CLIMATE CHANGE PERSPECTIVE IN PAKISTAN

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Abstract:

The objective of the study is to assess the past climate changes and compute the projected changes in different Agro-climatic regions of country for next half century using Regional and Global Climate models. In view of these changes, vulnerabilities of different regions may be accessed and suitable coping mechanisms/ adaptation strategies be proposed.

Analysis of past depicts that our climate is changing. The rate of change and the nature of the resulting impacts will vary over time and across the country, affecting all aspects of our life. In conjunction with efforts to reduce greenhouse gas emissions, it will also be necessary to adapt to the impacts of a changing climate. Understanding what climate change will mean for Pakistan is only one step in that process.

Future changes in climate of the magnitude projected by most global climate models would cause a major impact on our water resources, and subsequently affect food supply, health, industry, transportation and ecosystem sustainability. Problems are most likely to arise to southern parts of country where the resource is already under stress, because that stress would be exacerbated by changes in supply or demand associated with climate change.

Previous record and projections by GCMs and RCMs depicts that extreme events (drought and flooding) would become more frequent and of greater magnitude in different parts of the country. These extreme events would place stress on existing infrastructure and institutions, with potentially major economic, social and environmental consequences. Therefore, particular emphasis needs to be placed on the impacts/mitigation of such extremes.

Introduction:

The earth's climate has been evolving continuously over millennia but the last two centuries have witnessed the development of the greenhouse problem, which threatens to change climate in an unprecedented manner.

Patterns of solar variability, the effects of the El Niño-Southern Oscillation (ENSO), changes in the atmosphere (as revealed by isotopic studies of ice cores), variability in the extent and volume of land and sea ice, and natural variability of the biosphere

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illustrate both the variety of internal and external sources of variation and the range of responses caused by different earth system components.

Over the last century, an average annual increase in surface air temperature of about 2.9°C has been observed in boreal Asia. Nations in Asiatic region are especially concerned about the buildup of greenhouse gases in the atmosphere because of the potential effect on the region from climate change related shifts in patterns of storms, floods and droughts as well as a rise in sea level. Asiatic region has been historically vulnerable to fluctuations in the monsoons, the El Nino Southern Oscillations and tropical cyclones.

The Country Profile:

The country has a long latitudinal extent stretching from the Arabian Sea in the south to the Himalayan Mountains in north. It is located in sub-tropics and partially in temperate region. These are the home of about 180 Million people and probably a larger portion of those is most vulnerable to climate change. Large numbers of residents live in low coastal areas or river deltas where sea level rise and flooding are the likeliest devastating consequences of rises in global temperatures as the climate shifts.

Climatologically, most parts of Pakistan are arid to semi-arid with significant spatial and temporal variability in climatic parameters. 59% of the annual rainfall is due to monsoon rains; a dominant hydro-meteorological re-source for Pakistan

Greater Himalayan region above 35°N receives winter precipitation mostly in the form of snow and ice. The snow melt contribution keeps the rivers perennial throughout the year.

The coastal climate is confined to a narrow strip along the coast in the south and southeast,

The north is dominated by the mountain climate ranging from humid to arid.

In between, the climate is broadly of tropical continental nature

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Data and Methodology

Climatic data for the last 50 years (1951-2000) was analyzed for computing past climate changes. Graphs were drawn for the mean annual and seasonal rainfall,

maximum, minimum and mean temperature values for 60 stations in different agroclimates of the country

Temperature data (Mean & seasonal temperature both monsoon and winter periods) were analysed.

Precipitation data (Annual and seasonal totals) were analysed

Then trend lines were drawn and changes were worked out from the fitted curves. Contour lines were drawn on country maps and regions of positive and negative changes were marked.

GCMs Climate Scenario generator MAGIC and Regional Climate Model RegCM2 were used for projected rainfall and temperature data based on 1961-1990 data.

Analysis of Results & Conclusions:

Climate change is a primarily influenced by the total stock of GHGs in the atmosphere and not by annual GHG emissions. Historically, developed countries and economies in transition have been responsible for about 75% of the total global stock of GHGs. In terms of annual contributions too, the level of emissions across different countries shows considerable variations in terms of absolute amounts and per capita emissions. Pakistan is highly vulnerable to climate change as its economy is heavily reliant on climate-sensitive sectors like agriculture and forestry, and its low-lying densely populated deltas are threatened by a potential risk of flooding.

