Understanding patterns of climate-resilient development – the case of Senegal

Working paper

PRISE
Pathways to resilience in semi-arid economies

Research for climate–resilient futures

Understanding patterns of climate resilient development – the case of Senegal

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Catherine Simonet

Guy Jobbins

This report has been produced as part of a series of preliminary papers to guide the long-term research agenda of the Pathways to Resilience in Semi-arid Economies (PRISE) project. PRISE is a five-year, multi-country research project that generates new knowledge about how economic development in semi-arid regions can be made more equitable and resilient to climate change.

Front cover image:
Picture of Senegalese boats captured in Senegal

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Acronyms

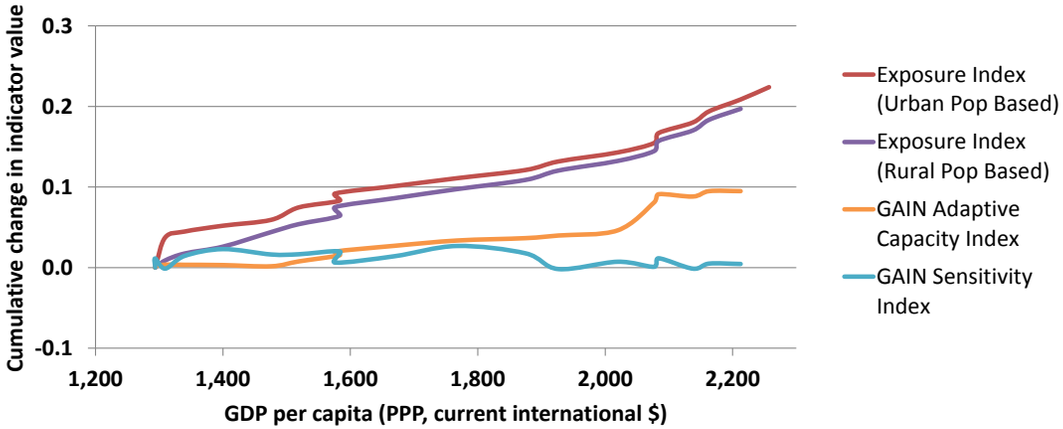
ANSD	Agence Nationale de la Statistique et de la Démographie
APIX	Agence pour la Promotion des Investissements et Grands Travaux
CSE	Centre de Suivi Ecologique
DFID	Department For International Development
EWS	Early Warning Systems
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
ICT	Information and Communications Technology
IED	Innovation Environment Développement
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
IRD	Institut de Recherche pour le Développement (Institute of Research for Development)
MDG	Millennium Development Goal
ND-GAIN	University of Notre Dame Global Adaptation Index
NGO	Non-Governmental Organisation
OECD	Organisation for Economic Co-operation and Development
OPHI	Oxford Poverty and Human Development Initiative
PEPAM	Programme d'Eau Potable et d'Assainissement du Millénaire (Millennium Drinking Water and Sanitation Programme)
PSE	Plan Senegal Emergent
REPAO	Réseau sur les Politiques de Pêche en Afrique de l'Ouest (Network on Fisheries Policies in West Africa)
SAPCO	Société d'Aménagement et de Promotion des Côtes et Zones Touristiques (Society for the Management and Promotion of the Coasts and Tourist Zones)
SONES	Société Nationale des Eaux du Sénégal (National Water Company)
TCI	Tourism Climate Index
TST	Tourism Satellite Account
UK	United Kingdom
UN	United Nations
UN-DESA	UN Department of Economic and Social Affairs
UNICEF	UN Children's Fund
WAEMU	West African Economic and Monetary Union
WDI	World Development Indicators
WFP	World Food Programme
WTTC	World Travel and Tourism Council

Key Messages

- In Senegal, socioeconomic development is characterised by growth that is diversified but unevenly distributed geographically
- The concentration of activities in urban centres and along the coast has reduced the country's vulnerability to droughts but has also contributed to increased exposure to new climate risks.
- Economic diversification in Senegal reduces vulnerability to climate change, especially by decreasing the sensitivity of agriculture to drought, and leads to a general reinforcement of adaptive capacity.
- The tourism sector, historically presented as an opportunity to reduce economic exposure to drought, has in fact contributed to new forms of vulnerability given the geographical and economic concentration of the sector.
- Diversified economic growth combined with geographical decentralisation of socioeconomic activities can provide the conditions for resilient economic development in Senegal.

