

SAINT-LOUIS

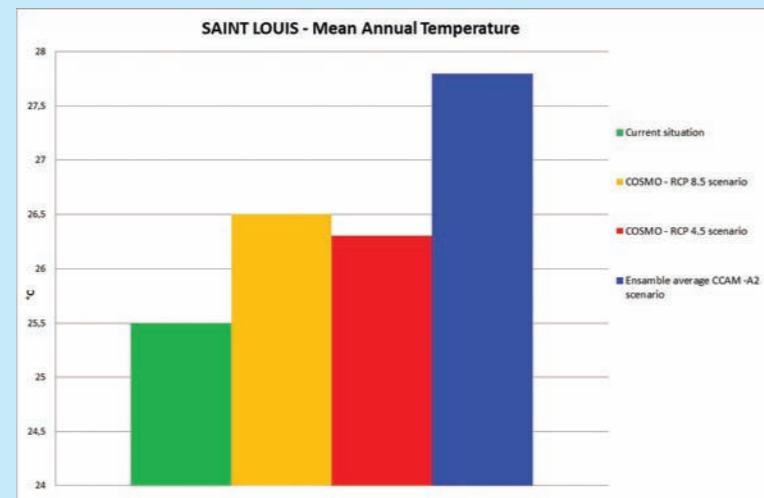
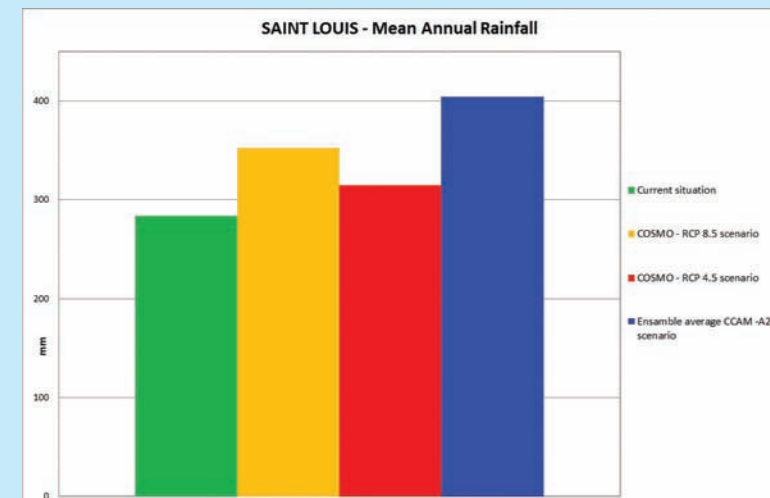
Senegal

CLIMATE CHARACTERISTICS

St. Louis exhibits a very dry climate with an average annual rainfall of less than 300 mm. The bulk of the city's rainfall falls during the boreal summer (June to August). During summer the average monthly temperatures are in the mid-20s, with the winters being cooler.

The results of climate simulations for the period 2010-2050 suggest that:

- mean annual rainfall could strongly increase;
- an increase of at least 1.5 °C in mean annual temperature is expected.

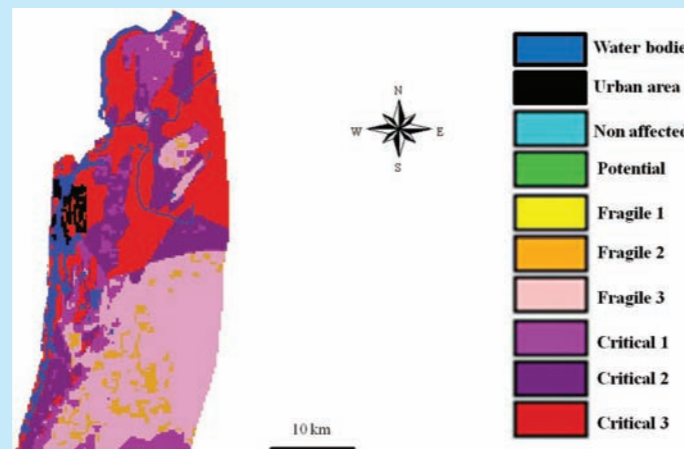


CLIMATE RELATED HAZARDS

Desertification

The map representing the spatial distribution of the Index of Environmentally Sensitive Areas (ESA) suggests that the northern part of Saint Louis area is critically sensitive to desertification mainly due to the overexploitation of natural resources.