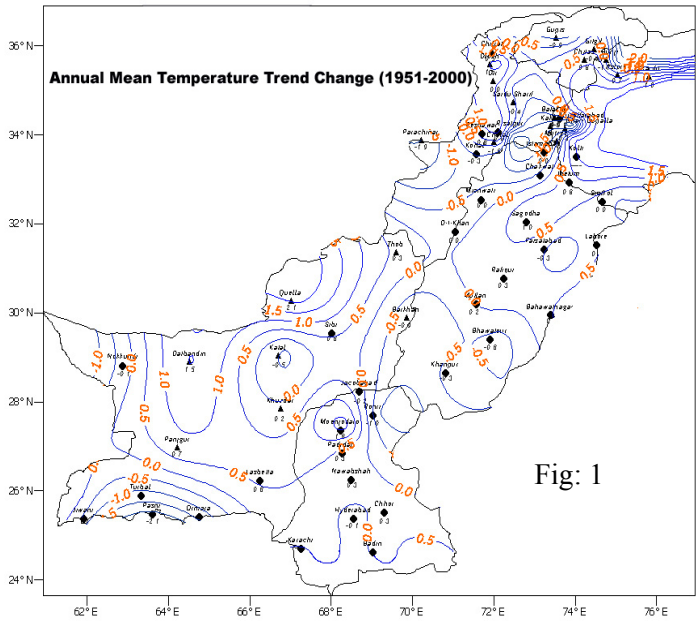


Fig: 1

In Pakistan, annual mean surface temperature has a consistent rising trend since the beginning of 20th century. Rise in mean temp. of 0.6-1.0°C in arid coastal areas, arid mountains and hyper arid plains, 10-15% decrease in both winter and summer rainfall in coastal belt and hyper arid plains, 18-32% increase in rainfall in monsoon zone especially the sub-

humid and humid areas is observed. There is 5% decrease in relative humidity in Balochistan, 0.5 to 0.7% Increase in solar radiation over southern half of country.

Table 1: Temperature Change during 1951 - 2000

S.No	**Region**	**Trend during last century**	**Range (°C)**
a	Over the Thermal Low Region	(Increased)	0.2 to 1.0°C
b	Coastal Areas (Balochistan)	(Decreased)	- 0.5 to -1.5°C
c	Monsoon belt	(Generally decreased)	- 2.0 to 0.0°C
d	Northern Mountains (Greater Himalayas)	(Generally increased)	-1.5 to 1.5°C
e	Thar region	(Increased)	0.3 to 1.0°c
f	Sindh Coast	(Generally Increased)	0.0 to 0.5°c

There is 3-5% decrease in cloud cover in central Pakistan with increase in sunshine hours, 3 5% increases in ETo due to 0.9°C temperature increase. 5% Increase in net irrigation water requirement with no change in rainfall. Expanding aridity in Northern parts outside monsoon range and arid regions. During last 100 years, 7 strong, 10 moderate and 7 weak EL-Nino events. 17-64% departure of rainfall from normal during strong events.

Table 2: Precipitation Changes during 1951-2000

Region	Annual Basis	During Monsoon	During Winter
Coastal areas	Negative	Negative	Positive
Quetta region & SE Sindh	Positive	Positive	Positive
Western Balochistan around Nokkundi	Negative	Negative	Negative
Monsoon belt	positive	positive	Mostly positive
Northern Mountains	positive	positive	Negative

