

Vulnerability, Risk Reduction, and Adaptation to Climate Change

SENEGAL

CLIMATE

DISASTER
RISK
REDUCTION

ADAPTATION



GFDRR
Global Facility for Disaster Reduction and Recovery



COUNTRY OVERVIEW

Senegal borders the Atlantic Ocean on the westernmost point of the African continent. Two distinct seasons characterize Senegal's climate: a dry season from roughly October to May and a rainy season from June to September. While Senegal has enjoyed a strong economic performance and a steady growth over recent years, the population's living standards are still very low. With a gross national income (GNI) of US\$540 per capita, life expectancy hovers at 56 years and the country retains a low, 40% adult literacy rate. In 2006, Senegal ranked 156th of 177 countries in the UN Development Programme's (UNDP) human development index. Poverty in Senegal is most prevalent in rural areas, where roughly 60% of the population resides. The other 40% are found in urban areas, where the majority live in rapidly growing urban suburbs. Low agricultural production, limited capacity of the economy to create sustainable jobs, and inadequate resource allocation for social services contribute to poverty¹.

Senegal is vulnerable to drought, locust invasion, flooding and related health epidemics, sea-level rise, coastal erosion and its corollaries, and bush fire. Priority areas for research and adaptation measures include water infrastructure, coastal zones, and the agriculture sectors, with particular attention to reducing vulnerability to flooding and improving water management in the Senegal River basin.

PRIORITY ADAPTATION MEASURES

Key Sectors

Agriculture
Water Resources
Coastal Zones

Source: Senegal's National Adaptation Programme of Action, 2006.

Senegal produced a National Adaptation Programme of Action (NAPA) in 2006, which details the country's priority adaptation responses. These include: reforestation, restoration of mangrove swamps, biological stabilization of sand dunes, physical protection against beach erosion and saline intrusion (using ditches, barriers, or other protection means), irrigation projects, restoration of soil fertility, water conservation methods, use of alternative crops, and improved education on adaptation.

CLIMATE BASELINE AND CLIMATE FUTURE

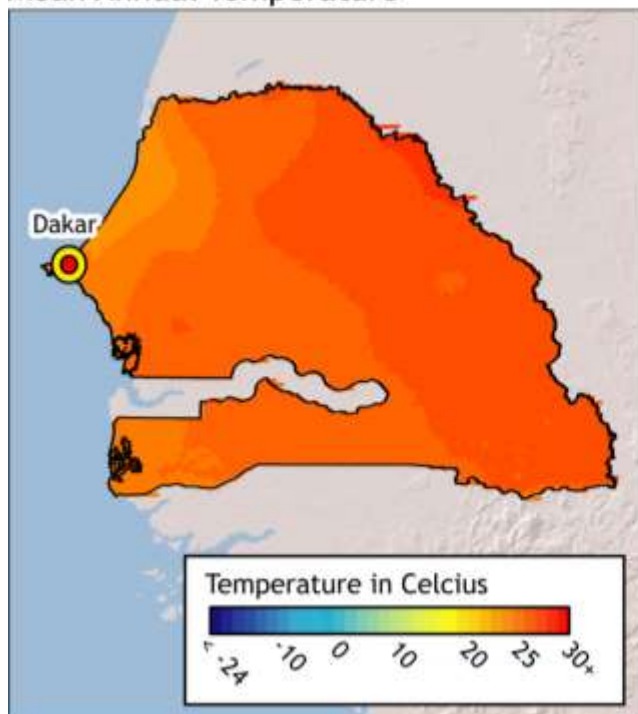
BASELINE

While a majority of Senegal has a tropical climate, the country's northern regions (located in the Sahel) are arid. The country experiences one long rainy season, which varies along a latitudinal gradient (north-south), from June/July to September/October, and is driven by the movement of the Inter-Tropical Convergence Zone (ITCZ). While the arid zones receive a rainfall under 300 millimeters (mm) per year, the forested south receives an average of 1200 mm/year². Rainfall is highly variable both on the inter-annual and inter-decadal timescales. The average annual temperature for Senegal was 27.8°C for the period 1960-1990, with monthly averages in the hottest seasons of up to 35°C.

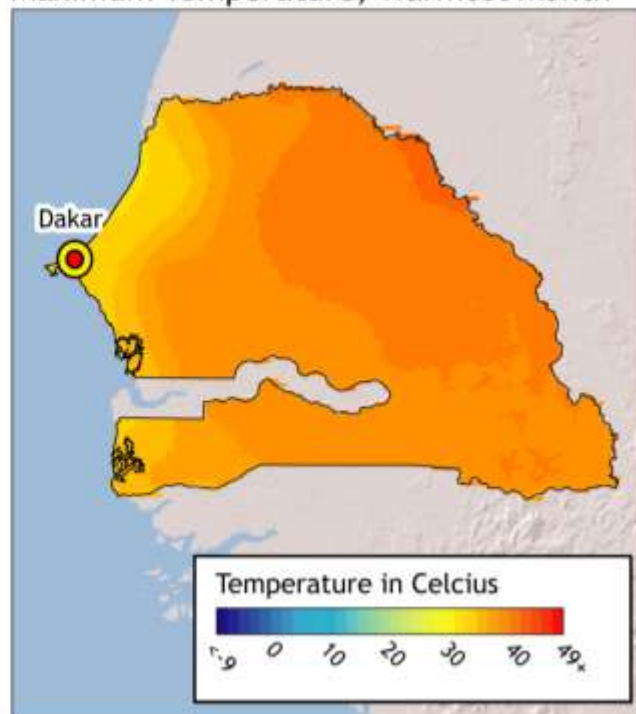
¹ IFAD. Rural Poverty Country Profiles. Senegal. Accessible at: <http://www.ruralpovertyportal.org/web/guest/country/home/tags/senegal>.

² MOE (2006). Programme d'Action National pour l'Adaptation aux Changements Climatiques au Sénégal.