Desertification maps are a valuable tool to promote a more efficient management of the affected areas and to address effective policies of desertification prevention, mitigation and adaptation. At the same time, these maps represents also the basis for future studies, considering the dynamic character of some of the considered environmental factors (e.g., vegetation cover).



ESAI Map for Saint-Louis.

Drought

The analysis of the monthly average rainfall clearly shows that the current condition is extremely dry. Analysis based on climate projections reveals that this condition is expected to continue in the next 40 years with an increase of the duration of dry periods.



Location of the city of Saint Louis (source Kane et al., 2013, Reg Environ Change (2013) 13:125-136).

Sea level rise and coastal erosion

Saint Louis is one of the most threatened cities by rising sea levels in the whole Africa. Indeed in 2007, a big part of Thiawllène's graveyard as well as some coastal houses have been destroyed by the sea in Langue de Barbarie. This strip of land is affected by the sea erosion which has caused irreversible damages on the houses of more than 500 families.

The erosion of the Langue de Barbarie has been exacerbated by the opening of a breach in 2003 in order to evacuate the water surplus from the Senegal river to the ocean and therefore resolve forever the problem of river flooding. The disruption of estuarine dynamics has led to a rapid expansion of this gap: a few meters wide at its excavation, it continued to widen to more than 2 km across today. Coastal erosion affects differently the two banks of the mouth: the northern banks accumulates little sedimentation, the southern bank is subject to erosion. This phenomenon keeps widening the canal constantly.

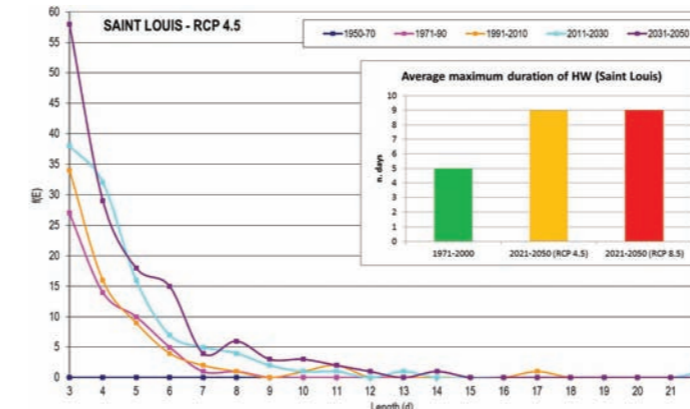


photo a : la brèche juste après son ouverture: 4 m de large
 photo b : la brèche 2 jours après son ouverture : 80 m de large
 photo c : la brèche 3 semaines après son ouverture : 330 m de large
 photo d, la brèche 8 mois après son ouverture : 800 m de large
 Source : photos Ibrahim Dtop, service hydrographique de la ville de Saint-Louis

Heat waves

Analysis of climate projections for Saint Louis reveals a strict correlation between heat wave duration and hot days number. The length of heat wave episodes shows a mean value increasing from 5 to 9 (RCP4.5 and RCP8.5) days, thus Saint Louis shows the lower increase in the heat wave length, respect the other cities. The frequency distribution plot of hot days duration for four separate bi-decadal periods (see figure) shows the temporal change of heat wave characteristics. This distribution has become longer tailed with time. For example the number of events with maximum length lasting 5 days could increase from 9 to 18 (21 for RCP8.5) over 80 years (from 1971-90 to 2030-2050).

The expected persistence of long-lived heat waves lasting approximately 1.5-2 weeks is clearly longer with respect to the climatological period (1961-1990). During 100 years, short lived but more intense waves are more than doubled in duration. It is evident the needs for the national health services to develop strategies for the mitigation of the heat wave effects, to enhance the resilience of the population, particularly the elder people.



Average maximum duration of Heat Wave phenomena and frequency distribution plot of hot days duration for four separate bi-decadal periods.

Floods

The analysis of Extreme Rainfall Events, based on climate projections data until 2050, suggests that the intensity and frequency of Extreme Rainfall Events is expected to significantly increase potentially affecting the flood hazard.

Floods in Saint Louis are the result of a combination of factors:

- Inundations from the Senegal river;
- Obstruction to the river flow by the Langue de Barbarie;
- Rising floodwaters due to tidal backflow during high tides;
- Blockages, made worse by the formation of sand bars and the silting up of river beds and the Langue de Barbarie;
- Lack of drainage, with rainwater runoff being impeded by the flat surfaces, limited infiltration capacity, lack of an effective drainage network and spontaneous and unplanned urbanization.