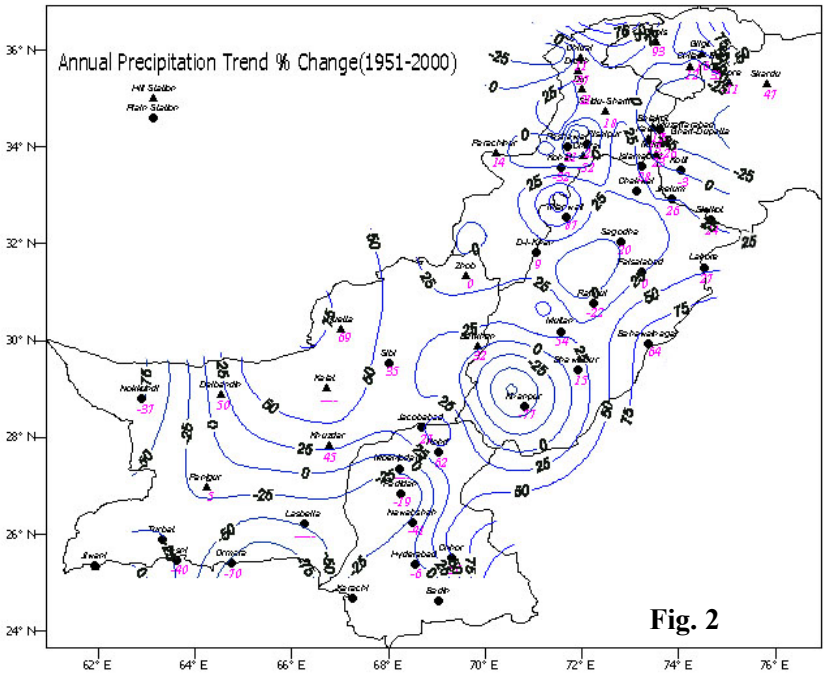


Fig. 2

Tropical cyclones are also an important feature of the weather and climate in various parts of Tropical Asia. The core area of cyclogenesis exists in the northern Indian Ocean, which particularly affects Bangladesh, India, Pakistan and Sri Lanka. Frequency of depressions and Cyclones has increased over Bay of Bengal and the Arabian Sea during last 50 years. Moreover the intensity of systems also increased during last quarter of the 20th century.

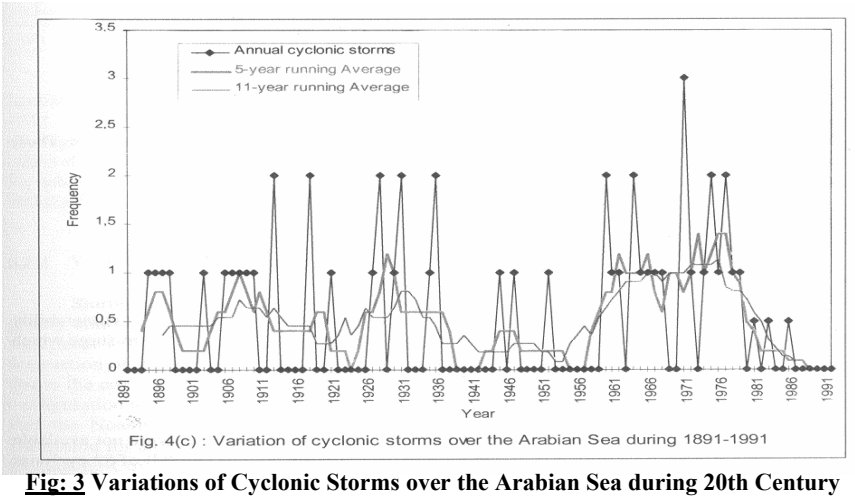


Fig: 3 Variations of Cyclonic Storms over the Arabian Sea during 20th Century

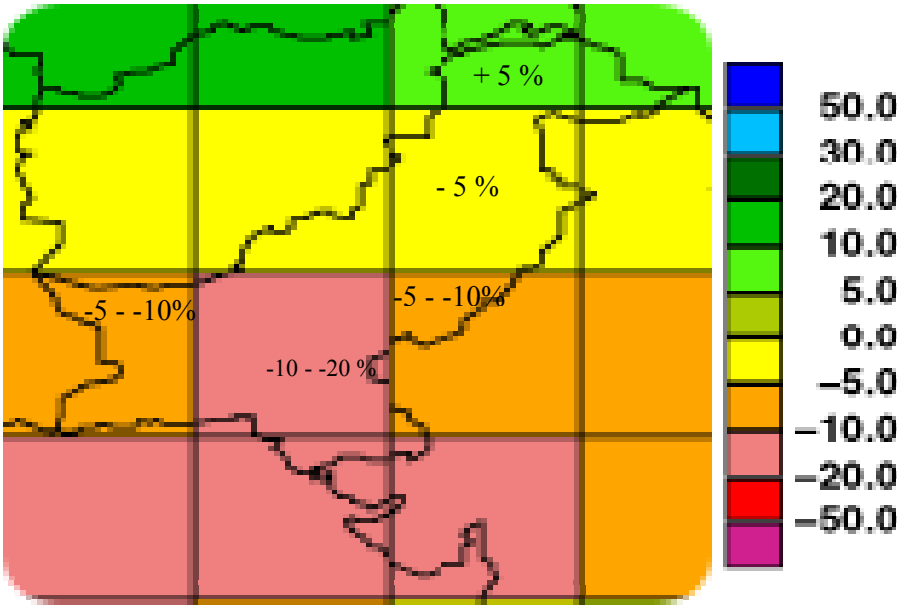
Other extreme events include low-temperature winds, such as those that blow from the North West into the southern plains of country during January. In the mega-cities and large urban areas, high temperatures and heat waves also occur. These phenomena are exacerbated by the urban heat-island effect and air pollution.

