

Adaptation to Climate Change and Mitigation of its Effects in the Arid Region of Pakistan (1961-2015)

Saifullah Khan^{1*}, Mahmood-ul-Hasan², Muhammad Aslam Khan²

¹Institute of Social Sciences and Directorate of Distance Education, Bahauddin Zakariya University, Multan, Pakistan

²Institute of Geography, Urban and Regional Planning, University of Peshawar, Khyber Pakhtunkhwa, Pakistan

*Email: saifullahkhan33@gmail.com

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Abstract: This research explains the weather and climate fluctuation adaptation and easing of its effects in dry climate region of Pakistan, based on weather data obtained from 40 weather observatories for the time duration of 55 years (1960-2015). The area of study is covering about 77 percent of the entire country, characterized by hot dry long summers and short warm moist winters. Pakistan has been dynamic on international and local scales to espouse a steadfast climate change strategy for the lessening of climate change effects in the arid region. The existing policy of the country, regarding adaptation to weather change in the dry lands, has not fulfilled the obligations and it is required to appraise it sporadically as per the country's economic, environmental and social desires. The main sectors that call for mitigation in the dry lands on national level are; surface and underground water, coastal management, overgrazing, deforestation, agriculture and livestock, drought and desertification, public awareness, emergency response, early warning system and monitoring, landuse change, waterlogging, energy and power resources, and health issues. The hydrological sector is more vulnerable to the effects of climate and weather changes in the study area. These effects will be reduced by means of fresh hydro-reservoirs, local dams, and waterway embankments to save the existing flow from swamping. It will also bring perfection in the sanitation and irrigation schemes, policy for flood water consumption, appraisal of the hydro-management policy, implementation, research and development funds.

Keywords: Arid region, climate change, adaptation, policy, water management, deforestation, public awareness.

Introduction

It was observed that the sharing of rainfall in the dry region of the country is appropriate to the horizontal atmospheric divergence as well as convergence and its altitudinal and latitudinal extent, the marine or land masses source of seasonal circulation, the regular change in the continental pressure system, and atmospheric circulation. The local heating transfer process, results due to earth deflection and reflection processes and vegetation cover, also causes fluctuation in the rainfall and surface temperature. Several workers have discussed the climate change in Pakistan as well as on an international level, in which there are many well-known contributors. UNFCCC (2015) has presented the impacts, vulnerabilities and adaptation strategies of climate change in different countries. Ali et al. (2014) have studied the effects of changing climate on agriculture and mitigation approaches of farming community in Pakistan. Khan et al. (2013) have evaluated the public opinion regarding climate fluctuation and mitigation in the dry lands of Pakistan. Vien (2011) has examined the adaptation strategies of climate change to crops and vegetation in Vietnam. Government of Pakistan (2002, 2012) has evaluated the national action program to combat desertification and climate change in Pakistan, focusing on the province of Sindh. Mahmood-ul-Hasan and Khan (2010) have observed the rainfall and temperature change in Swat district, Pakistan. Meisner et al (2005). Muhammad, et al(2009) has assessed the climate change-associated vulnerabilities and coping mechanisms with reference

to water resources in South Asia. Meisner et al (2005) has discussed evaluation and performance of permanent raised bed cropping systems in Asia, Australia and Mexico. Viet *et al* (2003) have argued climate change and approaches to mitigation in agriculture for sustainable growth in Vietnam. FAO (2002) analyzed the drought mitigation and management long term strategies in Iran. IPCC (2001, 2007) have published the summary of impacts, adaptation and vulnerability to climate change in different regions of the world. Khan and Khan (1961) have highlighted the impact of rainfall variability on the agriculture sector in the semi-arid and arid regions of Pakistan. Khan (1960) has presented his views regarding the current hydrological changes in the semi-arid and arid regions of Pakistan.