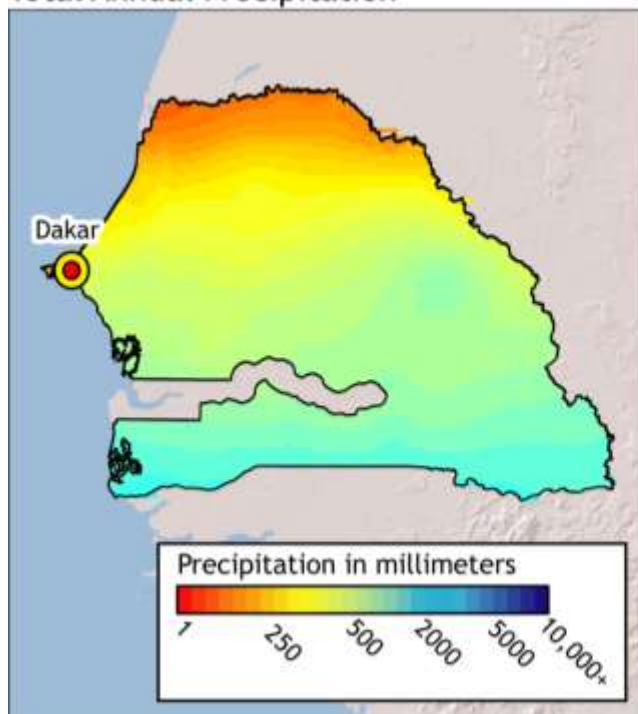
Mean Annual Temperature



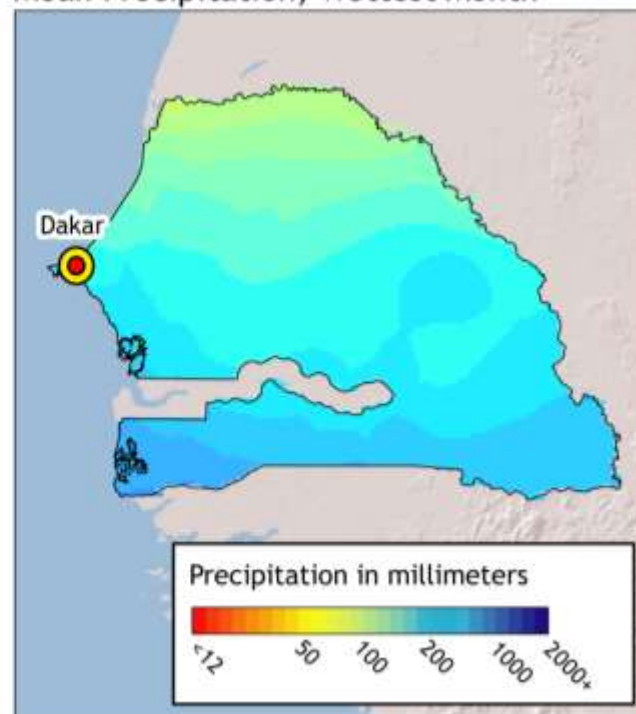
Maximum Temperature, Warmest Month



Total Annual Precipitation



Mean Precipitation, Wettest Month

Figure 1: Climate Baseline for Senegal-Mean Annual precipitation and Temperature (1960-1990)³

³ Worldclim 1960-1990 averages. Robert J. Hijmans, Susan Cameron, and Juan Parra, at the Museum of Vertebrate Zoology, University of California, Berkeley, in collaboration with Peter Jones and Andrew Jarvis (CIAT), and with Karen Richardson (Rainforest CRC). www.worldclim.org/current.

- ➔ Mean annual temperature has increased by 0.9°C since 1960, an average rate of 0.20°C per decade.
- ➔ Available data indicates that the average number of 'hot' nights per year increased by 27 (an additional 7.3% of nights) between 1960 and 2003.
- ➔ Sahelian rainfall is characterized by high variability on inter-annual and inter-decadal timescales, which can make long-term trends difficult to identify. A period of particularly high rainfall occurred in the early 1960s, while the early 1980s were particularly dry. Statistically significant decreases of around 10 to 15 mm per decade have, however, been observed between 1960 and 2006 in the southern regions of Senegal (during the wet season of June through September).
- ➔ Some unusually high rainfalls have occurred in the dry season in recent years (2000-2006), but this has not been part of a consistent trend.
- ➔ Senegal has experienced a statistically significant decrease in wet season rainfall between 1960 and 2006, with the 500 mm isohyets regressing about 100 kilometers (km) to the south.

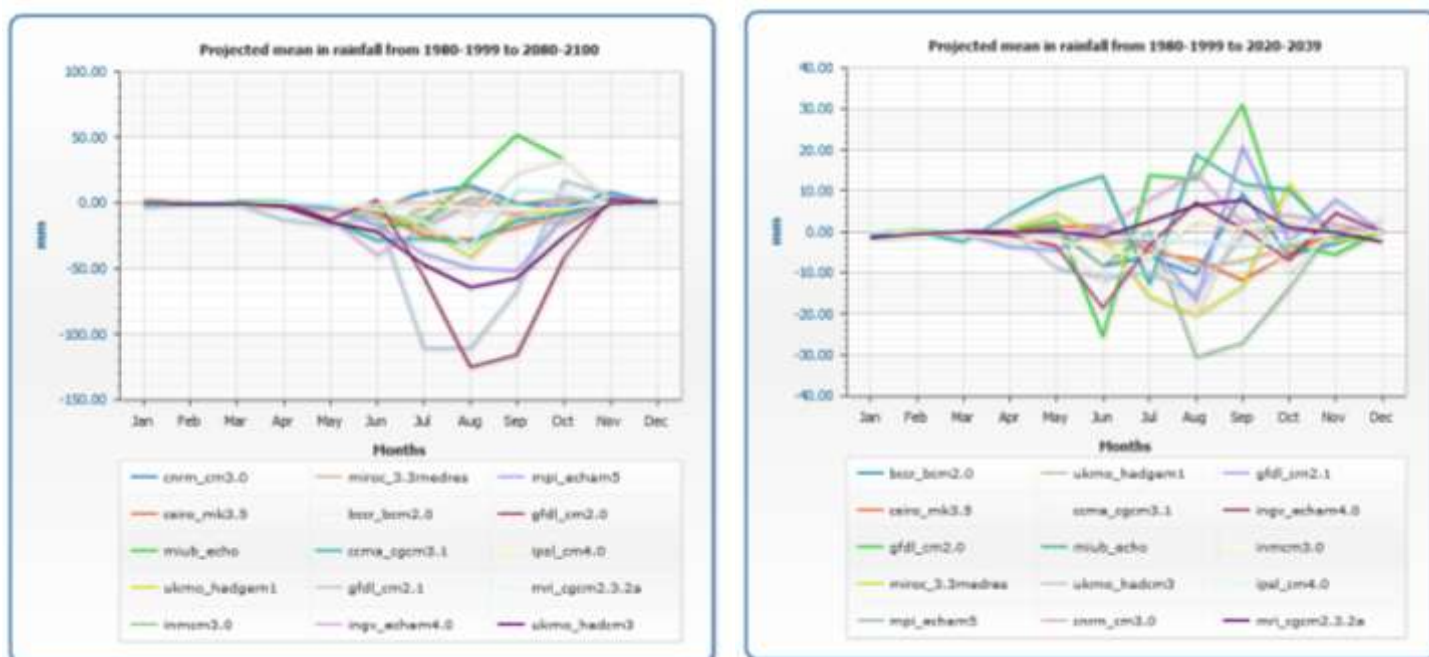
CLIMATE FUTURE⁴

Figure 2: Projected change in rainfall for Central Senegal under two time periods, 2080-2100 (left) and 2020-2039 (right), across 15 global Circulation Models of the IPCC⁵.