Geographically much more extensive is the El Niño-Southern Oscillation (ENSO) phenomenon, which has an especially important influence on the weather and inter-annual variability of climate. The strength of such connections for Pakistan has been demonstrated in several studies. El Nino phenomena suppress monsoon rainfall activity over Pakistan (Chaudhry 1995). La Nina phenomena has a negative impact on winter precipitation over Pakistan (Azmat 2002). Recent history's worst drought (1998-2001) over Pakistan and most of South Asia is linked with La Nina phenomena (Hoerling, M., and A. Kumar. 2003)

Projected Changes in Precipitation and Temperature:

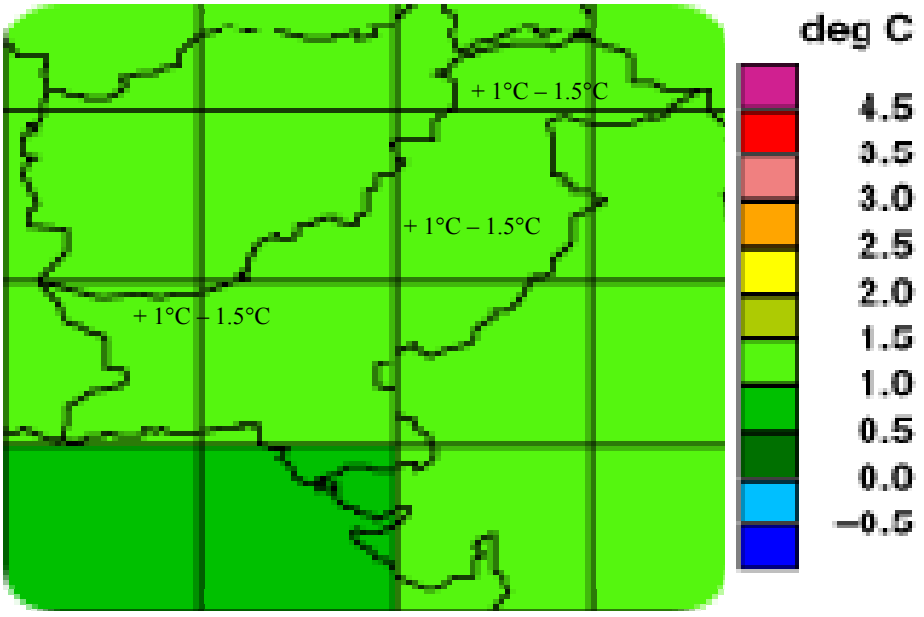
SCHENGEN model was used for generating climate change scenarios during next half of 21st century based on 1931-90 data. Results indicate a progressive change in temperature during the period. However changes in rainfall pattern may not be uniform and south-western coastline and western Balochistan may experience low rains.

Fig 4. Projected Precipitation Changes on Annual Basis using GCMs Output



Results indicate that during monsoon, temperature change over seasonal low is relatively slow compared to other arid and hyper arid region due to windy conditions.

Fig: 5 Projected Temperature Changes on Annual Basis using GCMs Output



RCMs Projections:

The RCMs analysis depicts a bit different results in relation to precipitation. Southeast Sindh and Cholistan depict a positive change during next half century. However temperature trend is nearly same.

Potential Impacts of Climate Change:

Climate change represents an additional stress over already resource stressed country. Projected climate changes in the region include strengthening of monsoon circulation, increase in surface temperature, and increases in the magnitude and frequency of extreme rainfall events. Climate-related effects also will include sea-level rise. These changes could result in major impacts on the country's ecosystems and biodiversity; hydrology and water resources; agriculture, forestry, and fisheries; mountains and coastal lands; and human settlements and human health.