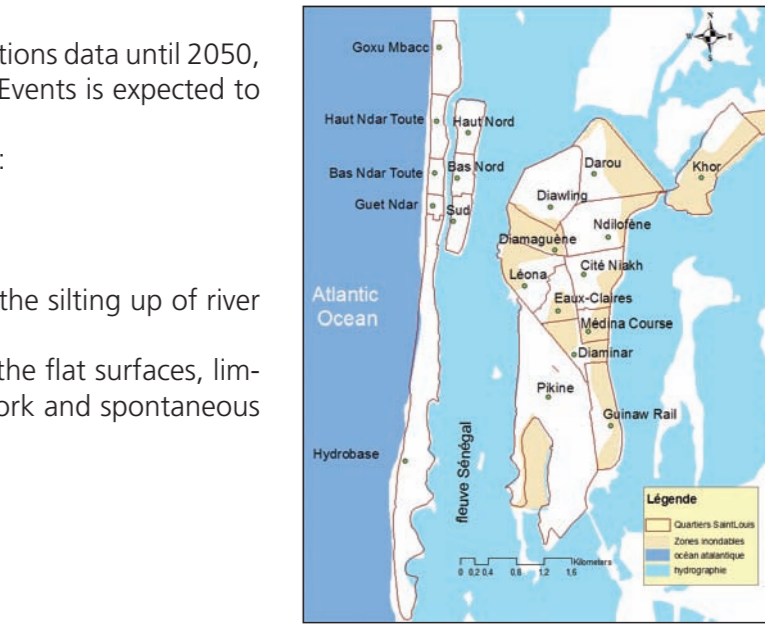


Flooding in Saint Louis.

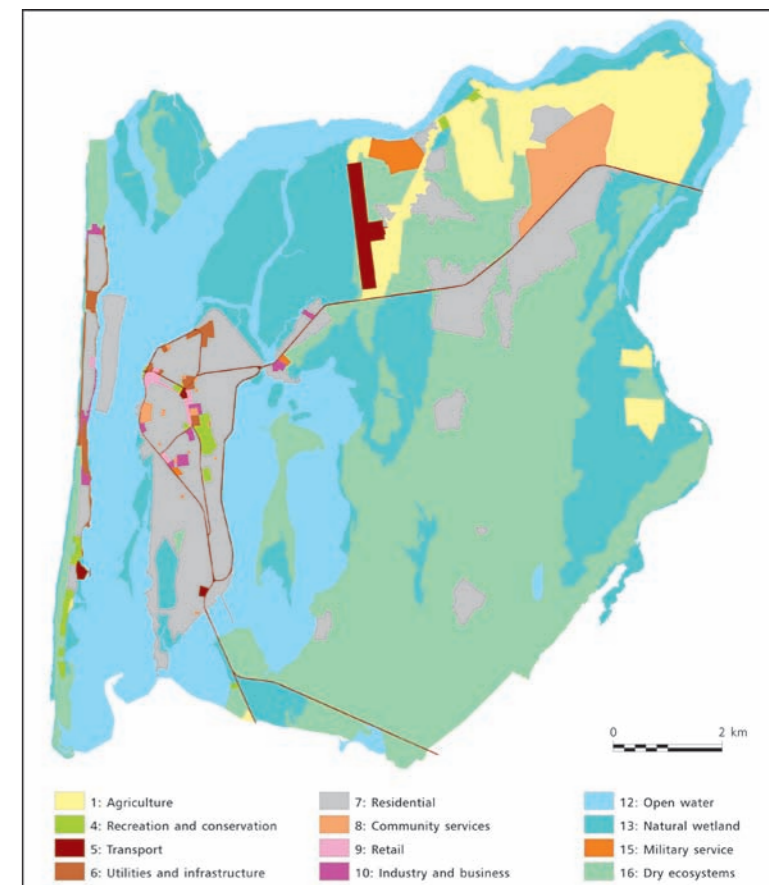
URBAN CHARACTERIZATION AND GREEN STRUCTURE MAPPING

Classification and mapping of Urban Morphology Types confirm the amphibious character of the city of Saint Louis: 22.8% of it is water and 20.4% natural wetlands. This is due to its estuarine position. But as a city of the Sahel, dry ecosystems also account for a large proportion of its area: 34.2%. In terms of built up areas, residential areas cover the most significant area corresponding to 11.6%, while agricultural areas cover 6.9%. The results also suggest that there are few infrastructure in the city accounting only 4.2%.

