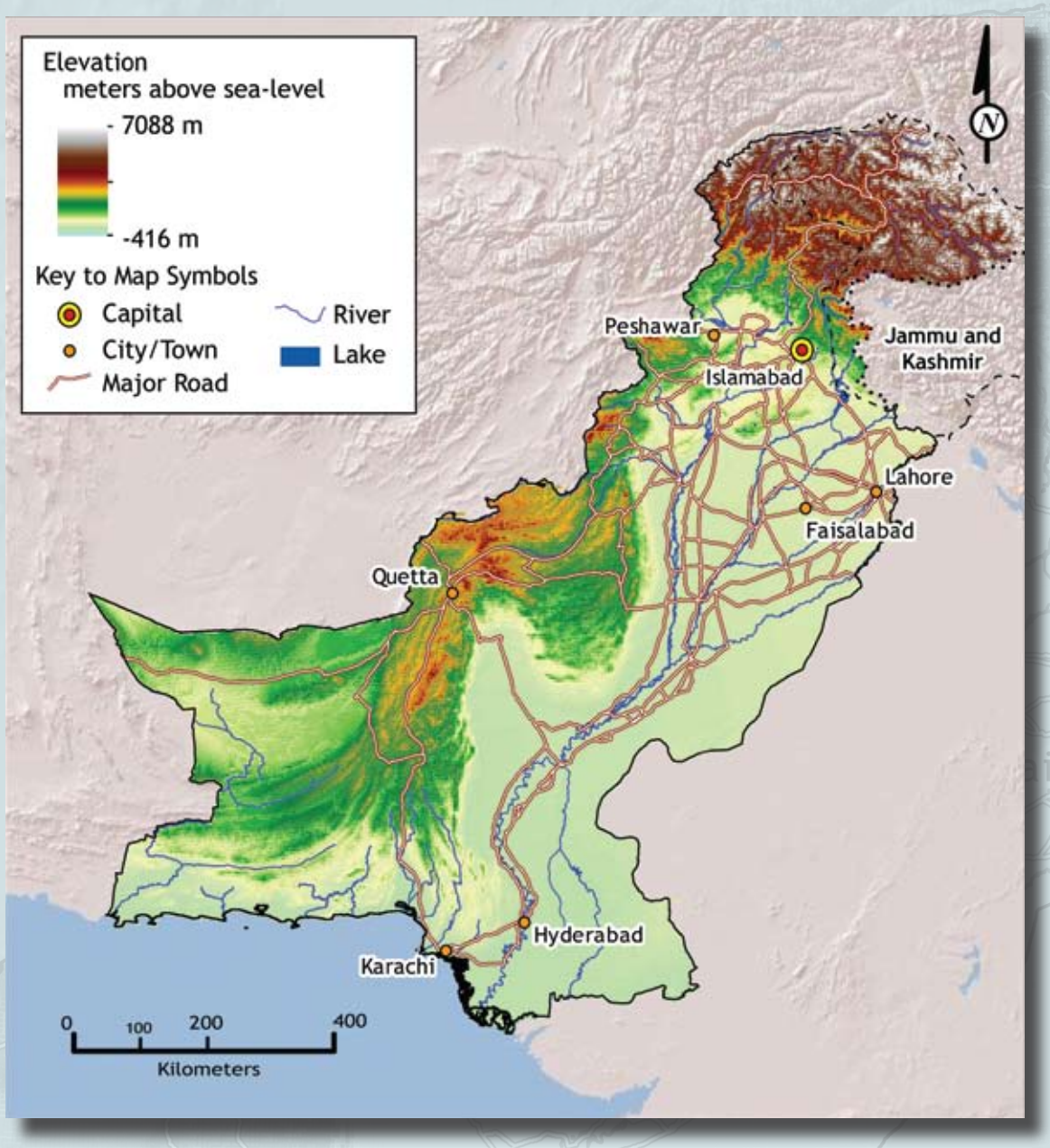


Vulnerability, Risk Reduction, and Adaptation to Climate Change

CLIMATE
DISASTER RISK REDUCTION
ADAPTATION

PAKISTAN

GFDRR
Global Facility for Disaster Reduction and Recovery

Climate Change Team ENV

COUNTRY OVERVIEW

Pakistan is a vast and diverse country occupying over 880,000 square kilometers (km^2) and characterized by a wide range of topography, ecosystems, socio-economics, and climate zones (Figure 1). Rich in natural resources, such as fertile lands, natural gas reserves, and mineral deposits, Pakistan struggles to establish a balance between economic development and environmental protection. A semi-industrialized country, Pakistan has grown from a primarily agricultural-based to a mostly service-based economy. Since 2001, the economy has generally shown slow growth, but 32.6% of the population still lives below the poverty line[1]. The majority of Pakistan's 170 million people live along the Indus River that is prone to severe flooding in July and August[2]. Major earthquakes are also frequent in the mountainous northern and western regions.