⁴ World Bank Climate Change Knowledge Portal and UNDP Climate Change Country Profile of Senegal.

⁵ World Bank Climate Change Knowledge Portal.

- ➔ Mean annual temperatures are projected to increase by 1.1 to 3.1°C by the 2060s, and 1.7 to 4.9°C by the 2090s, with projected rates of warming faster in the interior than in those areas closer to the coast.
- ➔ All projections indicate substantial increases in the frequency of days and nights that are considered 'hot' in current climate⁶, with such increases occurring more rapidly in the south and east of the country.
- ➔ All projections indicate decreases in the frequency of days and nights considered 'cold' in current climate⁷.
- ➔ Different models in the ensemble project a wide range of changes in the mean annual rainfall averaged over the country, from -41 to +48% by the 2090s—but more models show decreases⁸ (Figure 2). It is difficult to draw robust conclusions of changes in precipitation; however, it is likely that a greater proportion of precipitation will occur in heavy rainfall events. Given the range of changes in the projections for Senegal, it is important to incorporate scenarios of both precipitation increases and decreases in future planning.

CLIMATE CHANGE IMPACTS ON NATURAL HAZARD VULNERABILITY

AT A GLANCE

Senegal faces a number of hazard risks (Figure 3)⁹. Droughts, floods, sea-level rise, and coastal erosion are currently the natural hazards that pose the greatest threat to the country's development goals.

- ➔ **Droughts** – Floods occur more frequently than droughts, but droughts have more severe consequences and affect many more people per event. Droughts in Senegal are concentrated mostly in the arid and semi-arid Sahelian regions of the country, located in northern and center Senegal. Between 1977 and 2002, six major drought events affected the country. Droughts are the result of climate variability that manifests itself by a late onset of the rainy season, irregular spatial distribution of rains, and an early end to the rainy season. Droughts can cause a significant drop in crop yield. Peanut revenues declined from about 68.4 to 17.4 billion FCFA, and revenue from millet/sorghum fell from 30 to 12 billion FCFA during the 2000 droughts.

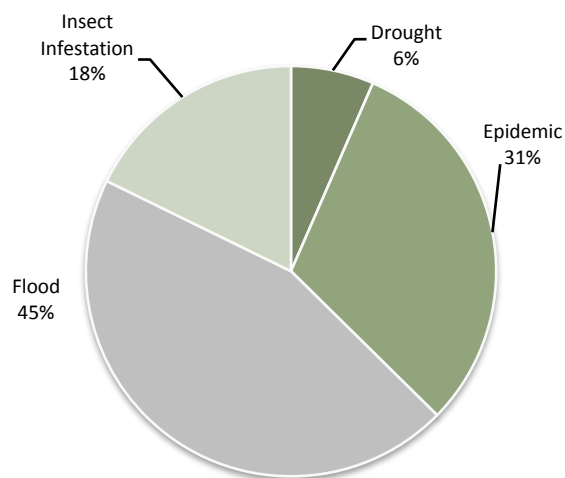


Figure 3: Average annual Distribution of Reported Disasters in Senegal.

⁶ Hot days are defined as the temperature exceeded on 10% of days or nights in current climate of that region and season.

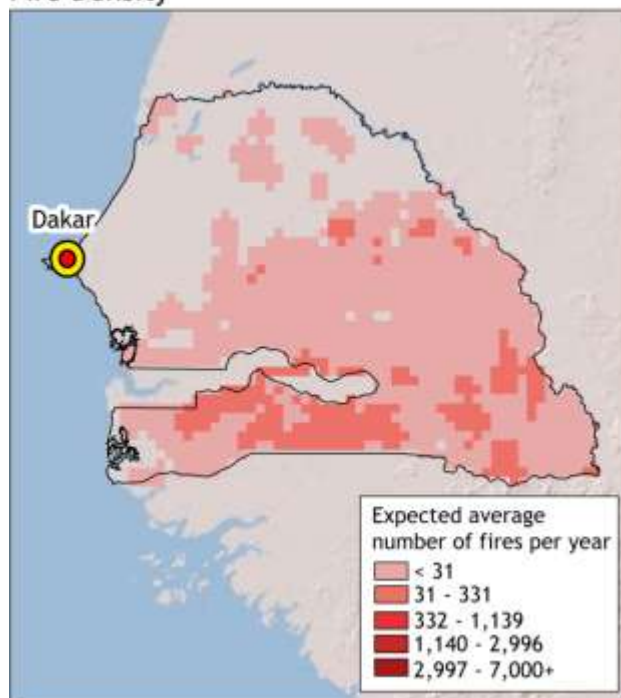
⁶ Hot nights are defined as the temperature exceeded on 10% of days or nights in current climate of that region and season.

⁷ Cold nights are defined as the temperature below which 10% of days or nights are recorded in current climate of that region or season.

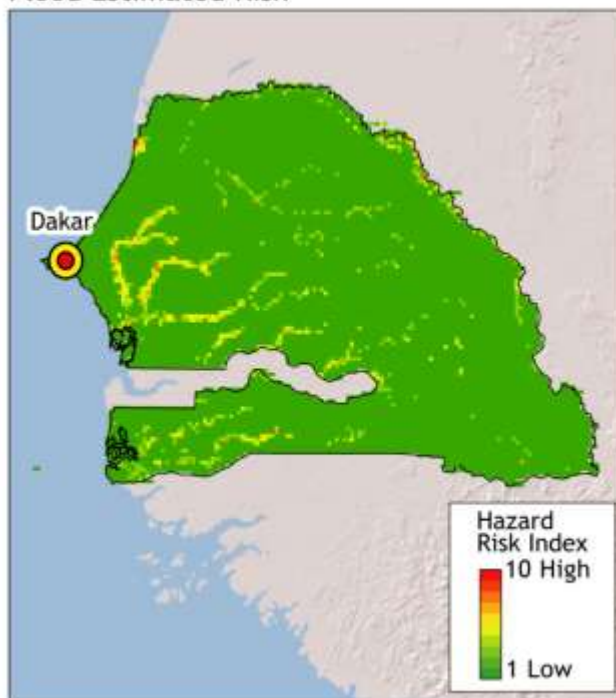
⁸ McSweeney *et al* 2008. UNDP Climate Change Country Profiles Senegal.

⁹ EM-DAT: The OFDA/CRED International Disaster Database, Université Catholique de Louvain, Brussels, Belgium.