The assessment of land cover (i.e. the observed (bio)physical cover on the earth's surface) within each category of Urban Morphology Type shows that the bare ground is the most predominant land cover type in Saint Louis (31.7%), followed by other impervious surfaces (16.3%) and grasses (11.0%). However, the land cover assessment was for the month of December, which is two months after the rainy season. This could also explain the predominance of bare ground, along with the fact that vegetation may be sparse or in poor condition.



Map showing the local districts in St. Louis and the extent of flood-prone areas (brown shading). Source: Gaston Berger University.



Urban Morphology Types in Saint Louis.

FINDINGS ON SOCIAL VULNERABILITY ASSESSMENT

Findings on social vulnerability for the communities of Goxxumbacc, Darou and Diaminar have been grouped according to four main vulnerability dimensions:

Asset vulnerability	
Goxxumbacc	Level of education: 50% of the households have no formal education; 36% do not go beyond primary school Economic livelihood sources: Public employee: 2,18%; Private employee: 32,24%; Self-employed:65,58%. 60% of the population are fishermen with two fishermen per household Income level: Unemployment rate 3,5% Economic activities: Primary sector: 96,5; Secondary sector: 1,5%; Tertiary sector: 1,5% Health issues: only one hospital for an estimated number of births to 500 per year, 1350 households and a density of 433 inhabitants per hectare for 17807 inhabitants in 2007 Dominant ethnic group: Wolof: 89%; Moorish: 8,5%
Darou	Level of education: only three primary schools. Economic livelihood sources: Public employee 14,90%; Private employee: 23,40%; Self-employed: 61,70% Economic activities: Primary sector 7%; Secondary sector 51%; Tertiary sector 42% Health issues: 411 cases of diarrhea and malaria due to the 2010 floods. One public hospital including a nutrition program for children. Dominant ethnic group: Wolof: 52,63%; Puular: 25,78%
Diaminar	Level of education: there is no primary school Economic livelihood sources: Public employee 11,95%; Private employee: 2,71%; Self-employed: 85,33% Economic activities: Primary sector: 12%; Secondary sector: 32%; Tertiary sector: 56% Health issues: 810 cases of diarrhea and 1019 cases of Malaria due to the flood of 2010. Health center: Ousmane Ngom located in Leona / Eaux Claires Dominant ethnic group: Wolof: 75,5%; Puular: 10%
Physical vulnerability	
Goxxumbacc	Hazardous disposal of solid wastes: only 17% of households dispose of waste into trash can Lack of a network system to collect waste water The existing drainage network of storm water is not effective and does not cover all district.
Darou	Hazardous disposal of solid wastes: 77% of households dispose of waste into illegal disposals Lack of sewer system
Diaminar	Lack of sewer system
Institutional vulnerability	
Goxxumbacc	Various institutions at district level including Government / NGO / Private / Other social network (CSA GIE female cells, Neighborhood Committee, Town Hall, CR, youth group, Partners)
Darou	Various institutions at district level including Government / NGO / Private / Other social networks (CSA GIE female cells, Neighborhood Committee, Town Hall, CR, youth group, Partners)
Diaminar	Various institutions at district level including Government / NGO / Private / Other social network (CSA GIE female cells, Neighborhood Committee, Town Hall, CR, youth group, Partners)
Attitudinal vulnerability	
Goxxumbacc	Risk perception: coastal erosion risk perceived as major risk by the 70% of the population. Community networks: the District Council brings together 94 associations active in various domains including Collection, Evaluation and Processing of Household Waste, Group Economic Interest, Basic Communities on Sport and the Citizenship, dealing with different issues such as economics, education, sanitation and management of environment. Collective actions: Local and international organisations assist communities in various ways including distribution of hygiene kits and food to the families affected by a disaster. 80.5% of people do not perceive the presence of the institutions, but the 42% of the residents is convinced that an emergency plan is established. The Municipality and the Government, through the Ministries of Interior, Social Action and National Solidarity also distribute donations.
Darou	Risk perception: flood perceived as major risk by the 93.7% of residents. Salinization perceived as serious risk by the 70.5% of residents. Community networks: the District Council brings together 72 associations active in various domains including Collection, Evacuation and Processing of Household Waste, Group of Economic Interest, Basic Communities on Sport and the Citizenship, dealing with different issues such as economics, education, sanitation and management of environment Collective actions: Local and international organisations assist communities in various ways including distribution of hygiene kits and food to the families affected by a disaster. 73.3% of people do not perceive the presence of the institutions. More than the 84.2% of people is convinced that there is no emergency plan. The Municipality and the Government, through the Ministries of Interior, Social Action and National Solidarity also distribute donations.
Diaminar	Risk perception: people of Diaminar perceive the flood as the major risk. Salinization perceived as a serious risk by the 6% of residents Community networks: the District Council brings together 23 associations active in various domains including Collection, Evacuation and Processing of Household Waste, Group of Economic Interest, Basic Communities on Sport and the Citizenship, dealing with different issues such as economics, education, sanitation and management of environment. Collective actions: Local and international organisations assist communities in various ways including distribution of hygiene kits and food to the families affected by a disaster. 54.5% of people perceive the presence of institutions, but only 4.5% of the residents is convinced that there is an emergency plan. The Municipality and the Government, through the Ministries of Interior, Social Action and National Solidarity also distribute donations.