Key Sectors
Water Resources
Agriculture and Livestock
Forestry and Biodiversity
Energy
Coastal Zones

Source: Pakistan's Initial National Communications on Climate Change, 2003 and Adaptation Learning Mechanism.

Measures to improve cultivation outputs and resilience to climate variation have long been underway, but a substantial push is still needed as amply demonstrated by the 2010 devastating floods. Priority areas for research and adaptation measures include the water, infrastructure, energy, and agriculture sectors, with particular attention being paid to reducing vulnerability to flooding and improving water management in the Indus Basin.

PRIORITY ADAPTATION MEASURES

Priority Adaptation Projects
Water management and planning for the Indus
Adjusting cropping patterns and type with water availability
Fodder banks/improved feeding to help restore degraded lands
Monitoring coastal zones in order to protect biodiversity

Source: Pakistan's Initial National Communications on Climate Change, 2003

A National Adaptation Programme of Action has yet to be published, but Pakistan's Initial National Communication on Climate Change (2003) identifies many of the country's urgent needs for adaptation action. Further research and possible action have been called for in the sectors of water resources, agriculture, forestry, coastal zones, livestock, biodiversity, energy, and industry.

CLIMATE BASELINE AND CLIMATE FUTURE

CLIMATE BASELINE

Major Climate Processes	Impacts on Climate
Monsoons	*- Drive Summer Rainfall (June-September)*
El Niño	*- Droughts associated (50% of time)*
Sea surface temperatures in the Arabian Sea	*- Regulate temperatures*
Western Depression	*- Regulates winter rainfall*

Source: IPCC 4th Assessment Report and UNDP Climate Profiles.

[1] World Bank (1999) - http://data.worldbank.org/country/pakistan.
[2] Pakistan's Ministry of Economic Affairs and Statistics - http://www.statpak.gov.pk/depts/pco/ (Retrieved 17 January 2010)

Climate baseline summary for Pakistan (since 1960)[3]:

- Mean rainfall in the arid plains of Pakistan and the coastal belt has decreased by 10-15%.
- Over the same period mean rainfall in Northern Pakistan has increased.
- The number of hot days[4] has increased by 20 days.
- The number of hot nights has increased by 23 days.
- The number of cold nights[5] has decreased by 9.7 days.
- The number of heavy rainfall events[6] has increased, and the nine heaviest rains recorded in 24 hours were recorded in 2010.

Recent Climate Trends

Pakistan lies in a temperate zone and its climate is as varied as the country's topography—generally dry and hot near the coast and along the lowland plans of the Indus River, and becoming progressively cooler in the northern uplands and Himalayas. Four seasons are recognized: 1) a cool, dry winter from December to February; 2) a hot, dry spring from March through May; 3) the summer rainy season, also known as the southwest monsoon period, occurring from June to September; and 4) the retreating monsoons from October to November.

A majority of the country receives very little rainfall, with the exception of the Northern regions, where monsoons can bring upwards of 200 millimeters (mm) a month from July to September. Inter-annual rainfall values vary significantly, often leading to successive patterns of floods and drought. Droughts are in some cases associated with El Niño events and can cause significant damage to crops and livelihoods, as in the consecutive droughts of 1999 and 2000, which caused crop failure and mass starvation in Pakistan. The unusually large rainfall from the 2010 monsoon caused the most catastrophic flooding in Pakistan's history, flooding one-fifth of the country. Recent evidence suggests the glaciers in the Indus valley region may be expanding due to increased winter precipitation over the Himalayan region in the last 40 years. In contrast, the reduced rainfall loads on the coast and Indus Delta (10-15% lower in the last 40 years) continue to severely degrade the country's wetland and mangrove ecosystems[7]. This trend, coupled with population growth—200 million additional people are projected over the next 50 years[8]—is likely to place further strain on urban areas already struggling with failing water and sewage infrastructure.

Nine of the 25 heaviest rains ever recorded occurred in Pakistan between July and August of 2010, including 620 mm of rainfall in Islamabad, 280 mm in Risalpur, and 274 mm in Peshawar.

[3] IPCC 4th Assessment Report and UNDP Climate Profiles.
[4,] Defined as the temperature exceeded on 10 percent % of days or nights in current climate of that region and season.
[5] Defined as the temperature below which 10% of days or nights are recorded in current climate of that region or season.
[6] Defined as a daily rainfall total which exceeds the threshold that is exceeded on 5% of rainy days in the current climate of that region or season.
[7] IPCC 4th Assessment Report, Working Group II, Asia Chapter.
[8] UN-DESA-PD (2002).