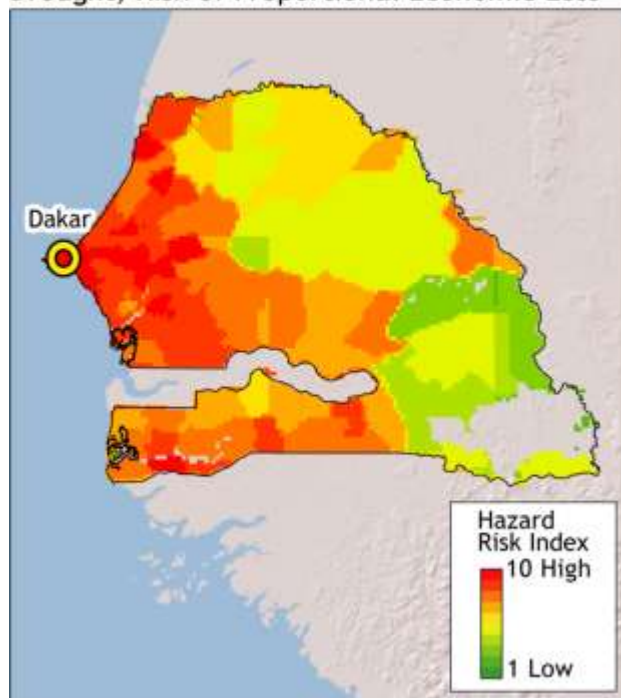
Fire Density



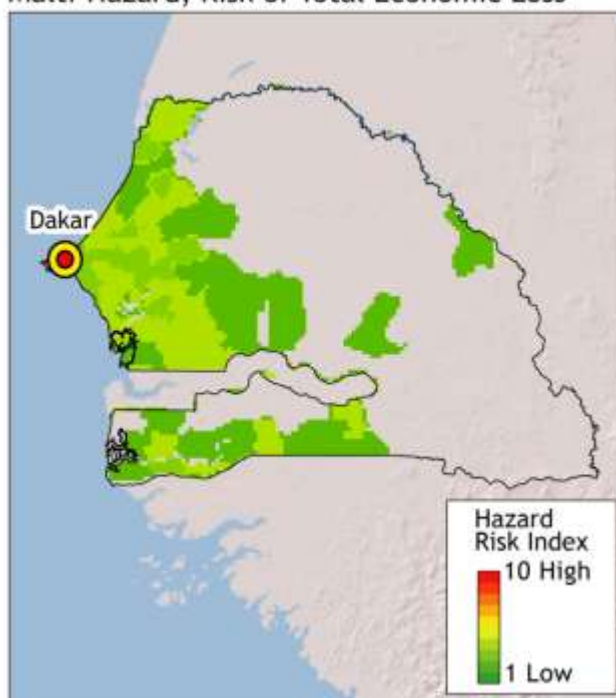
Flood Estimated Risk



Drought, Risk of Proportional Economic Loss



Multi-Hazard, Risk of Total Economic Loss

Figure 4: Exposure to climate-related hazards across Senegal¹⁰

¹⁰ Columbia University Center for Hazards and Risk Research (CHRR), the United Nations Environmental Program (UNEP), International Bank for Reconstruction and Development/The World Bank, and Columbia University Center for International Earth Science Information Network (CIESIN).

➔ **Floods** – Floods severely affected and continue to affect Senegal. From 1980 to 2008, floods have affected an estimated 400,000 to 600,000 people a year and caused estimated damages of over US\$42 million¹¹. Both urban and rural areas are vulnerable to floods; however, most at risk are the areas in and around Dakar, Saint Louis, Matam, Kaolack, Thies, Diourbel, Kolda, Kaffrine, and Tambacounda. Floods in the country are the result of river overflows (particularly in the Gambia and Senegal rivers due to heavy rains)- a combination of heavy rains and insufficient drainage infrastructure (in Kaolack and Dakar especially) - and storm surges leading to salt-water intrusion into agricultural lands (particularly in the Saloum Delta). At the same time, rapid urbanization has caused an explosion of buildings and roads that have reduced infiltration and exacerbated the impacts of floods. Urban areas such as the capital city Dakar have experienced floods due to a recent increase in rainfall, lack of efficient rainwater drainage systems, rising groundwater, uncontrolled urban sprawl, and the occupation of depressions and wetlands areas¹².

Floods affect the poorest residents, those who tend to live in underequipped and low-lying peri-urban areas¹³. Each rainy season, floods inflict serious damage on infrastructure, public equipment, and private property, often resulting in the need to temporarily relocate populations. Water-borne and mosquito-borne diseases (such as cholera and malaria) can also spread due to the presence of stagnant water. In 2008 alone, floods affected over 250,000 families and caused extensive damage, with 88 schools and 12 basic health centers under water. And again, in late August 2009, heavy rainfall caused severe floods.

➔ **Rising sea level** – Sea-level changes and increased intensity of storm surges are known to lead to coastal erosion, which poses a major threat to the population and economy of Senegal. Sea-level rise is exacerbated by the country's geology (including sediment deficits, natural instability of slopes, and surface runoff) and threatens 74% of households living in coastal areas. Economic activities such as fishing, tourism, and agriculture are adversely affected by sea-level rise. The observed decline rate of the shoreline varies between one to two meters (m) per year for sandy beaches, with the coastal zones between Joal and Djiffere and between Saint-Louis and the Mbao-Bargny most affected¹⁴. The main erosion areas identified within Dakar include the area of Camberene-Yoff, the West and East edges of Dakar, and the bay of Hann. The Mbeubeuss quarries also show serious signs of erosion. Coastal erosion is particularly felt in the area of Rufisque-Bargny with the narrowing of the beach of Rufisque, particularly along the center of the city, resulting in overhanging buildings and stripped roads in the sectors of Merina and Thiawlene. A broad calculation of the exposure and vulnerability of economic assets around the metropolitan Dakar area (Figure 5) was inferred from a spatial analysis of land price values. A total land value of US\$44 billion is estimated for the Dakar Metropolitan Area. Out of this total value, over \$2 billion or 5% of assets are considered exposed to high natural hazard potentials¹⁵.

¹¹ GFDRR Senegal Disaster Risk Management Country Note.

¹² Preparing to Manage Natural Hazards and Climate Change Risks in Dakar, Senegal. A Spatial and Institutional Approach. Pilot Study Report- WB 2009- Hyoung Gun Wang, Marisela Montoliu-Munoz, the Geoville Group and Ndèye Fatou D. Gueye

¹³ GFDRR Senegal Disaster Risk Management Country Note.

¹⁴ Ibid.

¹⁵ World Bank, 2009. Preparing to Manage Natural Hazards and Climate Change Risks in Dakar, Senegal. A Spatial and Institutional Approach.