Executive summary

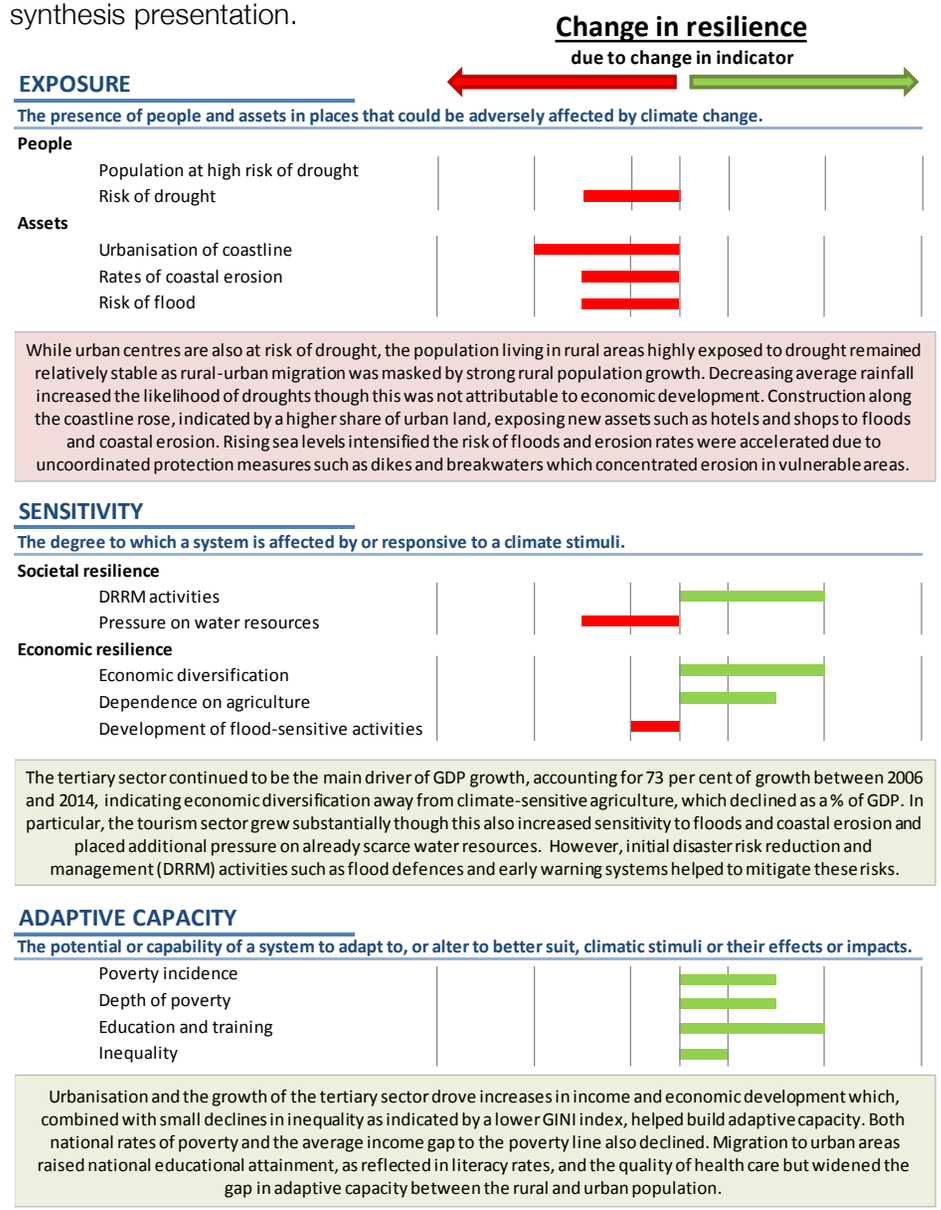
Urbanisation and economic diversification are transforming the climatic risks that Senegal faces and widening the rural-urban resilience gap. Internal migration from rural inlands to urban coastal areas in combination with strong growth of the tertiary sector, particularly tourism, reduced vulnerability to droughts but increased exposure and sensitivity to floods and coastal erosion. Economic diversification also decreased sensitivity to climate variability and led to broad-based improvements in living standards, social infrastructure and adaptive capacity. However, such benefits have been concentrated among urban centres and widened inequalities in resilience across Senegal.



Both rural exposure and urban exposure, based on approximations of the population living in areas at high risk of droughts and floods, respectively, have increased steadily with GDP per capita. Sensitivity, as measured by the ND-GAIN vulnerability index component, has shown some variation across the dataset, with Senegal becoming slightly more sensitive as GDP per capita surpassed $1,300 but then decreasing to initial levels from around $1,900. Adaptive capacity, from the same source, grew moderately with development until a sharp rise to around $2,000 per capita, after which it levelled off.

The case study addresses the question: 'How has coastal and tourism development affected exposure and sensitivity to droughts and floods as well as adaptive capacity in Senegal?' over the 1990-2015 period. It drew from desk-based research and fieldwork including the review of technical reports, policy and legal documents, national and international databases and interviews.

The direction and relative scale of the impacts presented in the scorecard below are subjective judgements based on quantitative data wherever possible. Due to the availability of credible and accurate data, approximations are used for each indicator which may vary by geographical focus or time period. and others may draw from qualitative research. A full discussion of analytical constraints is given in the synthesis presentation.



Are impacts different for the poorest?

Migration is often unaffordable for the poorest and their resilience has remained low as a result. The rural poverty rate and gap are approximately double that in urban centres, and access to electricity, water and sanitation facilities are significantly lower. Even when rural households can afford to migrate, it is typical for men to migrate leaving women and children vulnerable and draining remote areas of young, skilled labour and income.

Even within urban centres, exposure and sensitivity to floods varies across income groups. The poorest tend to settle in low-lying informal settlements with little social infrastructure or service provision, amplifying the damage caused by climatic events. Formal and planned areas, such as the historic centre of Dakar, which is only accessible to the rich, often benefit from higher locations and effective flood defences.

The poorest also tend to find seasonal or casual work in agriculture or tourism, both sectors that are highly sensitive to climate variability and, consequently, offer little job security. If harvests are low, farmers will hire fewer seasonal workers, leaving the poor with no income and severely limited adaptive capacity.