CLIMATE FUTURE

CLIMATE FUTURE AT A GLANCE

At a Glance			
Temperature	*Warming is more rapid in the south and coastal zones*	▲	1.4- 3.7 °C by 2060
Rainfall	*Projections vary by region and are more certain at the seasonal level.*		
	- dry season rainfall (January to June)	▲	
	- wet season rainfall (July to September)	▼	
Extremes	*Proportion of rainfall falling in heavy events.*	▲	
	- increase during dry season (January to June)		

Source: UNDP Climate Profiles and World Bank Climate Change Knowledge Portal.

Climate change summary for Pakistan[9]:

- Expected temperature increase in Pakistan as whole is higher than the expected global average increase.
- Projected temperature increase in the north is somewhat higher than in the south of Pakistan.
- Projected temperature increase in winter is more than that in summer.
- As yet, it is not possible to get a clear picture for precipitation change, due to large model uncertainties for the region.
- The yields of both wheat and rice will decrease everywhere except in the Northern Mountainous areas where wheat yields could potentially increase.
- The impact of climate change on Pakistan's water resources is unclear due to the uncertain behavior of the Karakoram glaciers.

CLIMATE CHANGE IMPACTS ON NATURAL HAZARD VULNERABILITY

AT A GLANCE

Pakistan is at risk from several natural disasters, of which the following pose the greatest threat under a changing climate (Figures 1 and 2):

- ***Floods***—Mostly a result of monsoon rains in July through September, Pakistan experiences frequent and severe flooding in the Indus River Basin where millions live on low-lying lands. In July 2010, an unprecedented rainfall inundated approximately one-fifth of the nation's land and affected an estimated 21 million Pakistanis[10]. River flooding is most common along the Indus in the Sindh and Punjab provinces, with significant economic losses affecting the northeastern Punjab, while hill torrents and the potential risk from Glacier Lake Outburst Floods (GLOFs) extend to the Northern Provinces, Khyber Pakhtunkhwa and Baluchistan.

[9] World Bank Climate Change Knowledge Portal.
[10] To put that number in perspective, more people were affected by this 2010 flooding than the 2005 Indian Ocean tsunami, the 2005 Kashmir earthquake, and the 2010 Haiti Earthquake combined.