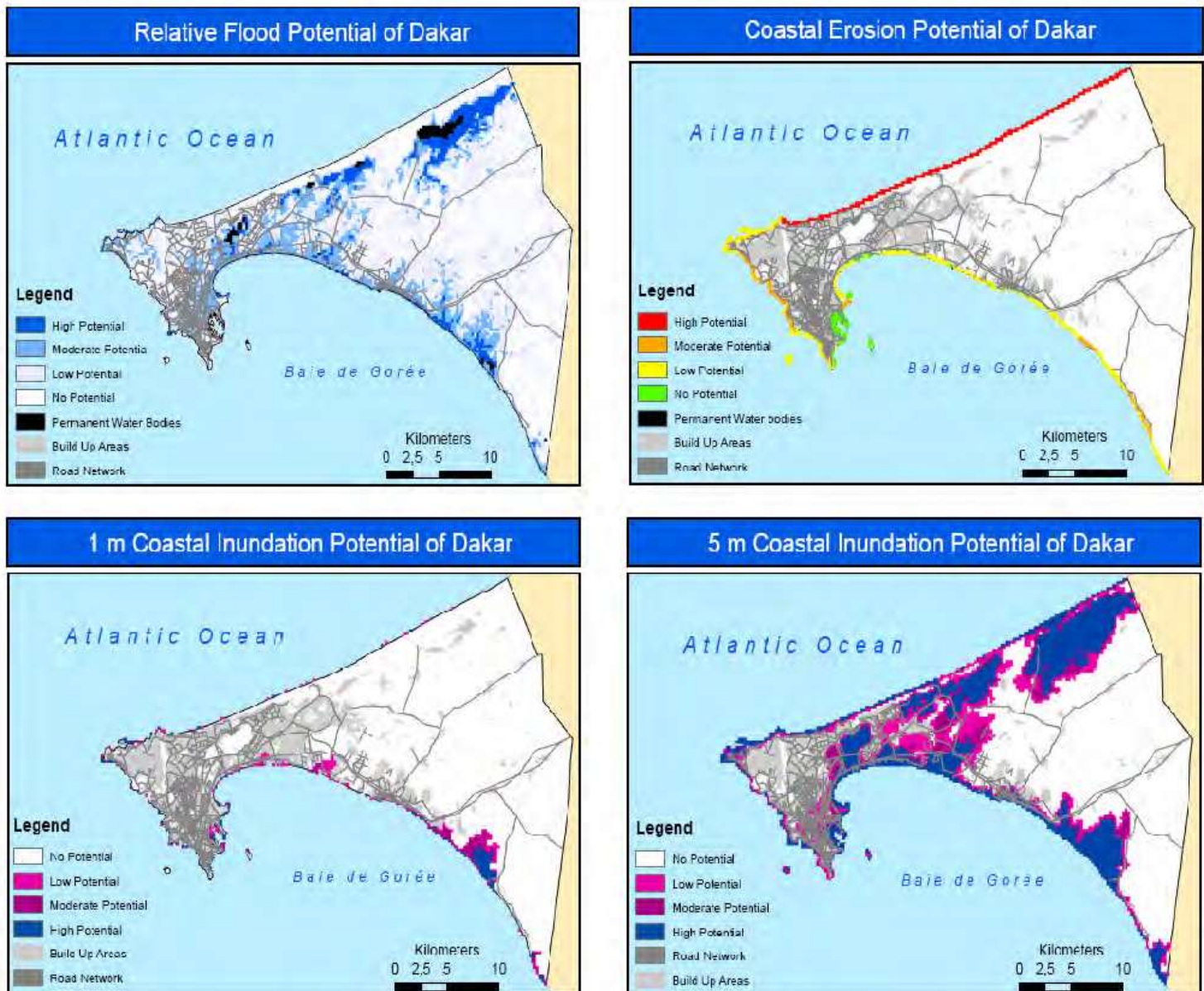


Figure 5: Hazard Mapping of the Dakar Metropolitan Area¹⁶

Implications for Disaster Risk Management

- ➔ Deteriorating climatic conditions in areas surrounding cities are likely to increase human migration into cities, further increasing already high urbanization rates. If left unmanaged, urban sprawl may worsen or even cause natural hazard events¹⁷.
- ➔ Sea level could rise by up to one meter by the end of the century¹⁸, and this would put at least 110,000 people, mostly in southern Senegal in the Cape Verde region, at risk of coastal flooding. Some studies, however, put the number of people at risk much higher¹⁹. The higher frequency of heavy rainfall events is likely to escalate the incidence of floods, leading to possible health impacts that include the spreading of

¹⁶ GeoVille Group for the World Bank. 2009

¹⁷ World Bank (2009). Preparing to Manage Natural Hazards and Climate Change Risks in Dakar, Senegal. A Spatial and Institutional Approach.

¹⁸ Ibid note 11.

¹⁹ Hinkel, J. (2010). Integrated Assessment of Coastal Vulnerability of Senegal and Gambia with the DIVA model.

water-borne diseases such as cholera in the after-math of floods.

- ➔ Increase in pest infestations due to changing climate patterns might spark food shortages and temporary migrations.

SECTORAL CLIMATE RISK IMPACTS AND REDUCTION RECOMMENDATIONS

AGRICULTURE

Senegal has significant land resources suitable for agriculture, amounting to 3.8 million hectares, or 385 hectares per 1000 inhabitants, although 11% of this area receives average annual rainfall values below 500 mm²⁰. Although it contributes only 16.8% of the gross domestic product (GDP), agriculture remains the main source of income for the majority of Senegalese. The agricultural sector employs three quarters of the workforce, and family farms represent 95% of agricultural activity. The main crops cultivated are groundnuts and cereals (peanuts, millet, sorghum, rice, cotton sugar cane, cassava, and niebe).

Although small-scale agriculture is the dominant livelihood activity of most Senegalese, the country's production falls far short of demand. Erratic rainfall, plant diseases, pest attacks, degradation of natural resources due to overexploitation of land, lack of infrastructure, lack of extension services available to farmers, as well as their weak asset base all constrain agricultural supply²¹. In particular, Desert Locust infestations are a recurrent threat to Senegal and other parts of West Africa. The role played by local environmental and meteorological conditions on Desert Locust infestations is widely discussed, and some authors²² have suggested locust population dynamics to be driven by synoptic climatic factors. Weak African Easterly Jet atmospheric circulation pattern during spring time seems to be a major trigger mechanism for locust population dynamics change. Future climate change might increase the frequency of such events.