Are impacts locked in?

The absence of a legal land use framework and inadequate urban planning in Senegal have undermined much of the urban construction exposed to climate risks. Such a framework is complex, costly and requires multi-stakeholder approval, and thus its absence may cause political lock-in of low adaptive capacity. Without it, informal settlements and construction could further expand into high-risk areas, and coastal zones could be further degraded.

The densely developed port of Dakar has caused physical lock-in of high exposure and sensitivity. As an international trade hub, the port is central to Senegal's economy. Little available land in the city (due to geographical characteristics) has caused development in areas prone to floods and coastal erosion. This has made relocation or coastal defence programmes highly expensive, if at all possible.

The growing tourism sector may also lead to economic lock-in of high sensitivity due to its high water consumption. Water supply in Senegal is often threatened by droughts. While current supply appears to be sufficient, a water management plan is required to manage increased competition among sectors, particularly if climate variability is set to increase.

What are the policy implications?

Economic diversification is a powerful climate risk mitigation tool. In Senegal, diversification away from agriculture and towards the tertiary sector has substantially reduced sensitivity to droughts but also introduced new risks associated with growing sectors. For example, the rapid expansion of tourism along the Senegalese coastline has created an increase in sensitivity to floods and coastal erosion. However, as the agricultural sector is a larger share of GDP, the impact of a drought is likely to be more severe than that of a flood. Therefore, Senegal is judged to have become less sensitive overall. From a risk perspective, standard economic policy may also encourage judicious diversification, but this is given greater emphasis by a climate resilience lens.

A legal framework for land use which accounts for climate risks may help focus development in low risk locations, increasing the resilience of assets. As much development in Senegal has been concentrated along the coastline, the value of assets exposed to floods and erosion has significantly increased. Due to a lack of information regarding climate risks, development decisions are often made without concern for resilience. A land use framework may have ensured that people and businesses accounted for climate risk and limited the development of informal settlements and tourism infrastructure in high risk areas. Such factors are unlikely to factor into standard economic development policy.

1. Introduction

1.1 Background to and context of the study

The physical effects of climate change will have direct and indirect impacts on economic and social structures and natural systems, and these impacts will have high costs (IPCC, 2001; 2014; Stern, 2006). Although the manifestation of climate change will vary across regions, at the global level the Intergovernmental Panel on Climate Change (IPCC) projects an increase in temperatures, melting ice sheets, rising sea levels and changing climatic variability, potentially leading to more extreme events such as flooding and drought (Field et al., 2012; IPCC, 2014). Many of these trends are already occurring, with attributed impacts on the fundamental components of human development, including livelihoods, health and food production (ibid.; Fischer et al., 2005; Sachs, 2015).

Within this context, it is important to consider how to build resilience, at both the macro, national, level and the micro, household and individual, level, to reduce or avoid the economic and societal costs of climate change. This will allow decision-makers within government and bilateral and multilateral donor agencies to identify what development trajectories can support climate-resilient growth and poverty reduction. As such, this research, focused on a case study of the Senegal, aims to understand better how patterns and trends of economic development affect vulnerability and exposure to climate impacts across sectors and populations, including distributional effects. This project is embedded within a broader agenda exploring the nature of climate-resilient growth in lower-income countries, in order to mitigate risks and avoid 'locking-in' vulnerability to hazards.

This report presents a case study from Senegal that explores the relationships between economic development and climate change. Commissioned by the Climate and Environment Department of the UK Department for International Development (DFID), it is one component of the project Understanding Patterns of Climate Resilient Economic Development, a research project to improve understanding of how climate change will affect economic development, and, in turn, how economic development shapes resilience to climate extremes and changes. It will make practical recommendations as to how policymakers in developing countries can influence patterns of economic development in order to avoid or reduce the costs of climate impacts. This phase of the research is undertaking four in-depth case studies to understand better how economic development has influenced vulnerability and exposure to climate impacts and the distribution of this vulnerability across different groups.

1.2 Conceptual framework

This case study was developed around a conceptual framework that aims to capture how patterns of geographic and sectoral development affect resilience, while also considering distributional effects, in particular the impact on the poor and marginal groups. Resilience is conceived within the IPCC-defined framework of exposure and vulnerability to climate-related hazards – that is, the presence of people or assets at risk to climate variation and the degree to which a system is susceptible to or unable to cope with adverse climate impacts (IPCC, 2001; 2014). Vulnerability – the propensity or predisposition to be adversely affected (IPCC, 2014) – can encompass a variety of concepts. In this report, we use a commonly cited framework in which vulnerability can be disaggregated as a function of sensitivity, the degree to which a system is affected by positive or negative climate variability or change (ibid.) and adaptive capacity, the ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences. These different aspects are integrated into the framework in Figure 1.

Figure 1: Conceptual framework for climate-resilient patterns of economic development

		Vulnerability	
	Exposure	Sensitivity	Adaptive capacity
Geographic			
Sectoral			
Distributional			

Source: Vivid Economics and ODI (2014), developed from Tarazona et al. (2014).

1.3 Methodology

The methodology of the case study included desk-based and field-based research, spanning January to April 2015. We collected and reviewed a variety of socioeconomic reports and data about Senegal and generated a list of research questions and data needs based on our conceptual framework. We visited Senegal (Dakar) for 10 days in March 2015, including the M'Bour region and Saly, to undertake interviews and site visits with stakeholders and to collect data. In all, we consulted 15 organisations and government agencies, often meeting with several staff from each.