In the reverse engineering process, the scanned points of an object are transformed into a point cloud or triangular mesh patterns so that further restoration operations can be performed. All features obtained for the specific point, such as shape, texture and color, can be used in CAD environments via triangular mesh. This process is called reverse engineering. The point cloud obtained at the end of the scanning of the object in concern with optical scanning devices is passed through a number of arrangements to obtain the CAD data of the object. The CAD data can be used for manufacturing later.

This research deals with the southern dry (arid region) latitudes of Pakistan having sum of annual rainfall between 0-10 inches (0-254mm). The area of study

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covers the northern latitudes of Pakistan (Gilgit-Baltistan province), whole of Sindh province, southern Punjab, Baluchistan province, Chitral and Dera Ismail Khan District (Khyber-Pakhtunkhwa). The arid region of Pakistan covers about sixty three districts which make up one third (1/3) of Pakistan (Fig. 1).

Materials and Methods

Generally, the research based on the monthly and annual normal data of rainfall covers a time period of fifty-five years (1961 to 2015). The research explains the effects of precipitation and temperature fluctuation on the agriculture sector and its mitigation in the dry lands of Pakistan. The weather and climate observations of twenty one meteorological stations throughout the country have been collected from Climate Data Processing Center (CDPC) and Meteorological Department from Karachi, Sindh. The collected data have been further computed into mean monthly, total annual and mean deviation and then put into tables and graphs for the purpose of investigation. To attain the net results, the mean monthly and annual data have been further ranked and converted into seasonal averages, sums and deviations.

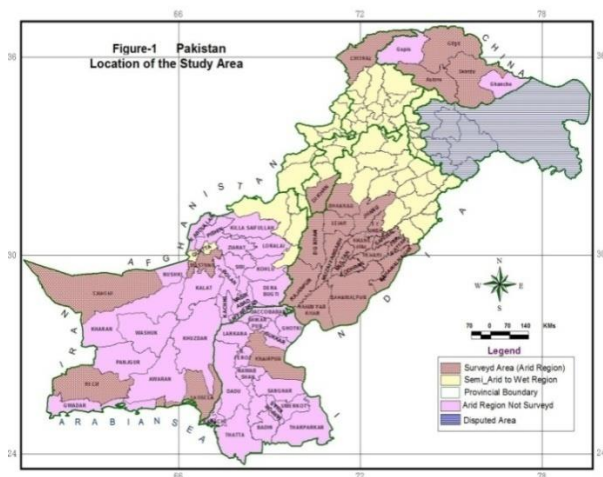


Fig.1 Location map of the study area.

The mean monthly seasonal precipitation and temperature have been marked on weather maps in order to plot isohyets that show the annual and seasonal sharing and fluctuation of precipitation and temperature. The same method has been selected for the preparation of the seasonal weather maps, charts and graphs. The annual and seasonal maps of precipitation and temperature have been compared and contrasted with each other in order to examine the regular shift and change in the annual and seasonal isohyets and to formulate suitable adaptation to the ongoing climate change in respect to surface water, agriculture, forestry, and coastal management. The adaptation strategies have been recommended on the basis of people's opinions, literature reviews and needs of the locals.

Results and Discussion

The arid region receives mean annual precipitation of 1.48 inches (37.6mm) and shows a decline of -0.05 inches (-1.27mm) during 1961-2015. Furthermore, during same time period, the area recorded a mean monthly temperature of 22 degree Celsius. The sum of deviation from the mean condition is showing 1.6°C increase in the mean temperature in the dry lands of Pakistan during the last 55 years. This fluctuation in the precipitation and temperature has severe effects on the agriculture, hydrology, flora, sea coast, and the socio-economic development of the arid region and needs adaptation. The key steps in this regard are stated as follows.

Arid Region Climate Change Adaptation

A number of different factors have been observed during the course of work for the climate change adaptation strategies in the arid region of Pakistan. The outmost elements among them are stated as below.

Water Sector

Among other environmental factors, the water sector is most vulnerable to the climate changes in the arid region of Pakistan. Mitigation to the worst consequence of climate change on hydrological sector, therefore, will have to be considered as a part of the wide ranging policy to prevail over the recent and future climate fluctuations. The key mitigation footsteps to the current environmental changes and its outcomes on the surface as well as underground hydrology in the dry lands are discussed as follows.