Senegalese soils have been cultivated for decades using inappropriate mineral and organic fertilizers. As a consequence, fertility has worsened over time, soil mineralization is commonplace, and in many regions of the country, soils have lost valuable organic matter. If current warming trends continue, the performance of agriculture in Senegal will be further eroded as higher temperatures (combined with the expected decrease in rainfall) will aggravate the country's water deficit. This will adversely affect both cultivated and natural vegetation growth and biomass production, which will lead to greater vulnerability and degradation²³.

Coupled with the fact that local production cannot compete with regional and international markets, these considerations explain why Senegal imports approximately 60% of its national cereal requirements, delaying progress towards a market-oriented, diversified, and competitive agricultural sector²⁴. Furthermore, complex relations between central and traditional local authorities make access to land difficult and ultimately impede competitiveness. Climate change will also affect potential crop productivity due to the changing patterns of rainfall and temperature (Table 1).

²⁰ These resources are far greater than both the African and world averages, which are 86 and 73 ha per 1000 inhabitants, respectively.

²¹ IFAD. Rural Poverty Country Profiles. Senegal. Accessible at: <http://www.ruralpovertyportal.org/web/guest/country/home/tags/senegal>

²² Chiara Vallebona, CNR, Firenze, Italy; and A. Crisci, A. Di Vecchia, L. Genesio, G. Maracchi, and M. Pasqui. 2008. Institute of Biometeorology.

National Research Council (IBIMET-CNR). Florence, Italy.

²³ Senegal National Action Plan for Adaptation (NAPA).

²⁴ African Development Bank. Senegal Country Brochure.

Table 1: Projected changes in the yields of major cereal crops for central Senegal under several growing conditions²⁵

Crop	Baseline Yield (1961 - 1990)	Future Projected Yield	Change %	Period	Options
Maize	8804	8637	-1.9	2020s	High Input, Rainfed
Maize	8804	7533	-14.44	2050s	High Input, Rainfed
Maize	8804	5372	-38.98	2080s	High Input, Rainfed
Maize	2307	0	-100	2080s	Low Input, Rainfed
Sorghum	7405	7515	1.49	2020s	High Input, Rainfed
Sorghum	7405	7251	-2.08	2050s	High Input, Rainfed
Sorghum	7405	5564	-24.86	2080s	High Input, Rainfed
Sorghum	1409	719	-48.97	2080s	Low Input, Rainfed
Pearl Millet	3471	3563	2.65	2020s	High Input, Rainfed
Pearl Millet	3471	3628	4.52	2050s	High Input, Rainfed
Pearl Millet	3471	2981	-14.12	2080s	High Input, Rainfed
Pearl Millet	1052	538	-48.76	2080s	Low Input, Rainfed
Best Cereal	8804	8637	-1.9	2020s	High Input, Irrigated
Best Cereal	8804	7781	-11.62	2050s	High Input, Irrigated
Best Cereal	8804	5959	-32.31	2080s	High Input, Irrigated
Best Cereal	2307	719	-68.83	2080s	Low Input, Rainfed

Priority adaptation measures in the agriculture sector are closely linked to the access and availability of technology, including:

- ➡ Dissemination of agro-forestry techniques;
- ➡ Crop diversification;
- ➡ Use of short cycle varieties;
- ➡ Use of varieties tolerant to salinity;
- ➡ Collection and water storage, (i.e. dams, retention basins, anti-salt structures, windbreaks);
- ➡ Expansion of community woodlots;
- ➡ Prevention of bush fires;
- ➡ Dissemination of fertilization techniques;
- ➡ Reorganization of farming systems;
- ➡ Establishment of an early warning system in rural areas. This will also include capturing the typical atmospheric circulation features that can trigger pest infestations, such as the West Africa Desert Locust²⁶;
- ➡ Institutional support and training for policy makers on climate change;
- ➡ Insurance mechanisms; and
- ➡ Social protection.

²⁵ World Bank Climate Change Data Portal—Agricultural Model Generated by IIASA.

²⁶ Ongoing efforts include the increase in capacity building to seven African countries to confront future locust invasions with the support of IDA Fund of 60 millions. An early warning system under FAO/CLCPRO coordination is currently operational and effective in the area since no invasion case has been noted so far.

WATER RESOURCES

Senegal boasts relatively large water reserves of approximately 35 billion cubic meters. Low human development levels in Senegal have greatly contributed to deteriorated water quality in many parts of the country and forced its inhabitants to pursue unsustainable water-use practices. All National Development strategies now include a focus on improving storage infrastructure and protecting Senegal's finite water resources²⁷. The water resources sector is expected to be among the sectors most sensitive to the impacts of climate change²⁸.

The Senegal River basin is particularly vulnerable, with around 3,500,000 inhabitants, of which 85% live near the river. Improved irrigation technology, as well as cultivation of a broad spectrum of produce—including rice, onions, tomatoes, potatoes, and sweet potatoes—drives development in the basin. Three dominant climates characterize this river basin: a rainy season, from June to September; a cold and dry off-season from October to February; and a hot-dry off-season, from March to June. Between July and October, the basin experiences a high-water period or flood stage, while in November through May/June it experiences low water levels. About 100,000 hectares of land are cultivated in the basin: two-thirds during the rainy season (June-September) and the remainder during the dry season (March-June).

Dams have played an important role in building socio-ecological resilience in the Senegal River basin. The largest of these is the Manantali Dam, built on the Bafing River. This dam regulates extreme floods, generates electric power, and stores water for irrigation in the wet season to compensate for dry-season flow. The Diama dam, near the mouth of the Senegal River in the delta, blocks seawater intrusion and protects irrigation wells. These “services” also support higher water levels in bodies upstream, which promote irrigation and double cropping²⁹. Dam construction has been instrumental in the provision of freshwater resources throughout the year, and irrigated agriculture in the valley has flourished. In addition, local populations enjoy access to improved drinking water. Yet the negative effects of these dams on human populations and ecosystems are not to be overlooked; the flood-plain ecology of the basin has changed remarkably, from a salty and brackish aquatic environment with marked seasonal changes to a low-flow perennial freshwater ecology. The dams have also displaced populations due to the widespread impacts of water-borne diseases, and vital ecosystem services have been lost³⁰.

Protecting current water resources requires proper management of available reserves through:

- ➡ Strict control of the use of chemicals (fertilizers and pesticides);
- ➡ Maintaining the balance between exploitation rate and renewal rate of groundwater;
- ➡ Management of rain water and river flows;
- ➡ Development and enforcement of a restoration plan for all housing projects³¹;
- ➡ Protection of hydraulic infrastructure, including the systematic care of catchment areas;
- ➡ Education programs to raise awareness on water resources, competing needs, and integrated management.

²⁷ Senegal's National Adaptation Programme of Action, 2006.

²⁸ Ibid.