1.4 Rationale for the selection of case study

Senegal was selected as a case study because of its socioeconomic profile. Senegal is a lower-middle-income country in the World Bank's classification. The average annual economic growth rate has been around 3% in recent years, with $14.79 billion gross domestic product (GDP) in 2013 for a population of about 13.5 million.

As in all West African countries, seasonal internal migration (accompanying seasonal agricultural production) characterises traditional population movements in Senegal. In the past decade, these movements have been coupled with permanent internal migration from rural to urban areas, accelerating urbanisation. Urban centres – mainly located along the coast – concentrate increasing numbers of people and economic activities and are generating new benefits and also new climate vulnerabilities.

Senegal has traditionally relied on rain-fed agriculture, and in many ways is representative of other West African Sub-Saharan economies. However, macroeconomic trends over the past decade highlight an economy in the process of diversifying, with growth in tertiary sector activities such as tourism and finance. Economic diversification of products and exports has contributed to economic resilience. Although climate change has not been a particular driver of this diversification, it provides a window to understand how economic transformations can increase or reduce resilience to climate change.

Dakar is a regionally important capital: the economic and political changes in this city often influence the whole sub-region. For this reason, Senegal offers insights on how urbanisation, and economic tertiarisation and diversification, might affect climate resilience across West Africa.

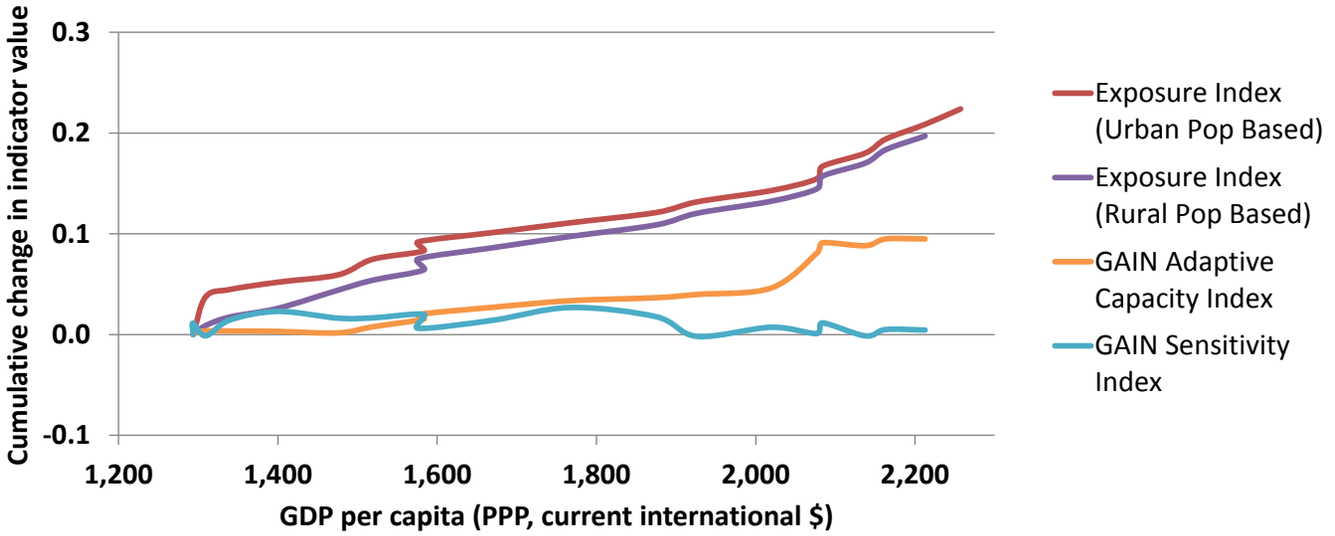
Indicators from ND-GAIN[1] suggest how economic trends in Senegal might affect resilience. Figure 2 shows the ND-GAIN indicators for exposure, adaptive capacity and sensitivity against national economic growth (assessed by GDP per capita). The graph shows an increase in exposure (in both rural and urban areas) and adaptive capacity dimensions, while sensitivity remains constant. However, in terms of aggregation and definition of indicators, the ND-GAIN data provide little insight into *how* economic growth has changed resilience. The current study therefore focuses on how economic and geographical patterns (i.e. urbanisation and tertiarisation) have shaped these general patterns of resilience.

1.5 Structure of the report

Our report is structured into three main sections. Section 2 presents historic economic patterns in Senegal. Section 3 assesses the impact of these patterns on resilience in the country. Section 4 discusses issues of policy, distributional impact and lock-in with respect to this analysis.

[1] The University of Notre Dame Global Adaptation Index (ND-GAIN) is calculated at the national level as a composite index of climate change vulnerability using three dimensions: exposure, adaptive capacity and sensitivity. Available at http://index.gain.org/

Figure 2: GDP per capita and ND-GAIN on climate change vulnerability



Source: ND-GAIN Index, http://index.gain.org/; WDI, http://data.worldbank.org/data-catalog/world-development-indicators; and authors' calculations.

2. Historic patterns

This section analyses three main socioeconomic patterns experienced by Senegal over the past decade. The first subsection explains why these patterns were selected, showing they are representative of regional changes and relevant to issues of climate-resilient development. It also outlines the broad national contexts within which these changes occurred. The second subsection provides figures and indicators to characterise and analyse these patterns over the past 10 years.