Water Management

The main element to covenant with the impact of temperature and rainfall fluctuation on drainage and surface hydrology in the arid region of Pakistan is hydro-resources management and construction of fresh hydrological reservoirs. Furthermore, it is required to initiate innovative strategies for the planning and management of the surface as well as underground water assets in the entire area. Some of the key recommendations in this regard are highlighted below.

Water Reservoirs

To cope with the dearth of surface as well as underground water resources, as a consequence of weather and climate fluctuation, it is required to establish new hydro-reservoirs and to prevail over the deficiency of hydro-reserves in the dry lands of the country. For evergreen Balochistan, it is required to channelize the Indus over flow from a newly constructed water reservoir at Rajanpur/Dera Ghazi Khan districts. This will not only help out in the provision of irrigation water for agriculture purpose in Balochistan but will also decrease the flow pressure in the tributaries of Indus River. The plan implementation will be possible by the construction of tunnel for a link or divert canal in the Suleman-Khirthar mountains and

by dropping the extra flow into any dry torrent of Balochistan or to log it in any nearby valley. The plan will not only lend a hand to change the barren Baluchistan into an agricultural land but will also raise the country's economy and the water table. Furthermore, this divert canal will protect the inhabited areas of Sindh and southern Punjab from summer floods and facilitate the government to log the summer overflow in different valleys of Balochistan and to utilize it properly.

Overflow Reservoirs

In Pakistan, each year, the seasonal floods in Indus River and its tributaries causes wreckage to the country's economy by means of damages to land masses, agriculture land and production, residential areas, transportation, communication, health units, government buildings, bridges and fauna. But there is no strategy to construct the linked canals and to log the seasonal flow in the inland dry areas of the country. The government should plan for the construction of bypass water dams on the Indus River and its tributaries which comprises Jhelum, Chenab, and Ravi rivers. The overall objectives of these bypass reservoirs comprise the logging of the seasonal overflow during monsoon or wet season and to add it into the normal flow during the dry seasons for the sustainable irrigation system in southern Punjab, Sindh and Baluchistan provinces. These bypass reservoirs will not only help to lessen the flood or overflow damage each year in the country but will also provide a base for the storage of extra flow and to consume it for the sustainable cultivation in the entire arid region of Pakistan. The well-known sites for the purpose of seasonal reservoirs are Kalabagh, Attock district, Chakwal district, Bhakkar district, central and southeastern Punjab, western and eastern Sindh, and Balochistan. The government of Pakistan is required to invest in this sector massively and to overcome the issue of seasonal flood disaster in southern Punjab and Sindh province.

Construction of Small Dams

Generally, the building of dams is the second option that can contribute to the water storage capacity of the country. The specific efforts for the edifice of small dams materialize to be crucial to alleviate the undesirable effects of the climate change in the dry lands of the country, more than ever, on the dry streams of Balochistan and Indus water system.

Valley dams/Lakes

Numerous dry seasonal channels and torrents are situated in the catchment areas (mountainous areas) of Indus and its tributaries in Balochistan, Gilgit-Baltistan, and Malakand division. Most of the seasonal streams and channels in the mountainous north of Pakistan are fit for the water dams (valleys seasonal traditional dams). These inland valley dams cater water nationwide, fulfill the cultivation requirements of the

locals, help out in maintaining watertable and improve energy resources particularly electric power. In case of heavy precipitation, these valley check dams will help out to log the seasonal flow in the catchment areas of the rivers and during dry months, the log water will be added to the main river to overcome the shortage of irrigation water in the southern latitudes of the country.