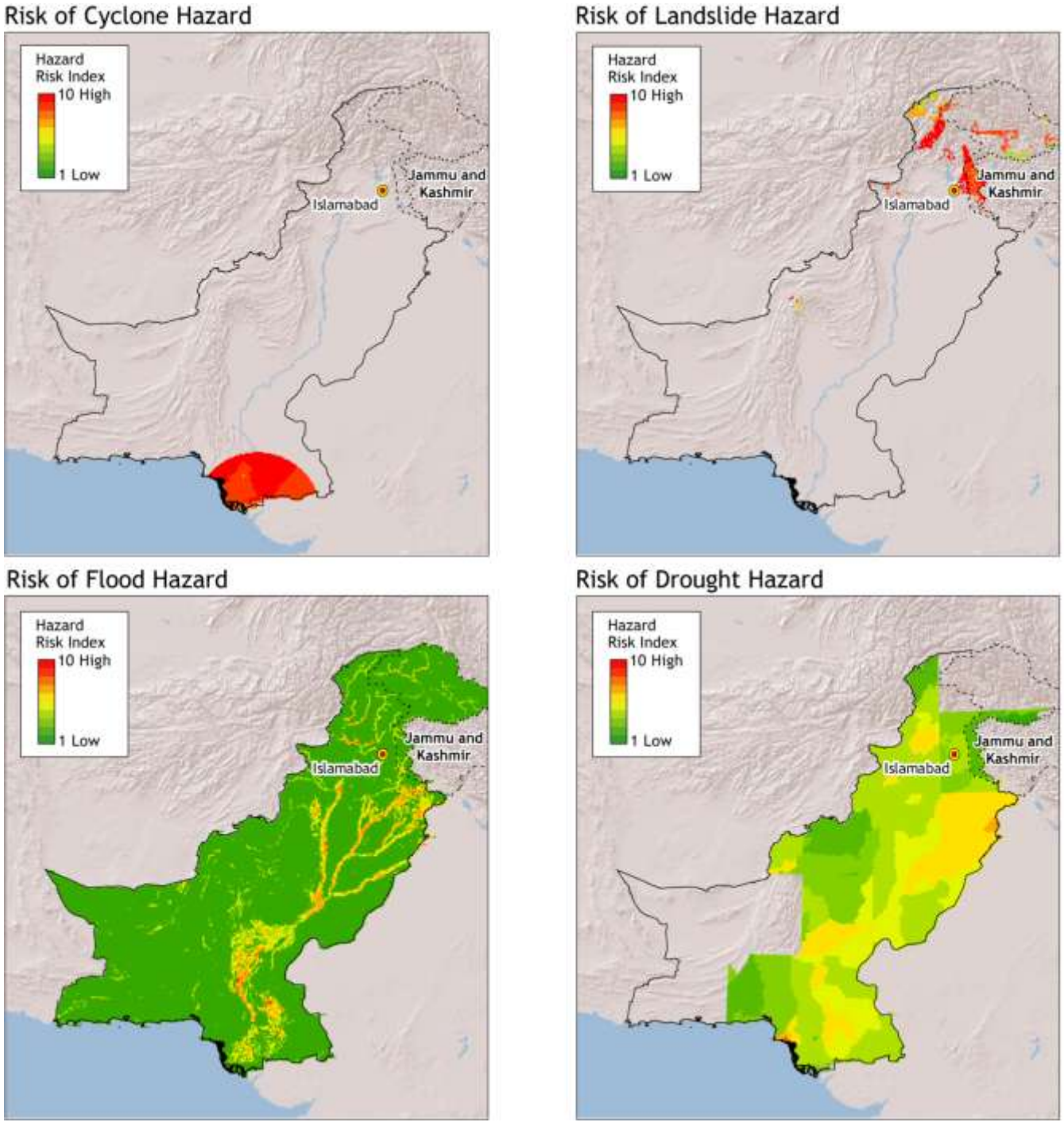


Figure 1: Exposure to climate-related hazards across Pakistan.[11]

[11] UNEP Global Risk Identification Programme (GRIP) www.gripweb.org

- ***Droughts***—In the arid southern and central regions of Pakistan, sparse and often erratic rainfall patterns from February to March can alter reservoir and river levels. From 1999-2002, Pakistan experienced a nationwide drought that revealed the limitation/vulnerabilities of the Indus River Basin irrigation system, as the total flows of water in major rivers declined roughly 34% below the monthly norm. People faced severe water shortages and major crop yields declined 10%[12]. While future precipitation projections remain inconsistent, it is expected that rainfall extremes will become more pronounced, changing the seasonal distribution of rainfall. Coupled with rising temperatures, this is likely to increase evaporation and reduce water availability in drought-prone regions.

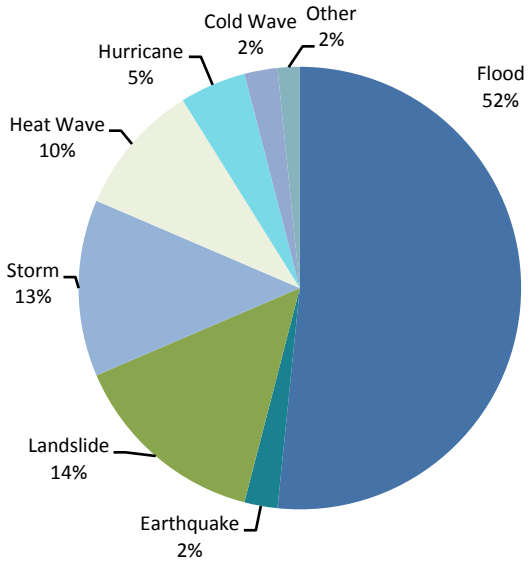


Figure 2: Natural disasters by type

- ***Sea-level rise***—The low-lying coastal regions of Pakistan, including the city of Karachi, are at significant risk from projected sea-level rise. Even under conservative scenarios, projections suggest a 40 centimeter (cm) rise by the end of the 21st century—much of which is set to occur in South Asia.
- ***Cyclones and storm surges***—The lowland plains of Sindh and Baluchistan, which include the urban regions of Karachi and Hyderabad, are vulnerable to the impacts of cyclones. In 2007, storm surges caused by Cyclone Yemyin had significant impacts on lives and property.
- ***Landslides***—The northern regions of Pakistan, particularly those connected to the Azad Jammu Kashmir (AJK) province, are severely affected by frequent landslides, which often limit transportation and evacuation routes.

Implications for Disaster Risk Management (DRM)

- Projected increases in warming are certain, but less certain projected increases in extreme rainfall events can lead to *flooding disasters* such as those experienced in 2010, and monitoring mechanisms need to be implemented to reduce these impacts.
- The low-lying coastal regions of Pakistan, including the city of Karachi, are at significant risk from *projected sea-level rise*, facing up to 40 cm rise by the end of the 21st century even under conservative scenarios.
- Rising temperatures and the increased potential of record-breaking heat waves could place severe *stress on food production* in arid regions, with implications for disaster response.

[12] Drought Mitigation in Pakistan: Current Status and Options for Future Strategies (2004) IWMI. Drought Series. Paper 3. Working Paper 85.