Forestry & Marine life: The effects on mangrove forests are at start. Pakistan, least affected by sea level rise, would face the loss of the mangrove forests which are the source of fuel wood and food to local inhabitants and breeding ground for 90 percent of Pakistan shrimp, its main fisheries export.

Agriculture Climate-sensitive crops—such as rice, other grains and cereals, vegetables, and spices are particularly important. There is little doubt that agricultural systems in Asia have adapted to a range of environmental stresses over the region's long history of human settlement and land-use change. Whether such resilience can continue in the face of climate change and economic and population changes is uncertain, although it is expected that the processes of ongoing adaptation to changing environmental circumstances will continue.

Agricultural productivity is likely to suffer severely due to high temperature, severe drought and flood conditions and soil degradation. As a result, the food security of many countries in the region would be under threat. Aquaculture productivity is al so likely to undergo dramatic changes as a result of temperature changes in water. The rise in the sea level would cause submergence of large tracts of the vast Asian coastline, leading to a recession of flat sandy beaches. The ecology of mangroves and c oral reefs around Asia too is likely to suffer severely.

In a warmer climate, the El Nino-Southern Oscillation (ENSO) events become stronger and more frequent. Therefore, their impact on the Asian monsoon could lead to high inter-annual variation in rainfall characteristics.

Tropical cyclones could become more intense. When combined with the sea level rise, this would result in an enhanced risk of loss of life and property in the coastal low-lying areas in cyclone-prone like Southeast Sindh. Warmer and wetter conditions would increase the potential for a higher incidence of heat-related and infectious vector-borne diseases such as malaria and dengue. Climate change would also exacerbate the threat to biodiversity due to changes in land use and land cover and population pressure.

Water Sector: Water and agricultural sectors are likely to be the most sensitive to climate change. Fresh water availability is expected to be highly vulnerable to the anticipated climate change. While the frequency and severity of floods would eventually increase in river deltas. The arid and semi-arid regions could experience severe water stress.

Diminishing flows in Indus Basin:

Glacial melt water is a key source of water for river system in Pakistan. However, along the eastern slopes of the Himalaya, glacier cover has decreased rapidly in recent years, and total cover is now approaching the lowest experienced in the past 10 000 years. The

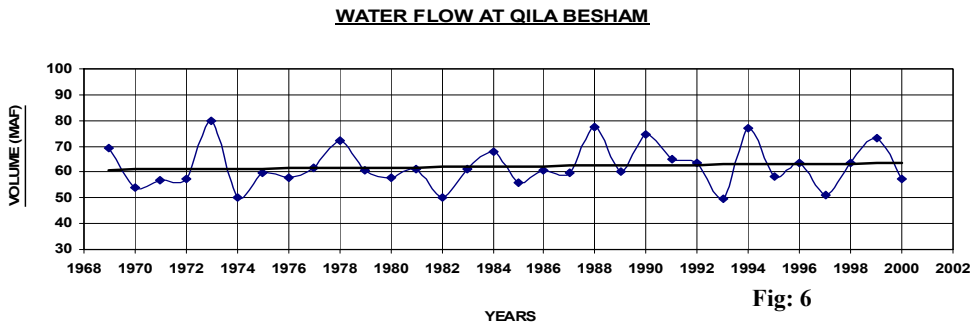


Fig: 6

Gangorti glacier is retreating 98 feet per year. At this rate scientists predict the loss of all central and eastern Himalayan glaciers by 2035.

As the glacial cover has decreased, so have the downstream flow volumes. Analysis of precipitation and inflow data shows a direct relationship indicating that, in dry years inflows are reduced despite the fact that temperatures were higher in upper watersheds.(Fig-3). This finding appears to contradict projections of the Intergovernmental Panel on Climate Change that warmer temperatures will cause glacial