Ponds/Khushkaba/Trai/Gabarbunds

Ponds can also be used to log the rainy water from nearby rural areas to the plain areas of Punjab and Sindh provinces. The ponds are required to hollow out land in the surrounding of settlements in the rainfed or agriculture land and to log the rain water in it. Besides this, the historical waterlogging methods (of Indus Valley Civilization) of Khushkabad, Trai and Gabar Bunds system for the storage of rain water in streams and valleys are more suitable for the irrigation systems and help increase the agriculture production in the arid region. It will also be applicable in areas located far from rivers and in areas of deeper watertable especially southern Punjab, southeastern Sindh and Balochistan provinces.

River Embankments

During heavy flow, the land along the sides of the main rivers is not capable to handle the stress of water pressure particularly during summer monsoon. Nearly all of the drainage sites are rendering to the process of abrasion, attrition, and corrosion. These harmful processes not only cause severe destruction to human resources during flood season but also broaden the river's base and damage the major parts of the agriculture area and switching it into swamp and marshy lands. Apparently, it is important to fabricate the river banks (embankments) as well as to restrain the river beds up to the volume of river flow. The most obvious existing example of such a strategy is the building of Ghazi Barotha bypass canal for the control of Indus River flow and historically, the Lothal docks (Fig. 2) during Indus Valley Civilization. The cemented banks and beds of rivers and canals will save the agricultural fields from seepage and help us in using water resources properly. This will also provide a base for the proper use of billion acres of agricultural land under the influence of waterlogging on both sides of Indus River and its tributaries. Therefore, the construction of cemented embankments is proposed for the rivers and canals in plane and mountainous areas of Pakistan.

Public Awareness

Escalation of stakeholder consciousness through glowing systematized campaigns, education, mass media, research and development, and economics etc should be a precondition to any retort in the arid region. This will make a national, regional, local dialogue and debate among planners easy. This will also help the contribution of different effective groups of the humanities including vulnerable communities, land

cultivators and the poor groups, in the formulation and execution of responses and get better approaches of the treatment of water resources in the entire arid area. The natives of the arid region are required to be aware of the climate change with respect to its cultural and economic effects so that they shall understand and act on this matter with more consistent methods. In other words, humans are the basic component that contributes to climate change in the area. They are the ones who shall provide better solutions for adaptation to climate change on local basis. So the involvement of locals for the planning and management of climate change adaptation and issues are of prime importance in this matter. The ignorance of the local's needs and opinions will make the climate change policy incomplete and meaningless.

Water Management Policy

The existing water management policy of Pakistan is very old and outdated and it is required that it must be revised per national needs. Besides, the policy is not going to fulfill the people needs, agricultural requirements, and hazards management, drop off in the water table, need of power reserves, development of national economy and the current climate change scenario. Due to lack of planning, a major part of the surface water flows into the Arabian Sea and can be utilized for the growing economy of Pakistan. This will only be possible, if we revise the water resources policy, extend the irrigation system into the far flung areas of the arid regions and channelize the extra flow into the newly established canals and its distributaries. This will not only help in the share of agricultural produce of the arid lands into the national economy, but during seasonal floods, the deposition of soil in the shape of layer will convert the desert lands into fertile land with the passage of time.

Planning for Water Resources

The recognition of effects and adaptation to the weather and climate fluctuation in the dry lands of the country is indispensable for the water resources usage in the future. The mitigation policy for the future climate change crisis in the arid region of Pakistan should be focused on the water reserves strategies, in which improvement and execution shall be detailed, technologically advanced and farsighted.

The hydro-reserves strategies, expansion and execution in the great Indus basin are economically, technically and communally intricate. The adaptation to the effects of weather and climate fluctuation in the entire arid region would be merely effectual, if these complications will be made appropriately implicit. The water policy and strategies shall be concentrated on the rising demands, values and rejuvenation in the system of hydrological reserves. Besides, the impact of heavy flow, sedimentation, weather and climate signify lofty precedence in favor of further exploration and policy. The climate change inflicted contemplations shall be integrated into ordinary and enduring hydrological

savings strategies and schemes assessment. Keeping in view the significance of Indus drainage system, this will be advisable to extend the range of water resources planning and to tackle the lasting effects of climate and weather changes in coincidence by means of imperative hydrological issues in the dry lands (arid and semi-arid) of Pakistan.