SECTORAL CLIMATE RISK REDUCTION RECOMMENDATIONS

AGRICULTURE

Pakistan is home to a variety of agro-ecological zones, which will require an equal number of adaptation efforts to adjust to a changing climate. Agriculture employs 43.6% of the country's work force[13] and contributes 21% to Gross Domestic Product (GDP)[14], making adaptation in the agricultural sector a high priority. Any shift in climate variations will have a resounding effect in countries heavily dependent on agricultural production. While many farmers in Pakistan have already adjusted to new practices, future weather predictions suggest a growing need for thorough and prudent location-appropriate adaptation that include, for example, changing cropping patterns to decrease growing season length due to increased temperature (Table 1). The five most important crops in the country, wheat, rice, cotton, sugarcane, and maize, are grown predominantly by subsistence farmers (80% of farmers subsist on small landholdings; 81% of all farms are smaller than five hectares; and only 7% of farms are over 10 hectares[15]). Although an estimated 34.7 million hectares of land are fertile, a "staggering 96% of arable land does not contain the full spectrum of organic matter needed for optimum agricultural productivity"[10].

Table 1: Effect of Increase in Temperature on Length of Growing Season of Rice in Semi-Arid Areas of Punjab (Cv. Basmati Super Transplanted in 1st week of July)

Temperature (°C)	Length of Growing Season (Days)
Baseline	108
1	102
2	100
3	98
4	92
5	89

Source: http://cmsdata.iucn.org/downloads/pres_arshad_khan.pdf.

Pakistan's vulnerability to floods and droughts is projected to increase as the frequency and intensity of extreme weather events increases. Floods cause loss of life, inundate fertile land, kill livestock, destroy standing crops, and reduce or eliminate yields. Droughts can be equally devastating to rural livelihoods. From 1999-2002, droughts in the Sindh and Baluchistan provinces killed two million livestock and necessitated emergency relief to provide drinking water and food aid to farming communities. Even minimal changes in precipitation spread over prolonged periods can alter the country's food production by placing greater pressure on the country's extensive irrigation network. As rainfall grows more erratic and temperature increases, agriculture production will be affected and yields reduced if no adaptation actions are put in place (Table 2). The largest and most important sector of Pakistan's economy will be affected by the reduction of cash crop yields, such as cotton. Pakistan is the fifth largest producer of cotton in the world—the industry contributes 10% of the country's GDP and employs approximately 30% of the country's farmers, many of whom are rural women receiving daily wages.[16]

[13] World Bank (2007) - http://data.worldbank.org/indicator/SL.AGR.EMPL.ZS.
[14] World Bank (2009) - http://data.worldbank.org/indicator/NV.AGR.TOTL.ZS.
[15] SCEA/NC.
[16] Pakistan's Initial National Communication on Climate Change (2003).

Table 2: Projected Changes in Rainfed Maize Yields across Pakistan

Crop	Baseline Yield (1961-1990)	Projected Yield	Change %	Period
Rice	1356	1345	-0.81	2020s
Rice	1356	1335	-1.55	2050s
Rice	1356	1318	-2.8	2080s
Maize	3952	3945	-0.18	2020s
Maize	3952	3942	-0.25	2050s
Maize	3952	3978	+0.66	2080s
Maize	1409	1475	+4.68	2080s
Pearl Millet	527	347	-34.16	2020s
Pearl Millet	527	667	+26.57	2050s

Source: World Bank Climate Change Data Portal –Agricultural Model Generated by IIASA.

Coastal Resources

Pakistan's coast extends over 990 km and is home to the biologically diverse and valuable Indus Delta and mangrove forests. The mangrove ecosystems along the coast are already facing severe impacts from increased sediment loads, reduced fresh water inflows, a growing number of invasive species, clear felling of forests, and pollution from human activities. Sea-level rise and delta flooding are already severely impacting the coastal zone, leading to water shortages, declining property values, loss of invaluable archeological sites, and a decline in tourism. Water logging is also a serious concern in many low-lying areas of Sindh. Coastal erosion and monsoon waves are already threatening towns and farms situated along the west Makran coast. Beaches are being eroded away and valuable mangroves lack legal protection. While protective infrastructure, such as port walls in urban areas in Pasni and stone pitching in Gadni have already been built, a comprehensive and geographically explicit vulnerability assessment is necessary in order to develop a coordinated and comprehensive coastal conservation plan. Although intense tropical cyclones are extremely rare in the Arabian Sea and their frequency has been in decline since 1970, the dynamic, and in particular the intensity, of future storms could change significantly with rising sea surface temperatures, resulting in severe damages by large storm surges. A noted increase in small cyclonic activity has brought intense rainfall that already causes severe flooding in low-lying areas.