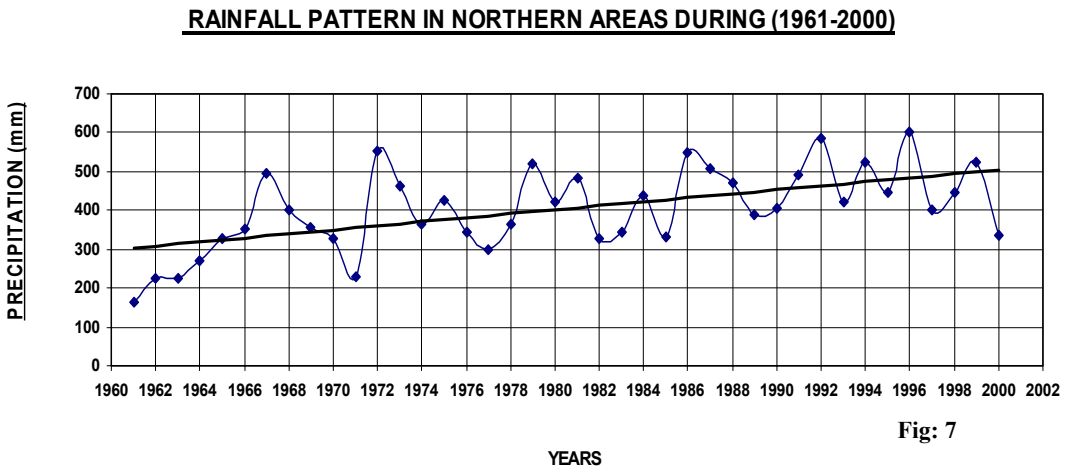


Fig: 7

contributions to downstream flow regimes to increase in the short term. However, historical stream flow data indicates that this increased flow phase has already passed, and that the basins have entered a potentially long-term trend of declining flows. The continuation of this trend would exacerbate water shortages that were already apparent across the country during recent severe drought.

Increased temperature with or without any change in precipitation, over the last few decades is causing glacier melting leading to higher rates of sliding and sediment loads in the upper watershed.

Quality of Fresh Water:

Water quality would suffer from the projected impacts of climate change. Poor water quality effectively diminishes the availability of potable water, and increases the costs associated with rendering water suitable for use. Changes in water quantity and water quality are inextricably linked. Lower water levels tend to lead to higher pollutant concentrations, whereas high flow events and flooding increase turbidity and the flushing of contaminants into the water system.

Warmer air temperatures would result in increased surface-water temperatures, decreased duration of ice cover and, in some cases, lower water levels. These changes

may contribute to decreased concentrations of dissolved oxygen, higher concentrations of nutrients such as phosphorus, and summer taste and odour problems

River flows are expected to become more variable in the future, with more flash floods and lower minimum flows. Both types of hydrological extreme have been shown to negatively affect water quality.

Ecological Impacts:

"Water is also a critical, limiting factor in the existence and distribution of our natural ecosystems. Wetlands, important natural modifiers of water quality, are highly sensitive to climate change. As water flows through a wetland, contaminants such as metals, nutrients and sulphates are often filtered out.

Lower water table levels, however, decrease the assimilative and purification abilities of wetlands. Drier conditions have also been associated with acid pulses (which can cause fish kills) and the formation of highly toxic methyl mercury.

Water Demand:

The consequences of climate change for water resources depend not only on possible changes in the resource base (supply)…but also on changes in the demand, both human and environmental, for that resource.

Future water demand will be affected by many factors, including population growth, wealth and distribution. Globally, it is estimated that between half a billion and almost two billion people are already under high water stress, and this number is expected to increase significantly by 2025, due primarily to population growth and increasing to climate change and improved groundwater monitoring

Recommendations:

The developing countries of Asia like Pakistan, where impacts of climate change are likely to be felt most severely because of resource and infrastructure constraints, need to develop and implement incremental adaptation strategies and policies to exploit no-regret measures and stressing the importance of considering climate change in planning, designing and implementing development activities.

The first is a macro strategy and involves rapid sustainable and equitable development that will increase income levels; education and technical skills; improve public food distribution, disaster preparedness and management and health care systems and reduce vulnerability. The second strategy is a micro strategy and involves the management of sectors most sensitive to the climate change. This means developing new institutions or modifying existing ones to promote adaptation to climate change. It would also involve modifying climate-sensitive infrastructures already planned or implemented or other long-term decisions that are sensitive to climate.

Continued monitoring and analysis of variability and trends in key climatic elements is the need of hour. Weather forecasting systems in the region must be improved and implement reforms on land-use planning. New techniques for confident projection of regional climate change and its variability, including extreme events must be applied. Coordination of climate change adaptation activities among countries in the region may be enhanced and non-governmental organization (NGO), community and the public must be kept aware of developments on risks of climate change and involve them in planning, adaptation, and mitigation strategies.

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