Coastal Management

Keeping in view the existing climate changes in Pakistan, the government is required to formulate following strategies for coastal management adaptation.

- To upsurge coastal management directives in accordance with the narrated laws, ascertain an assimilated coastal zone management system and synchronization mechanism, develop demonstration sites for integrated management, and perk up design standards for ocean mound and harbors.
- To establish the observation sites in coastal areas for the early-warning and response systems regarding ocean currents erosion, deposition, change in the coastal land forms, floods, and cyclones etc.
- To plan mega projects for the purpose to distil the salt, deposited by the Arabian Sea tides at coastal belt, for the domestic use and export on an international level. This will not only enable the government to spawn returns from the sea salt, but also lend a hand in trimming down waterlogging and salinity in the coastal belt and to utilize and supply the purified water for domestic use in the intact coastal region.
- The coastal belt of Pakistan is endowed with an appropriate atmosphere for the airborne irrigation system for the entire arid areas of Balochistan and Sindh provinces. It is therefore required to plan for small scale airborne irrigation system projects for the arid areas of the Balochistan. This will not only boost the crop production but also assist in the recharging of water table in Sindh and Balochistan provinces.
- To establish projects for perfection of the sea beaches for tourism purpose in Balochistan and Sindh provinces. This will help to collect more revenue from tourism sector and will also become an adaptive element for the protection of residential areas at coastal belt in Pakistan from high tides and sea level rise.

Agriculture Sector

Generally, the vulnerability appraisal has shown a substantial reliance on the crops production on the states of climate change and variability. As far as the dry lands of Pakistan are concerned, it comprises of pure desert, seasonal desert, rain-fed, irrigated, and mountains areas. In case of precipitation, deficiency and temperature rise, the irrigated lands will lessen and rain fed lands will swell. Adaptive steps to cope the vulnerability of

agriculture sector to weather and climate fluctuation in the dry lands are as follows.

Adaptation Strategies

Noticeably, the Pakistan regime is necessitated to mull over a numerous policies and actions to overcome the effects of climate change and its adaptation to agriculture sector in the arid region of the country. Some of the key steps in this regard are discussed as follows.

Development of Agricultural Infrastructure

- Pakistan needs to streamline the existing irrigation network and to extend it into new agricultural lands near the available water resources in the country.
- The government is required to establish new water reservoirs and inland dams in the dry lands particularly in Balochistan, Sindh and southern Punjab to overcome the needs of the water resources over there and to promote the agricultural activities in the entire area.
- To be in command of the broadening of medium and lower yield cultivated zones and to make the restitution of disgraced cultivated lands stronger.
- To control the farmlands from division into small units and to promote the farmland's cultivation in the area and to make sure that the agriculture loans are given to the deprived cultivators in the area.

Agriculture Productivity and Crop Choice

For more reliable planning regarding the effects of climate change on the agriculture productivity in the arid lands of the country, the government is required to educate the farmers about the selection of crop choices keeping in view the seasons, soil fertility as well as water availability. Most of the farmers are favored to cultivate the main crops like wheat, cotton, maize and oil crops and they neglect the cultivation of rice, vegetables, soybeans, sugarcane, and potatoes on the irrigated lands of Sindh and southern Punjab. The training programs about the crop choices will educate the farmers for the assortment of suitable crops on irrigated and rain-fed areas in the dry lands and will increase the productivity of each crop on national level.

Investment in Irrigation Infrastructure

- Balochistan province covers about 44 percent of the total area in Pakistan. The government is required to invest massively on the irrigation system of the province, which is more vulnerable to the surface hydrology due to its bad topography, low fertility, immature sandy soil, sand dunes, deep valleys and limited financial resources.
- In Balochistan, most of the cultivators have turned to the use of groundwater (wells, tubewells, Qanat) to preserve the yield which has adversely affected the water table. This adverse change in water-table has been scrutinized during 2000 in Sindh, Balochistan, southern Punjab and Tribal Areas. So, the

establishment of canal network will facilitate to boost the crop yield and help in the recovery of underground water level for domestic use in the entire area.