2.1 Context

National and regional socioeconomic dynamics

Senegal is similar to other West African countries in terms of agricultural production systems and climate risk. Agriculture is largely based on traditional rain-fed and pastoralist systems and so is highly dependent on climate conditions. Correlations between agricultural performance, agricultural prices and rainfall variability are both important in West Africa, although these relationships can be complex (Aker, 2012; Araujo-Bonjean and Simonet, 2012; Ndamani and Watanabe 2014; Yengoh, 2013).

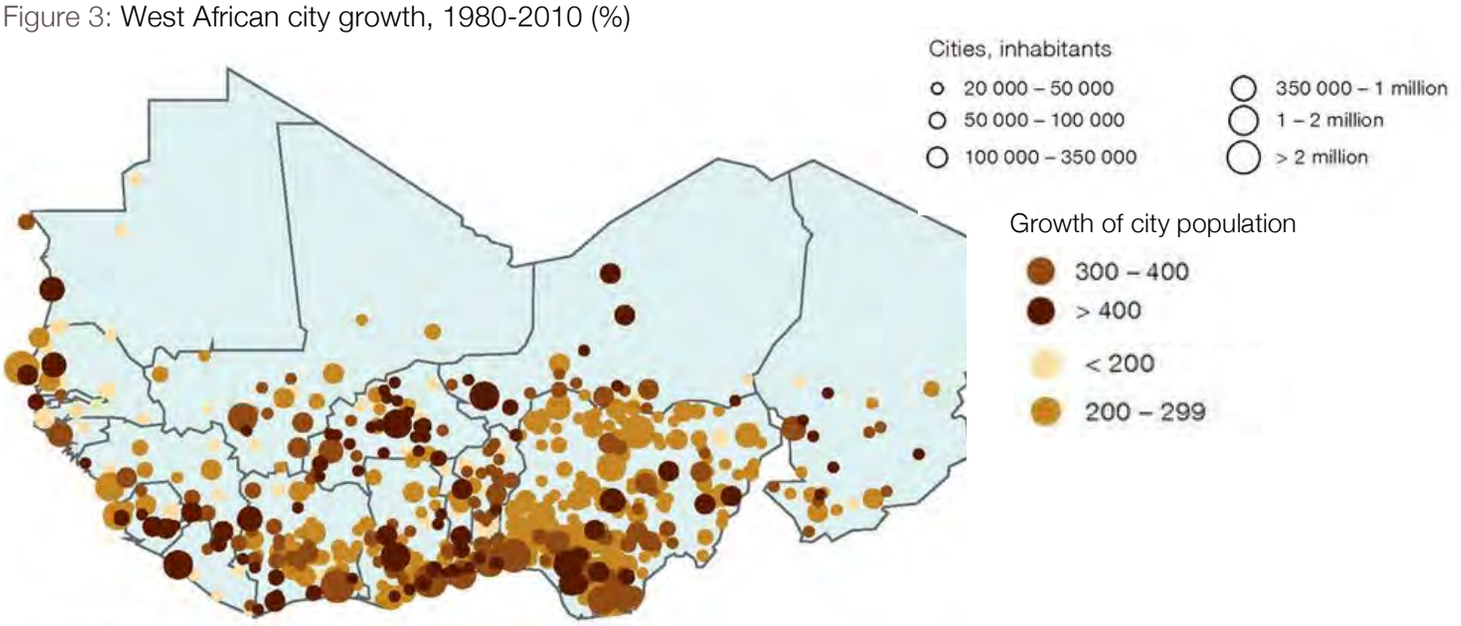
As in other West African countries, Senegal is experiencing large internal migration and urbanisation (Figure 3). The population of Senegal is estimated at 13.5 million, of which about 50% live in urban areas.

In Senegal, this internal migration is coupled with an unbalanced population distribution between the interiors and the coastal areas. Urban centres, economic activities and half the population are concentrated along the coast.[2] In a context of political decentralisation being implemented in Senegal and across the West African region at various level (Caldeira and Rota-Graziosi, 2014), the question of uneven population distributions and their consequences for equitable economic development is important. Especially for Senegal, this economic disequilibrium combines with specific geographic and climate vulnerabilities.

Finally, Senegal is experiencing significant economic tertiarisation and diversification. Most Sub-Saharan African economies are still dominated by a primary sector and agricultural production that is highly vulnerable to drought events. In this context, Senegal's experience of economic diversification (the country is one of the most diversified economies in West Africa) provides an important lesson for neighbouring countires. In Sub-Saharan African economies in 2013, the average share of GDP from the agriculture sector was 25% (IMF, 2014):

[2] The World Bank (2014) defines the Senegalese coastal area as the territory of 10 km to the shore along the coastal line (531 km). We refer to this area when we cite the World Bank report. Unfortunately, specific socioeconomic data have not been produced on this area. For socioeconomic dimensions, we consider the coastal regions of all Senegalese regions with access to the sea.

Figure 3: West African city growth, 1980-2010 (%)



Source: OECD (2013).

in Senegal, it was 17.5%. In the same year, real GDP economic growth in Senegal was estimated at 3% (using World Development Indicators database, the National Agency for statistic in Senegal ANSD estimates it at 3.5%), mainly because of the growth of the services sector (6.4%). Economic diversification in general and tertiary sector development in particular, which have accelerated over recent years, are regarded as key to increasing economic growth and strengthening economic resilience to shocks.