Energy

The energy sector in Pakistan is hampered by inefficiencies—low plant-load factor, high generation cost, power theft, non-realization of revenues—which cause frequent shortages and erratic supply. Under future climate impacts, Pakistan's energy sector will face increasing pressures from floods, cyclones, and storm surges. The country's National Communication's recommendations include detailed assessments and mapping of energy infrastructure and mechanisms to prevent construction on low-lying coastal areas. Previous efforts to address climate variability have focused on mitigation of greenhouse gas emissions from the energy sector, including the commercialization of wind power, the replacement of vehicle diesel fuel with natural gas, and a push to improve fuel efficiency. The International Finance Corporation (IFC) has supported these initiatives through the creation of an Environmental Opportunities Facility to support the privatization of utility companies and the development of renewable power generation.

Power sector reforms must lead the public enterprises reform program. Inefficient power plants should be offered incentives to improve efficiency. Losses persist at about 20% in transmission and distribution[17].—one percent is over six billion Pakistani Rupees. Power tariffs were not corrected for increased production and distribution costs between 2003 and 2007. Moreover, there is a regressive tariff structure in which organized

[17] 1% corresponds to over 6 billion Pakistani Rupees.

industries pay much higher tariffs than private and farm consumers in contrast with comparable economies. Non-payment of dues, especially by government departments and enterprises, further exacerbates the debt of generating and distributing companies, forcing them to curtail production and postpone modernization.

INFRASTRUCTURE

Floods and landslides pose a significant threat to the country's fragile transportation infrastructure, often limiting aid access in response to disasters. The extensive irrigation and water management infrastructure, which includes levees and dams, is at risk from storm surges, torrential downpours, and Glacial Lake Outburst Flooding (GLOF). The National Communication urges that the construction of new infrastructure must be approved by a flood management agency, and the establishment of major infrastructure near the coastline should be discouraged.

Higher temperatures coupled with erratic rainfall could increase evaporation and reduce fresh water inflows to critical estuaries. Reservoirs will need to be built in the Indus delta to meet the water needs of the riparian forests and wetlands, and to maintain water levels in the delta and mangroves. Pilot projects such as converting irrigation pumping to solar energy, developing solar water heating, and a compact fluorescent lamp (CFL) distribution project have already been launched, and plans are underway to disseminate lessons learned from these activities[18]. Flood protection measures will need to be implemented to deal with future climate impacts.

URBAN AREAS

The urban population of Pakistan is rapidly growing, placing significant pressures on ailing infrastructure and public services. One third of the inhabitants in Karachi live in informal settlements that lack clean drinking water, sanitation, and health services. Pakistan's current water system not only has limited capacity but also inadequate efficiency of its sanitation services. Studies indicate a decline in access to clean drinking water, dropping from 68% in 1989 to 60% in 1997. There is a need to build public awareness on water conservation measures in order to relieve existing pressures. The National Communication calls for a comprehensive review of best practices for urban water systems, followed by the drafting and implementing of new economic and structural policies that address water quality conservation measures.

ADAPTATION

Pakistan has a history of adopting new methods to improve productivity. During the Green Revolution, high-yield cultivars - wheat, rice, maize, and cotton - and chemical fertilizers were widely used. More recently, the cotton fields of central Punjab and Sindh provinces have been slowly replaced by food crops—onions, potatoes, tomatoes, cauliflower, and cabbages—that are grown along ridges to avoid a rising water table and lessen the impacts of a longer dry season[19]. This central valley has been quite responsive, but the country's National Communication highlights a number of other adaptation measures that will still need to be implemented.

A number of international organizations and non-governmental organizations (NGOs) are currently working in Pakistan to increase the resilience of rural communities to disasters. Activities include: "the construction of houses on raised plinths, floating vegetable gardens, cages for fish culture and gabion spurs to deflect flooding, tree planting to stabilize hillsides, improving breeds of goat to raise incomes, vegetable gardening to provide incomes for women, and regeneration of desert vegetation" (IDS working paper - Practical Action). During the recovery from the monsoon rains and flooding in 2008, attention was also paid to 'climate proofing' development. Action by Churches Together International (ACT) helped adaptation to climate change through the promotion of water tolerant seeds and construction of flush latrines. The Asian Development Bank has invested in the Baluchistan

[18] Pakistan's Country Assistance Strategy.
[19] Pakistan's Initial National Communication on Climate Change (2003), page 56.

Rural Development and Drought Mitigation Project aimed at improving "community watershed and rangeland management and water conservation methods such as water harvesting and community irrigation"[20].