- The government of Pakistan is required to enhance the canal irrigation system as a substitute of other irrigation sources that depend on groundwater like tube wells, karez (Qanat), and wells etc.
- Keeping in view the ground facts, Pakistan should use more funds for the extension of the seasonal flow (rain and flood) for the extension in the canal network in Balochistan, Sindh, and southern Punjab. The establishment of irrigation system will not only help in declining the desertification processes but will also raise the share of Balochistan in the national economy. For the coastal belt, the government should introduce the airborne precipitation (artificial rain) for the cultivation of farmlands.

Water Saving Technologies

It is necessary to put together treatment plants for waste water in order to produce appropriate water for agriculture in the nearby lands and to educate the farmers regarding the sowing of drought resistant crop varieties.

Basic Technology Needs

The government is required to employ progressive agricultural tools and technologies for the increase in productivity of the agriculture sector. It will also be advantageous to introduce systematic and hi-tech competences for land cultivation, comprising of long-standing weather observation schemes. The further adaptation strategies of basic technological needs in the arid region of Pakistan are;

- It is required to execute joint agricultural technological and terrain recuperation measures for improving the structural areas under cultivation in the entire arid region.
- It is required to rationalize the crop rotation, combined with all-round mechanization, chemicalization, and application of biological methods to combat agricultural pests.
- It is recommended to initiate plan to put off land swamping and waterlogging along canals, major torrents and rivers particularly at the coastal areas.
- It is advised to launch agricultural insurance program in private and government sectors for the stability of cultivators and to enhance and motivate the capability of cultivators towards farm cultivation in the entire area.
- It is necessary to spread awareness among the cultivators regarding the cultivation of drought resistance and high-yielding varieties that need rare water and increase agricultural production.

- It is suggested to bring in hasty-growing, diseased and solar stress opposing crop varieties.
- It is required to take timely measures and employ forecasting systems for deterrence of agriculture nuisances and syndromes distribution in terms of weather states.
- It is appreciated to increase the effectiveness of agricultural water system with the help of water-saving technologies.

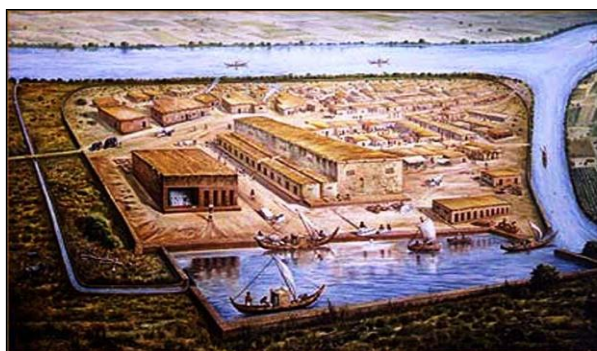


Fig. 2 Dockyard, at Lothal, Indus Valley Civilization, (Kenoyer, 1998).

Agricultural Yield and Management

- Cultivation of water resistant crops like cotton, sorghum, maize, soyabean and sunflower whichever on the ridges or seasonal river beds would be needed as an alternative of level planting to regulate for deficiency in hydro-supplies and for sustainable crop production.
- The exactitude terrain leveling with the help of scientific know-how is a superior choice for the cultivation of rice and to have improved growth and resourceful drainage resources use, in accumulation to control and manage salinization. Obviously, the rise in surface heat will raise the warming degree of waterlogged rice fields and negatively influence the yield and growing duration of rice in the irrigated lands. The terrain leveling and smoothness will lend a hand in efficient flow of hot logged water in dry climate and weather.
- Evidently, in the dry zone of the country there are scarce agriculture water resources, hence underground water is a crucial way of drip irrigation. The underground water, in the target regions is declining with the passage of time. In case of climate change, there shall be an issue in the stability of the water table and will enhance the evapotranspiration. However, decisive irrigation all the way in the shape of well/tube wells/qanat will be more appropriate to enhance the agricultural yield in the Sindh, southern Punjab, and Baluchistan provinces.