National context specificities

A few key contextual factors are useful background to understand how Senegal's economy has grown, why and the implications for climate resilience.

- **A sustainable political stability.** Considered by the World Bank as one of the most stable African countries, Senegal has a strong democratic and political administration. The international community recognised the last election as transparent. Compared with recent events in Côte d'Ivoire, Mali and North Africa, Senegal represents political stability in an agitated sub-region. As a result, Dakar is effectively the regional hub of West Africa.
- **A vulnerable and indebted economy.** Political stability has not been matched by an acceleration in economic growth. Senegal's recent economic growth rate has been on average 3% per year. The country is still included on the list of least developed countries. Its Human Development Index ranking remains low, and the country faces significant economic vulnerability. A frequent attendee of the Paris Club, Senegal is heavily indebted in spite of debt relief under the Multilateral Debt Relief Initiative in 2006. Senegal's public and external debts ratios have been substantially augmented in recent years, from 25% of GDP in 2007 (just after the 2006 debt relief) to 49% planned in 2014 by the International Monetary Fund (IMF). The current ratio of the debt service is again close to levels of the initiative for developing countries (3.8% of GDP) and represents a warning threshold for various stakeholders. This level is one of the highest of West African Economic and Monetary Union's countries (WAEMU). Senegal has to implement long-term and important reforms without financial flexibility.
- **A dominant informal sector.** In 2010, the informal sector accounted for more than 90% of employment in Senegal, 39.8% of total national production and 57.7% of non-agricultural added-value (ANSD, 2013) Income in the informal sector is generally volatile: risks are high and often uninsured, and salaries are lower than in the formal sector. The informality of the economy erodes the country's budget and fiscal base. The formalisation of the private sector remains a political major challenge for the country (IMF, 2014). Data included in this report need to be considered, keeping in mind that a large part of the Senegal economy is informal and, therefore, not fully reported here.
- **Decentralisation reform and the Emerging Senegal Plan (PSE).** Two key national policies support diversification and strengthening of the Senegalese economy. In principle, decentralisation reforms should empower municipalities, stimulating growth in urban centres and consequently diversifying destinations for migrants and reducing migration towards Dakar. The PSE aims to redistribute investment around the country and to support economic diversification, particularly in the tertiary sector. These two reforms are key policy drivers of the socioeconomic patterns in Senegal.

Selection of the socioeconomic historic pattern for the analysis

Against this background, our study examines three key geographic and socioeconomic patterns:

- **Migration from inland to coastal areas.** This pattern is also related to rural–urban migration, as the largest and fastest-growing towns and cities are in coastal areas. It leads to unequal subnational development, with concentrations of investment, poverty, sectors and economic activity, as well as socio-demographic characteristics. We consider how this migration has contributed to changes in climate risk exposure.
- **Urbanisation.** Urbanisation is a global phenomenon, but particularly high in Africa. Africa is urbanising faster than the other regions of the world and is projected to become 56% urban by 2050 (UN-DESA, 2014). This case study considers how national patterns of urbanisation are shaping vulnerability to climate change.
- **The tertiarisation of the economy with a focus on tourism sector development.** The role of economic diversification as a way to reduce the impact of shocks is well known in the macro and microeconomic literature (Barrett et al., 2001; Rugman, 1976). We consider how recent economic diversification has affected climate vulnerability at the national scale. In particular, we focus on the tourism sector, and ask how tourism development has changed the risk profile of the national economy to internal shocks (e.g. drought) and

external shocks (e.g. regional health crises).

The following subsection details these three socioeconomic patterns and the next section studies vulnerabilities and opportunities for climate-resilient development led by these transformations.

2.2 Historical trends

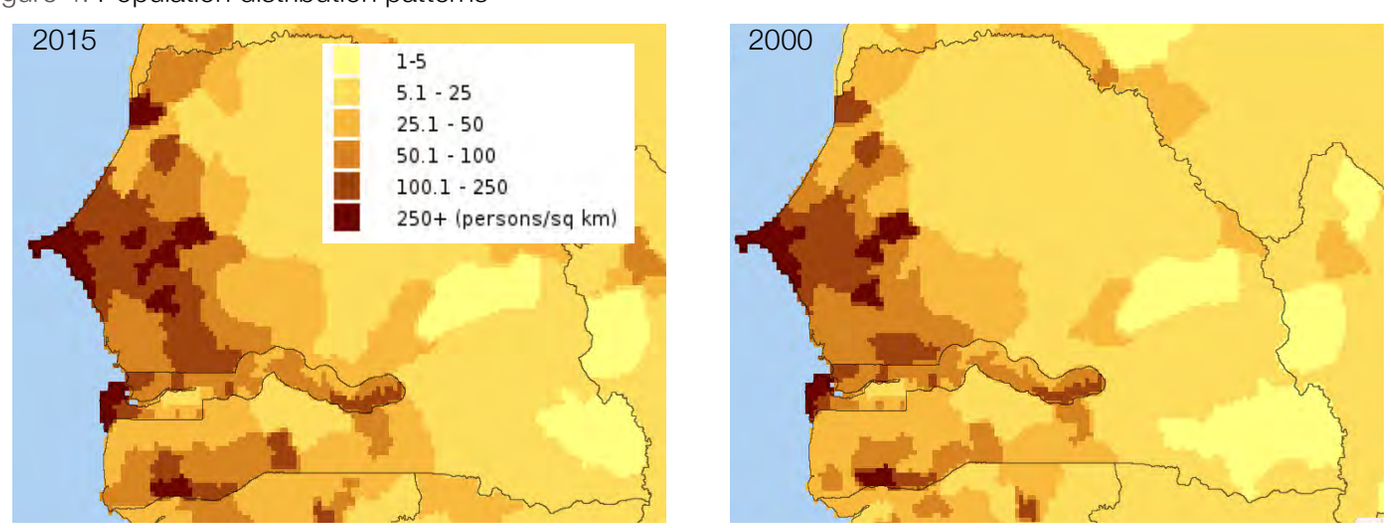
Internal migration, migration from interiors to the coast