Ongoing Efforts—At a Glance

Vulnerability Reduction

- Country Case Study on Climate Change Impacts and Adaptation Assessment
- Asia Least Cost Abatement Strategy (ALGAS)

Vulnerability Reduction

- Food Security Programme (FSP) run by the Government of Pakistan since 2000: this large scale program assists millions suffering from rising wheat prices.
- Rural Access Programme (RAP) funded by ADB/WB/GTZ/WFP: this program supports environmental policy, transportation needs, and infrastructure planning.
- Pakistan Poverty Alleviation Fund (PPAF) has built a Water Management Center that focuses on "safeguarding against vulnerability related to water scarcity and/or water-related disasters"; this includes 24 drought mitigation projects, 750 water-efficient irrigation projects, and 60 micro-hydro electric projects.
- Food Security Information and Early Warning System (FSIEWS/FAO)
- Himalayan Climate and Freshwater Programme: aims to enhance the livelihood of people living within the Indus River Basin.

GFDRR Interventions

- Building capacity to effectively deliver safety nets in post-disaster situations in Pakistan
- Phase 1 of an Activity to Support National Red Cross and Red Crescent Societies
- Results and Lessons in the Rural Housing Reconstruction Response to the 2005 Pakistan earthquake

EXISTING ADAPTATION FRAMEWORK/STRATEGY/POLICY AND INSTITUTIONAL SETUP

Among the existing priorities, the following emerge as strategic actions in the country:

- Revival of the old Hindustan Tibet highway, to ensure year-round mobility and as an alternate route.
- The National Communication proposes the establishment of a permanent group of "fully trained" personnel prepared to manage flood protection structures, including the "sophisticated management of reservoir and barrage releases and canal abstraction." The Flood Protection Agency now has to issue permits for building in new areas.[21] Irrigation management should also include regulation of existing reservoirs for flood control.
- Comprehensive assessment of river flows and water management structures to help identify locations for the installation of small and check dams on the Indus and its tributaries. This would contribute to increase storage capacity particularly in areas where capacity has been reduced due to heavy siltation.
- Reforestation projects to reduce siltation, particularly in the Kunar province and the Kabul River Basin, and appropriate monitoring and enforcement of the moratorium on timber harvesting in the upper reaches of the major tributaries of the Indus River.
- Reinforcing existing capacity for the provision of rapid assistance to those affected by disasters, including floods and earthquakes.

[20] ADB-IDS working paper, page 67.
[21] Pakistan's Initial National Communication.

RESEARCH, DATA, AND INFORMATION GAPS

Pakistan's strong dependance on agriculture makes it particularly vulnerable to the effects of climate change. Moreover, Pakistan does not have adequate monitoring systems for predicting extreme events or changes in weather patterns, thus making the task of developing short-term response or disaster mitigation strategies extremely difficult. Adaptation strategies are likewise difficult to formulate unless detailed vulnerability and impact assessment studies are undertaken. These challenges are outlined below.

RESEARCH, DATA, AND INFORMATION GAPS

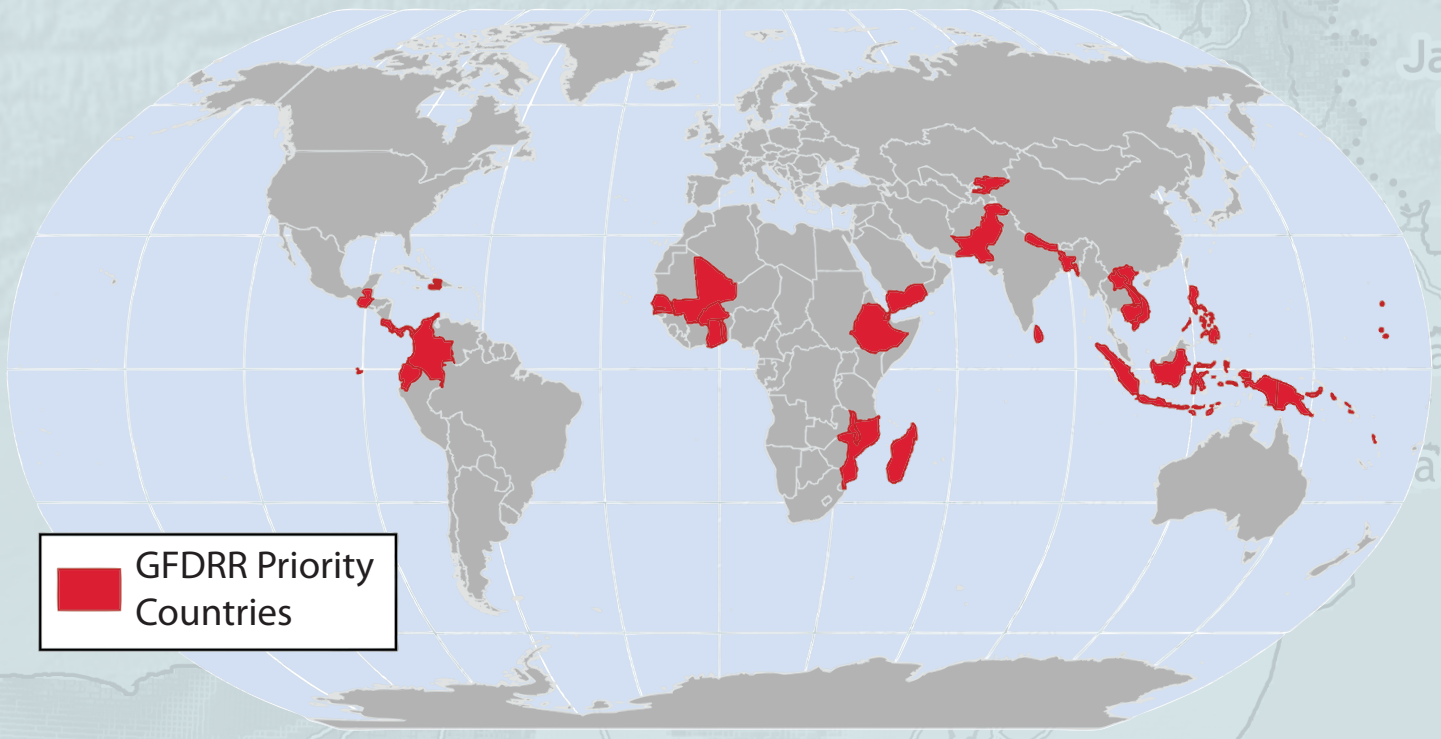
- Adequate mapping and demarcation of flood-prone areas could support a suite of activities for water management, including, but not limited to, community-based contingency planning on management regimes for reservoir and barrage releases. Floodplain management structures should be enforced, and encroachment areas should be relocated in light of projected changes in flood regimes.