Expansion in Irrigation System

The exterior water provisions from the contiguous catchments shall manage for distraction to cultivated lands, if the river flows are permanent. In case, the river flows are seasonal (non-perennial), the overspill shall be logged in dams and reservoirs and afterward normalized to supply water for agriculture during dry seasons or shortage. There is an immense potential of logging overflow sites within or outside the Indus basin in lower Punjab, nearby dry torrents of Baluchistan, and Sindh, which will also diminish the flood disaster in the area. The procedure of waterlogging used by the Indus valley Civilization (2600 to 1900BC) in dockyard Lothal was unique and is presently suitable for the waterlogging of extra flow and power generation in the entire southern latitudes of Pakistan (Fig. 2). The demand in agricultural water needs due to climate and weather fluctuation shall compel the cultivators to initiate the use of mediocre water in delicate atmospheres in the arid region of the country.

Flora and Wildlife

The adaptive strategies and steps to overcome the problem of forestry and wildlife are summarized as follows.

- To guard forests in the dry lands, Pakistan needs to develop nationwide forests guidelines and regulations. The key aspects of this strategy will be wildlife, water conservation, diseases and insects, desertification, farmland plantation, forests fire, mass media and climate change.
- To initiate an inclusive monitoring system for forests resources, green ecosystem and wildlife.
- To toughen the security of existing flora, reinstate disgraced natural ecosystems gradually, protect dry land forests, expand the total area of forest reserves, and widen bio-corridors among the forest reserves and wildlife.
- To control the forests fires and amalgamate existing forests fires monitoring systems into a reliable monitoring structure for forest conservation in the arid lands.
- The focus should be directed towards forest fire control, forest insects and diseases control, and development of tree species with a soaring resistance to climate stress, disaster, pests, and diseases.
- To focus on biodiversity conservation and restoration, and monitoring technologies for forest resources as well as wildlife.
- To launch National Center of Forests and Wildlife on Federal and provincial levels for the wellbeing of this unique sector.
- To implement the research for the wellbeing of forests and wildlife on a national level.

- To gather taxes from various industries, which are the main sources of Chlorofluorocarbon and Hydro fluorocarbon contributors to atmosphere and to invest it in the forest and wildlife sector massively.
- To revise the flora and wildlife policy both at the federal and provincial level through contribution of multi-stakeholders for the reforestation in the deforested areas and arid region.
- To make the locals aware about the effects of clearing fauna on the environment using mass media and community participation. Besides this, public-private partnerships should be encouraged for advanced forest and wildlife management policies in the entire arid region of the country.

Monitoring and Early Warning System

Owing to the rise in the extreme meteorological events in the southern latitudes, Pakistan has to get better early warning system and monitoring network for vulnerable sectors which comprise of coastal management, agriculture, disasters, water issues and vegetation. The following are some elements that should be handled with effects of climate change.

- To oppose disasters, local governments are required to develop the urban overflow centers and to improve the sewerage system.
- To initiate modern irrigation system and technology for the examining and untimely caution scheme of flow alerts and disasters.
- To get better climate forecasting system and to establish new observatories throughout the arid region of Pakistan.

Public Awareness

- The governmental stakeholders, officials and institutions should be given access to climate change information and efforts should be made to increase public awareness.
- Pakistan is required to use the mass media to broadcast knowledge about climate change using books, newspapers, journals, audio and video aids, documentaries and the cyber media. Government is required to assimilate comprehensions regarding weather and climate change in the education curriculum at university, college and school level.
- The initiation of an inducement fund to encourage public and enterprise involvement, enhance the precision of decision-making procedures, local guidance, and persuade social and private groups to take part in the mitigation to climate change in the dry lands.
- To enhance the international cooperation on people responsiveness, more than ever high-quality

performances on climate change scenario dissemination and education.

