taylor J, Bell M (2008) The demography of desert Australia. Rangel J 30(1): 29–43. Viewed 22 April 2014, http://www.publish.csiro.au/paper/RJ07043

Collins AE (2009) Disaster and development. Routledge, Taylor & Francis Group Ltd., Oxford/Abingdon

Food and Agriculture Organization of the United Nations [FAO] (1989) Arid zone forestry: a guide for field technicians. Forest Department, Paris

Government of Pakistan (GOP) (2007) National disaster risk management framework Pakistan. National Disaster Management Authority, NDMA, Prime Minister's Secretariat, Constitution Avenue, Islamabad

Government of Pakistan (GOP) (2010a) Five year plans. Viewed 15 June 2014, http://www.planningcommission.gov.pk/National_Plans.html

Government of Pakistan (GOP) (2010b) 'National Disaster Management Act 2010', Act, The Gazette of Pakistan, Senate Secretariat. NDMA, Islamabad. http://www.preventionweb.net/files/32317_ordinance.pdf

Government of Pakistan (GOP) (2013) 'The National DRR Policy', Policy, National Disaster Management Authority. NDMA, Islamabad. http://www.ndma.gov.pk/Documents/drrpolicy2013.pdf

Johnson DL (1979) Management strategies for drylands: available options and unanswered questions. In: Mabbutt JA (ed) Proceedings of the Khartoum Workshop on Arid Lands Management. United Nations University Press, Khartoum, pp 26–35. Retrieved June 15, 2014, from Strategies for development, extension, and management in the drylands: http://archive.unu.edu/unupress/unupbooks/80198e/80198E03.htm#. Management Strategies for Drylands: An Interim Report D. L. Johnson

Khan AN (1993a) An evaluation of natural hazard reduction policies in developing countries with special reference to Pakistan. Pak J Geogr III(1 & 2):81–100

Khan AN (1993b) Towards an appraisal of hazard-response theory with special reference to landslide hazard. J Rural Dev Auth XXV(4):42–63

Khan AN (2010) Climate change adaptation and disaster risk reduction in Pakistan. In: Shaw R, Pulhin J, Pereira J (eds) Climate change adaptation and disaster risk reduction: an Asian perspective, community, environment and disaster risk management. Emerald Group Publishing Limited, London/Bingley

Khan AN (Forthcoming Nov 2014) Introduction to disaster planning and management, 1st edn. Printman, Peshawar

Kolmannskog VO (2008) Future floods of refugees: a comment on climate change, conflict and forced migration. Norwegian Refugee Council, Oslo

Shah Z-U-H, Arshad M (2006) Land degradation in Pakistan: a serious threat to environments and economic sustainability. Viewed 15 June 2014, http://www.eco-web.com/edi/060715.html

The United Nations Educational, Scientific and Cultural Organization (UNESCO) (2009) 'Facing the challenges: the United Nations World Water Development Report 3', UN Report, UNESCO, World Water Development, Earthscan, London

United Nation International Strategy for Disaster Reduction (UNISDR) (2004) Living with risk: a global review of disaster reduction initiatives. Viewed 15 June 2014, http://www.unisdr.org/eng/about_isdr/bd-lwr-2004-eng.htm

United Nation International Strategy for Disaster Reduction (UNISDR) (2010) Natural hazards, unnatural disasters: the economics of effective prevention. Viewed 15 June 2014, http://www.gfdrr.org/sites/gfdrr.org/files/nhud/files/NHUD-Report_Full.pdf

United Nations Combat to Desertification [UNCD] (2011) Global drylands. Zoi Environment Network, Bresson

United Nations Decade for Deserts and Fight against Desertification [UNDDD] (2014) UNDDD. Viewed 15 June 2014, http://www.un.org/en/events/desertification_decade/value.shtml

United Nations Environment Programme [UNEP] (2014) United Nations Environment Programme: Environment for Development. Viewed 15 June 2014, http://www.unep.org/dewa/agassessment/reports/IAASTD/EN/Agriculture%20at%20a%20Crossroads_Global%20Report%20(English).pdf