- Monitoring climate
  - Although several weather stations are actively collecting weather data across Pakistan, the country's varied topography means that many critical regions are left uncovered.
  - Glaciers—Initial findings suggest the Karakoram glaciers are expanding, but these findings are based on limited measurements of glacier snouts (the point at which they end), and limited studies on glacier mass suggest that a clear loss of mass in the Karakoram glaciers may reduce subsequent water availability and quality. Additional studies and monitoring of the Karakoram glaciers feeding the Indus River are needed to understand how glacier mass will impact future flows.
  - No meteorological stations exist on the Hunza river basin, which severely limits the utility of modeled river flows under a changing climate.

- Use of climate information
  - Downscaled climate information is available in Pakistan from the Global Change Impacts Study Centre for both the PRECIS (UK Met Office), RegCM3, and WRF regional climate models and this information is currently being applied in a national study of future impacts on the agriculture and water sectors. These efforts need to be supported, scaled up, and the information emerging from these studies disseminated in usable form to the development and management community.

- Impact Studies
  - Studies on the impacts of climate change on wheat production suggest yield increases are possible in the Northern regions, with potential opportunities for increasing production in these areas; however, additional feasibility studies are required to support these activities, particularly with regards to water availability.
  - Whilst impact studies are already underway, there is a need to expand these studies to investigate shifting rainfall patterns and the linkages between climate change and shifting land and water management patterns.
  - Development of sea-level rise and storm-surge scenarios and installation of monitoring stations to support potential responses, particularly in the low-lying areas around Karachi and the southwestern coasts of Sindh province.

This Country Profile *(**http://countryadaptationprofiles.gfdrr.org**) is part of a series of 31 priority country briefs developed by the Global Facility for Disaster Reduction and Recovery (GFDRR) as part of its Disaster Risk Management Plans. The profile synthesizes most relevant data and information for Disaster Risk Reduction and Adaptation to Climate Change and is designed as a quick reference source for development practitioners to better integrate climate resilience in development planning and operations. Sources on climate and climate-related information are linked through the country profile's online dashboard, which is periodically updated to reflect the most recent publicly available climate analysis.*



Acknowledgments: The *Country Profiles* were produced through a partnership between the Global Facility for Disaster Reduction and Recovery and the Climate Change Team of the Environment Department of the World Bank, by a joint task team led by Milen Dyoulgerov (TTL), Ana Bucher (co-TTL), and Fernanda Zermoglio. Additional support was provided by Sarah Antos, Michael Swain, Carina Bachofen, Fareeha Iqbal, Iretomiwa Olatunji, Francesca Fusaro, Marilia Magalhaes, Habiba Gitay, and Laura-Susan Shuford. IT, GIS, and map production support was provided by Varuna Somaweera, Katie McWilliams, and Alex Stoicof from the Sustainable Development Network Information Systems Unit (SDNIS). Jim Cantrell provided design. The team is grateful for all comments and suggestions received from the regional and country specialists on disaster risk management and climate change.

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