Research and Development

- Pakistan is required to launch Dry Land Research and Development program to control the disaster, desertification, soil erosion, water deficiency, crops yield and land use change.
- The research and development fund should be run through specialists and experts of climate change and desertification.
- The government has to encourage systematic research and development to explore the consequences of environmental change on the economic growth, benefits as well as costs in reaction to climate change, drought and desertification.
- The central, provincial and local administrations have to set up efficient inducement and contest methods and a positive scholarly atmosphere for researchers, fosters, academic specialists and distinguished candidates with international exposure and the capability to lead climate change studies, and give confidence to fresh research.
- To employ polygonal support from overseas and international organizations to help out research and development on environmental alteration science and technology in the dry lands of Pakistan.

Drought and Desertification

- To be conscious of the severe wear and tear of the natural resources around the dry zone and of the requirements to locate techniques of humanizing the life standards of the people.
- To activate and develop hydro-resources in the arid areas and to find out new locales and irrigation sources for the agriculture, and livestock.
- To build up agriculture connected with hydrological works that will present massive socio-economic benefits such as jobs, income level, and economic advantages.
- To manage the major alter in the usage of the dry lands, resulted by the surface flow deficiency and human pressure.
- To create emergency response strategies to secure the humans and fauna during drought condition.
- To construct seasonal ponds to store rain flow throughout wet period and to utilize it for the domestic and irrigation purposes during dry months.
- To cultivate drought resistant crops and flora in the entire arid region particularly in Baluchistan and to overcome the process of desertification.

- To prepare and apply comprehensive land reclamation strategies and advance technologies.
- To increase plantation and irrigated forests, particularly the wattles trees, around the dry lands to combat drought and desertification processes.

Overgrazing

Due to hasty growth of farm animals as well as human population of the Pakistan, the land under grazing has been severely overgrazed. Resultantly, the grazing land has shriveled and that which remains is being used for a larger number of livestock grazing. The grazing and fodder crops are decreasing with the increase in livestock population in Baluchistan, Sindh and Punjab which has exposed the surfaces to reflection, deflection and scattering of the solar radiation and requires re-plantation. The overgrazing has reduced the vegetation cover resulting in accelerated soil erosion, deforestation and chronic overgrazing. Therefore, much of the arid region of the country is assuming the appearance of a lunar landscape or badlands. To avoid overgrazing, the number of livestock to be fed in a certain area shall be kept within the carrying capacity of the grassland. In order to prevent animals from overgrazing, the livestock shall be confined to parts of the fields for specific time duration on seasonal basis.

Conclusion

The surface and underground hydrology is vulnerable to the effects of weather and climate change in the dry as well as rain fed lands. These effects shall be decreased by means of establishment of hydrological reservoirs and inland ponds, upgrade of water supply system, policy creation for water reserves and exploitation of the over flow, revision of hydro-managing planning, and establishment of research and development funds. To make Balochistan evergreen, it is recommended to log the overflow of Indus River at any district of southern Punjab and to divert it into any seasonal river/valley of Balochistan by making a tunnel in the Suleman-Khairthar Mountains. The coastal management regulations, coordination mechanisms, improved design standards for sea embankments and ports, fisheries, mangroves forests at Indus delta are the need of time and the government is required to invest in this sector massively. The agriculture sector requires development in irrigation infrastructure, and water saving technologies. The major steps for the forest sector are national level policy, water and soil conservation, control of diseases and pests, desertification, farmland plantation, and forest fire prevention. The improvement is required in the techniques used for the early warning system and monitoring of weather, natural disasters, agriculture etc. The government of Pakistan is required to create awareness among the locals using mass media and to educate the cultivators. There is a need to

acknowledge research organizations and to use international finance with proper strategic planning. Furthermore, it is required to establish drought control system, emergency response teams, availability of food and drinking water to the locals, recharging of the water table, monitoring system, education of the locals through training programs, creating awareness about crop choices, protection of livestock, control on overgrazing, soil degradation, reforestation, and land use change. The government of Pakistan is needed to revise the climate change policies and to include it in the curriculum at school, college and university levels.

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