²⁹ World Water Development Report: Case Study on Senegal River Basin, Guinea, Mali, Mauritania, Senegal.

³⁰ Ibid.

³¹ Wastewater is the primary contributor to pollution of ground water

COASTAL ZONES

Coastal zones are home to diverse and essential ecosystems, including rocky shores, sandy beaches, deltas, estuaries, coastal wetlands, sea grass meadows, and lagoons. In addition to the rich biodiversity that characterizes these ecosystems, they provide vital services upon which local economies are highly dependent. The main problems facing the Senegalese coasts are linked more or less directly to climatic factors, the most important of which are flooding, coastal erosion, salinization of soils, degradation of mangroves, and changes in fishing regimes. The industries, settlements, and societies located in the coastal zone are highly dependent on climate-sensitive resources and highly prone to extreme weather events³². Moreover, the coastal zone is experiencing rapid urbanization, which heightens vulnerability to climate variability and change.

Coastal erosion is affecting almost every major coastal city in Senegal and is directly responsible for major losses in physical and financial assets. Observed shoreline erosion rates vary with location, but are on average between one and two meters per year for sandy beaches. The areas most affected by coastal erosion are, from north to south, the St. Louis area, Mbao-Bargny, and stretches of coast between Petite Côte and Ndangane Dijiffere. Rocky cliffs recede at a much lower rate (at an average of 0.1 to 0.7 m per year), but still forcefully. The increasing trend of house construction, usually of high value on cliffs in Dakar and on the Petite Côte, poses new threats in the context of increasing coastal erosion. Problems with coastal erosion may be reduced if human activities are better controlled. Appropriate regulations and improved building practices (such as avoiding the use of beach sand for construction) for infrastructure construction in coastal zones, in addition to improved urban and land use planning, could have a positive impact, particularly where environmental impact assessments are conducted and regulations followed.

Projections indicate that a one-meter rise in sea level by 2100 would result in the disappearance of between 55 and 86 square kilometers of the country's beaches and could flood 6000 square kilometers of low-lying areas, notably the estuaries. Likewise, with a rise of 40 to 120 cm, coastal facilities and human settlements could suffer heavy damage³³. Mangroves are extremely dependent on sea-level variations, rainfall, and salinity and could therefore migrate or decrease significantly.

Fishing is the second largest employer and source of livelihood in Senegal, especially for those living in the Senegal River valley and delta. Yet stocks are declining due to overexploitation, leading to a decline in productivity and a decreasing biodiversity along the coastline³⁴. The fishing sector faces severe challenges under climate change as a result of changing water temperature and projected mangrove losses³⁵. Changes in sea surface temperature will also adversely affect fish stocks³⁶.

Tourism is also an important economic activity in Senegal. All of the country's touristic infrastructure lies along the Petite Côte (especially around Saly, in Saint Louis, and Casamance—which are themselves already threatened by coastal erosion). The potential loss of this valuable infrastructure and consequent loss of employment, represents a substantial risk for the many actors whose primary income is derived from tourism.

³² UNDP, 2004. *Adaptation to Climate Change—Responding to Coastline Change in Its Human Dimensions in West Africa through Integrated Coastal Area Management (ACCC)*.

³³ IPCC, 1997. *The Regional Impacts of Climate Change: An Assessment of Vulnerability*

³⁴ African Development Bank. *Senegal Country Brochure*

³⁵ Mangroves provide valuable services such as spawning, breeding, and nursing grounds for numerous species.

³⁶ UNDP, 2004. *Adaptation to Climate Change—Responding to Coastline Change in its human dimensions in West Africa through Integrated Coastal Area Management (ACCC)*

Adaptation mechanisms to be implemented in coastal areas include³⁷:

- ➡ Integrated coastal zone management, including coastal zone mapping and regulation of infrastructure in coastal zones;
- ➡ Encouraging the proper use of beach land and implementing protective measures for coastal areas;
- ➡ Livelihood diversification of fishing communities and the exploration of alternative species for markets;
- ➡ Banning beach-sand mining and adopting related policies (Senegal is making major progress in reducing coastal vulnerability, supported by the 2009-2010 Poverty Reduction Support Credit).

EXISTING ADAPTATION FRAMEWORK/STRATEGY/POLICY AND INSTITUTIONAL SETUP

The Senegalese have a long history of adapting to climate variability and dealing with locust invasion, floods, coastal erosion, and droughts. Yet Senegal's growth and economic development will be hampered by ongoing and projected climate change and variability unless appropriate adaptation initiatives - guided by an adaptation strategy - are implemented, and knowledge of climate change is incorporated into the core of the development process. Numerous projects that address the impacts of current climate variability are ongoing at the local level. These include reforestation, irrigation, soil restoration, irrigation and mangrove restoration schemes, as well as risk and disaster management plans. Integrated approaches are emerging, including a project called "Adaptation to Climate Change—Responding to Climate Change and to Its Human Dimensions in West Africa through the Integrated Management of the Coastal Area" (ACCC) and the Climate Change and Development Adapting by Reducing Vulnerability (CC DARE) Project. Senegal also hosts a large collection of NGOs and research institutes whose primary goal is to improve adaptation capacities and build adaptation networks (such as INFOCLIM, CONGAD, and ISRA). Other development organizations and agencies, such as the Japanese International Cooperation International Agency (JICA) and the UNDP, among others, are making efforts to realize co-benefits between adaptation interventions, such as in the agricultural and health sectors.

Ongoing Efforts—At a Glance

<i>Vulnerability Reduction</i>	<i>Agency or Donor</i>
Integrating climate change risk implications in national planning and strategic programming.	CC DARE, UNDP, UNEP, UNFCCC
Integration of climate risks in urbanization plans.	CC DARE, UNDP, UNEP, UNFCCC
Strengthening of capacities related to local plans for adaptation to climate change.	CC DARE, UNDP, UNEP, UNFCCC
Supporting integrated and comprehensive approaches to climate change adaptation in Africa.	CC DARE, UNDP, UNEP, UNFCCC
Combating coastal erosion exacerbated by climate change and rising sea levels in Senegal.	Adaptation Fund (direct access financing)
Reduction of vulnerability to locust infestations.	World Bank

³⁷ Hinchel, J. 2010.

GFDRR Interventions

Agency or Donor

Climate Change and the Changing Role of Children in Household Risk Management Strategies.	(ESW) – World Bank
Economic and spatial study of the vulnerability and adaptation to climate change in Senegal's coastal zone.	World Bank
Senegal's Post-Disaster Needs Assessment.	GFDRR

INSTITUTIONAL AND POLICY GAPS

Among existing priorities, there are notable shortcomings in capacity, accountability, and coordination among local agencies, as well as between them and agencies at other administrative levels. Breaking down path dependencies and adopting an integrated approach to climate change and disaster risk management is vital. This may include, for example, the development of shared local databases on key climate risks and the training of local agency staff to use this information successfully³⁸.