Migration in Senegal is a traditional and seasonal phenomenon, documented at least since the 19th century. This migration is very particular. Early authors studying peanut production, named *navétanes*, found migration followed each peanut-growing season. This seasonal labour migration was a coping strategy for rural households to diversify their income (De Haan and Zoomers, 2005). Since 1960, migration studies have identified a change in the characteristics and an acceleration of permanent rural to urban migration. Evidence suggests the decision factors driving this migration include the impacts of drought, lack of water resources and decreasing yields during this period. As climate extremes appear to have been driving mobility historically, experts identify that climate change could have a role in accelerating patterns of migration (Thiam and Crowley, 2014). The role of climate change as a push factor of migration in Senegal is still debated but Sall et al. (2011) argue that, even if climate change is not a trigger for migration, mobility is still clearly an adaptive strategy. Droughts and bad harvest are driving factors, while searching for socioeconomic opportunity (e.g. jobs) is the main pull factor. The difficulties of the work and the uncertainties of rain-fed production are often presented as reasons for migration decisions (ANSD, 2013).

Population distribution over the country is highly imbalanced between interior and coastal areas. Coastal areas have high concentrations of population and economic activities. Population densities are five times higher along the coast than in the centre of the country, and around 60% of the population is located in the coastal zones, generating 68% of GDP. This high concentration of economic growth is reinforced by current national migration and leads to environmental vulnerabilities. The Senegalese coastline is densely urbanised, at 25.7% of the shoreline (over the period 2005-2010). The strong and rapid expansion of human activities near the fragile coastline raises local sustainability issues.

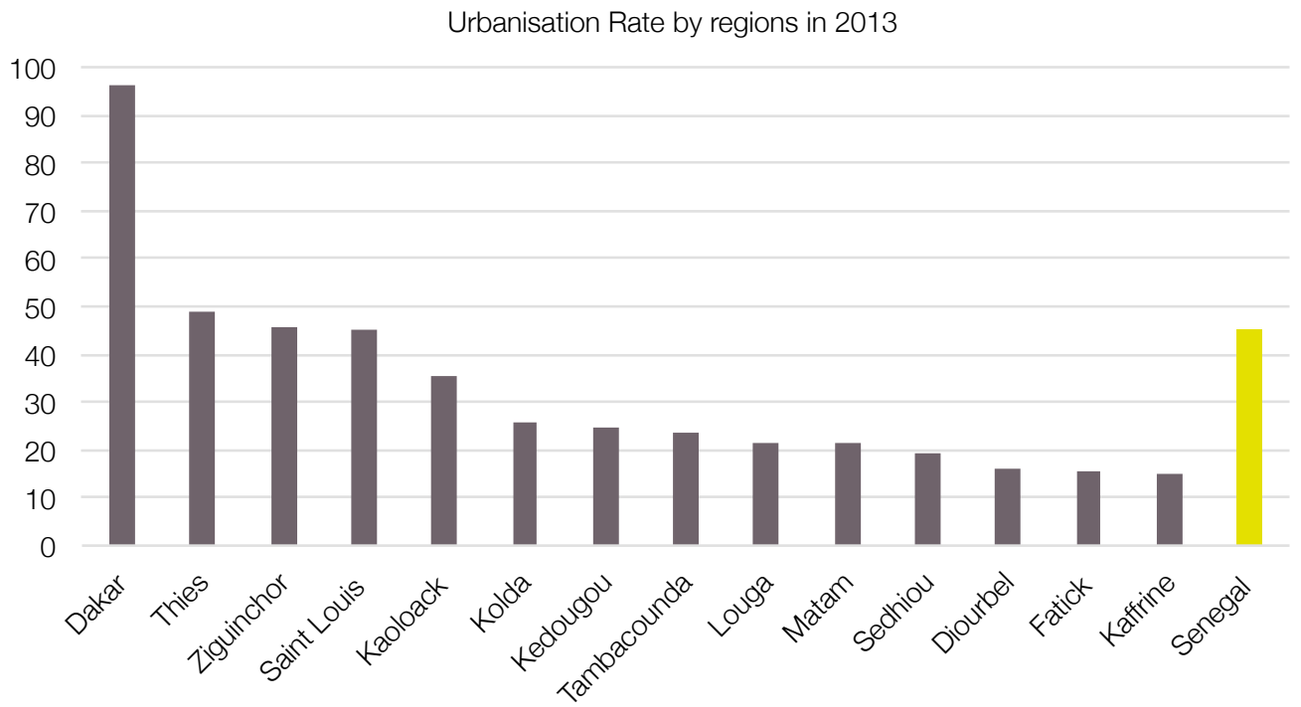
Economic patterns over the past 10 years have been characterised by the development of coastal regions in the urbanised western part of the country. Increasing population density and activity along the coast is visible over the past 15 years (Figure 4). Current projections indicate growth of the Senegalese urban population at 16% over the period 2005-2030, with maximum growth along the Petite Côte, an area south of Dakar that runs for 110 km from Bargny to Pointe de Sangomar, of about 49% (World Bank, 2014).