Specific recommendations

Specific risk mitigation strategies for the city of Saint Louis are difficult to formulate unless detailed vulnerability and impact assessment studies are undertaken. In particular, a priority area of research should be aimed at reducing vulnerability to flooding and improving water management in the Senegal River basin.

Research needs in this area include (1) an appropriate monitoring and modeling of projected changes in sea level and storm surges in the vulnerable coastal region around the Senegal River delta; (2) new methods to improve water use in agriculture and encourage the use of new cultivars and improved seeds, to face the water deficits during the dry seasons; (3) tool to promote a more efficient management of the areas most susceptible to desertification and to address effective policies of desertification prevention, mitigation and adaptation.

To carry out these research activities data and information gaps need to be filled:

- 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.
- The spatial coverage of climate stations, including along the coast, needs to be improved.
- A high-resolution topography and bathymetry are required in order to identify appropriate adaptation measures;
- Well-structured information about desertification in relation to other environmental issues (biodiversity, climate change, rural development planning...) at various levels (scientists, farmers, policy makers,...) needs to be developed;
- Monitoring and evaluation of sustainable land management should be performed.

Improved elevation measurements, more detailed population data, locally derived return periods for high water levels, 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.

The authorities can also take advantage of the following guidelines and recommendations developed in the CLUVA project to define a quantitative planning of risk mitigations:

- Guidelines on engineering design and management of storm water systems
- Guidelines for reliability analysis of roadway network including procedures for emergency response management
- Guidelines for vulnerability assessment and reinforcement measures of adobe houses
- Green Infrastructure: An essential foundation for sustainable urban futures in Africa
- Recommendation of how climate change can be better integrated in the planning and government system

GENERAL PRESENTATION

The city of St. Louis is an archipelago and located on low-lying islands encompassing the Langue de Barbarie spit, Ndar Island and the Sor district along the east-west axis. The city is surrounded by low-lying floodplains and marshes while sitting on the edge of the Sahel. The main economic activity is fishing.

With an annual rate growth of 2.4%, St. Louis has about 200,000 inhabitants. Urban growth, poverty and natural hazards constitute main problems for the socio-economic stability in the city.

St. Louis is divided into 20 districts and 22 quarters or neighbourhoods. 33% of households feature low income revenue and unemployment. The majority of those affected by floods are very poor. Guet ndar quarter is one of the most populated zones of West Africa with 15 people per room.

List of contributors (text and photos)

Paola ADAMO, Edoardo BUCCHIGNANI, Paolo CAPUANO, Adrien COLY, Andre D'ALMEIDA, Francesco DE PAOLA, Mouhamadou M. DIAKHATÉ, Ibrahima DIOP, Oumar DIOP, Angela DI RUOCCO, François ENGELBRECHT, Simonetta GIORDANO, Maurizio GIUGNI, Souleymane GUEYE, Pietro IAVAZZO, Nathalie JEAN-BAPTISTE, Fatim KANTE, Sarah LINDLEY, Moussa LO, Nicolas NAKOUYE, Mariétou NDIAYE, Ndèye Marème NDOUR, Timack NGOM, Demba NIANG, Fatimatou SALL, Cheikh SARR, Abdou SENE, Ingo SIMONIS, Aly SINE, Amadou Abou SY, Boubou Aldiouma SY, Stefano TERRACCIANO, Maria Elena TOPA



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