RESEARCH, DATA, AND INFORMATION GAPS

Senegal's status as a developing country dependent mainly on agriculture and fishing makes it particularly susceptible to the effects of climate change. Added to this is the fact that, like most other developing countries, Senegal does not have adequate monitoring systems for predicting the likelihood of extreme events occurring, or for assessing possible changes in weather patterns, thus making the task of developing short-term responses for 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 GAPS

Priority areas for research include water, infrastructure, coastal zones, tourism, and agriculture sectors, with particular attention to reducing vulnerability to flooding and improving water management in the Senegal River basin. Research needs in these areas include³⁹:

- ➔ Appropriate monitoring and modeling of projected changes in sea level and storm surges, particularly in the vulnerable coastal regions around Thies, Dakar, and the Senegal River delta, based on an agreed approach.
- ➔ New methods to improve water use in agriculture and encourage the use of new cultivars and improved seeds, in particular in those regions that are currently facing water deficits during the dry seasons.

DATA AND INFORMATION GAPS

- ➔ Conduct a baseline needs inventory of Senegal's coastal resources. This mapping exercise can help to identify sensitive areas and support the identification of appropriate mechanisms to reduce future impacts.

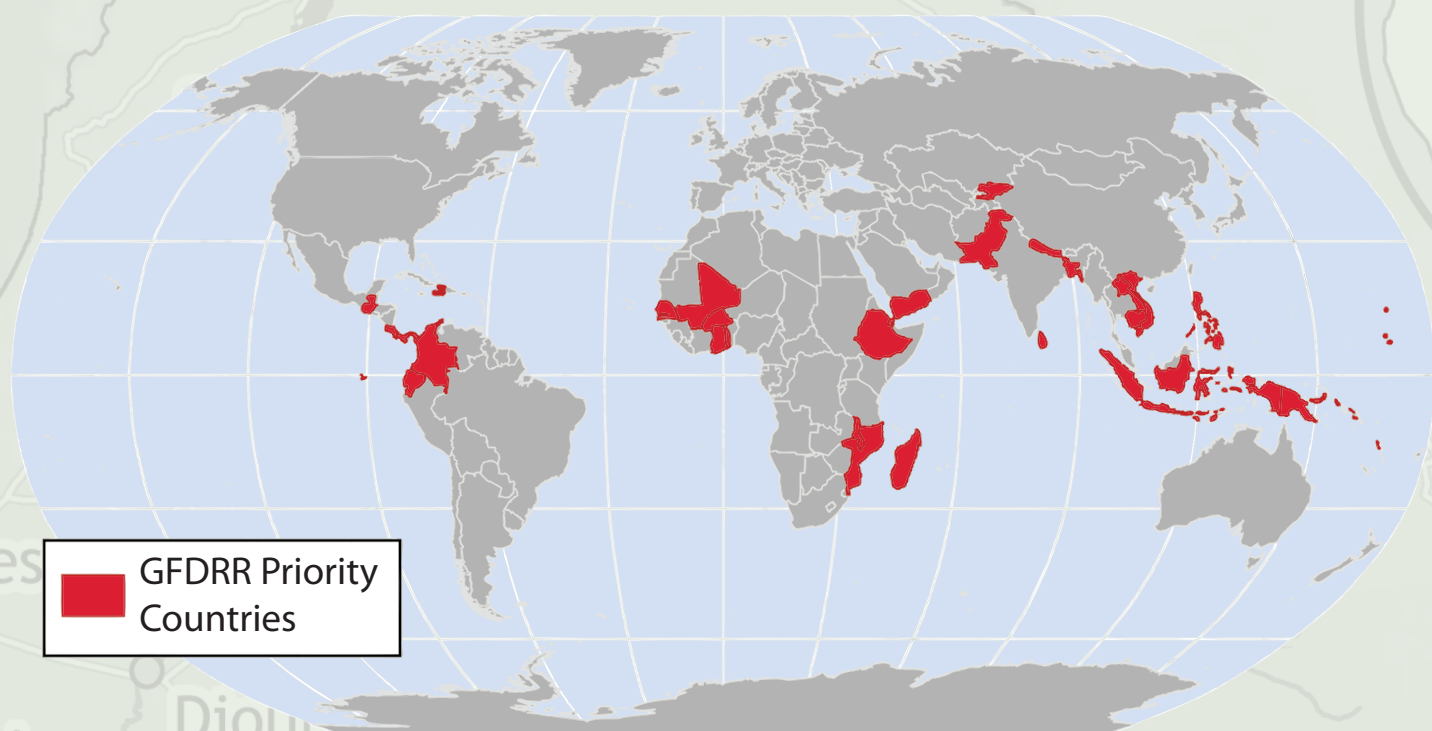
³⁸ World Bank, Geoville Group and African Institute of Urban Management, 2009. Preparing to Manage Natural Hazards and Climate Change Risks in Dakar, Sénégal.

³⁹ Senegal's National Adaptation Programme of Action, 2006.

- ➡ Many gaps exist in flood prevention and response, including a lack of detailed forecasts and risk zone maps, and suitable flood vulnerability assessment methods and data collection systems. Building such a system could offer guidance on effective early warning and response at the national level.
- ➡ Downscaled climate information is available for several stations in Senegal, but the spatial coverage of country-wide stations, including along the coast, needs to be improved.
- ➡ Detailed vulnerability analyses for rural regions in the south to identify not only potential risks to food security but also opportunities that may arise due to projected changes in climate.
- ➡ In coastal areas, a higher-resolution segmentation of the coastline is required in order to further develop and identify appropriate adaptation measures. Improved elevation measurements, more detailed population data, locally derived return periods for high water levels (1 in 1, 1 in 10, 1 in 100, etc.), coastal geomorphology, sediment loads, and improved sea-level measurements could all help to refine areas and the numbers of people potentially at risk from flood damage.

Climate Risk and Adaptation Country Profile

This Country Profile (<http://countryadaptationprofiles.gfdr.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.

© 2011 THE WORLD BANK GROUP
1818 H Street, NW
Washington, DC 20433
Internet: www.worldbank.org
Contact: Milen Dyoulgerov,
mdyoulgerov@worldbank.org

This volume is a product of the World Bank Group. The World Bank Group does not guarantee the accuracy of the data included in this work. The boundaries, colors, denominations, and other information shown on any map in this work do not imply any judgement on the part of the World Bank Group concerning the legal status of any territory or the endorsement or acceptance of such boundaries.

All rights reserved.



GFDRR
Global Facility for Disaster Reduction and Recovery



SENEGAL