Figure 4: Population distribution patterns



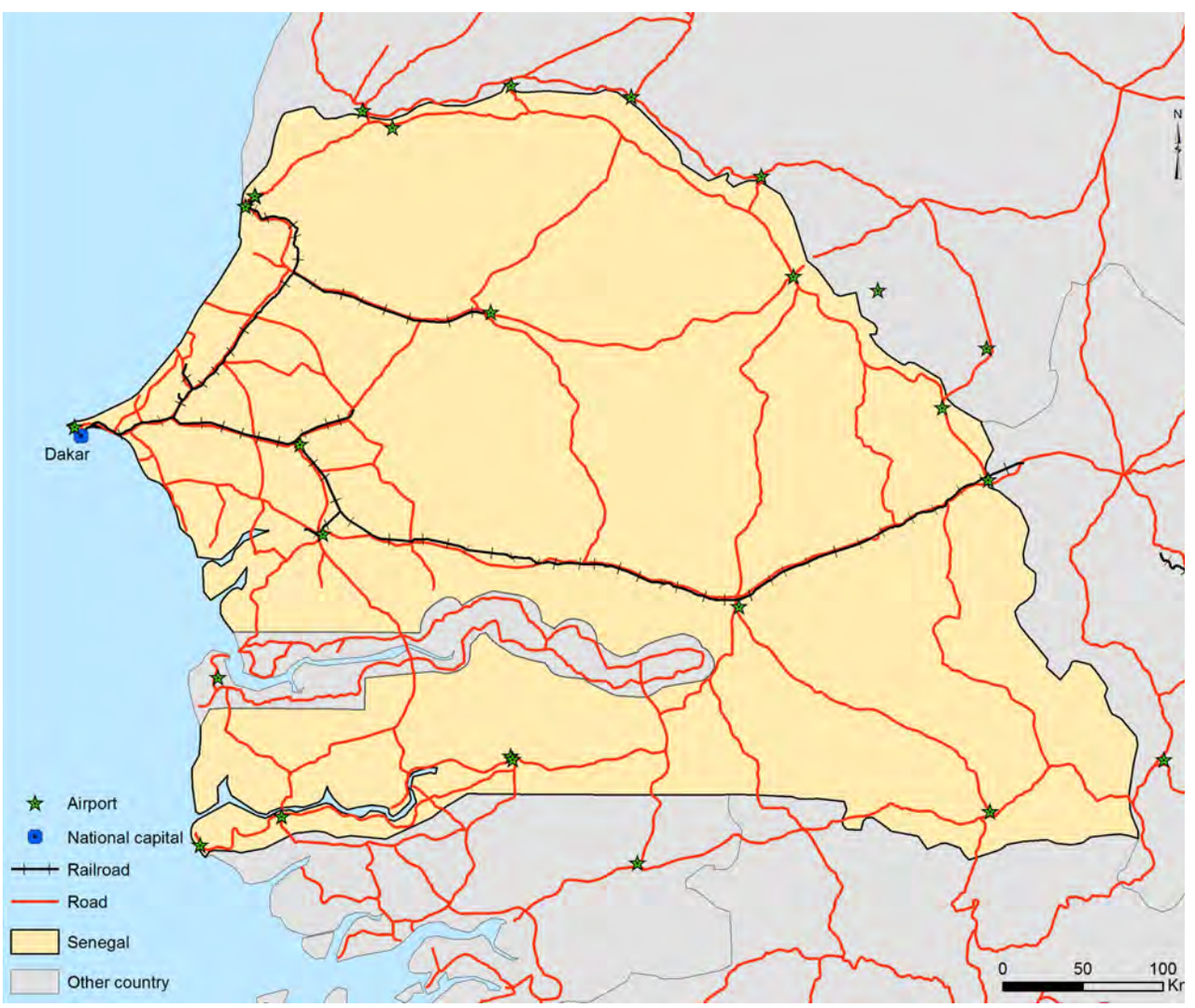
Source: CEISIN Population Density website: http://sedac.ciesin.columbia.edu/.

Figure 5: Urbanisation rate by region, 2013 (%)



Source: Authors' calculations based on National Census data (2013).

Figure 6: Location of assets



Source: Authors' calculation using http://www.basegeo.gouv.sn/Senegal-vectoriel.html database and FAO roads map.

Coastal areas hold concentrations of urban centres and economic activities. The national Census of 2013 confirms the unequal geographical dynamics of Senegalese regions (Figure 5). The coastal regions of Thiès, Ziguinchor and Saint-Louis have an urbanisation rate greater than the national average. Conversely, inland regions have a negative migratory budget, especially Louga and Kaolack (ANSD, 2013).

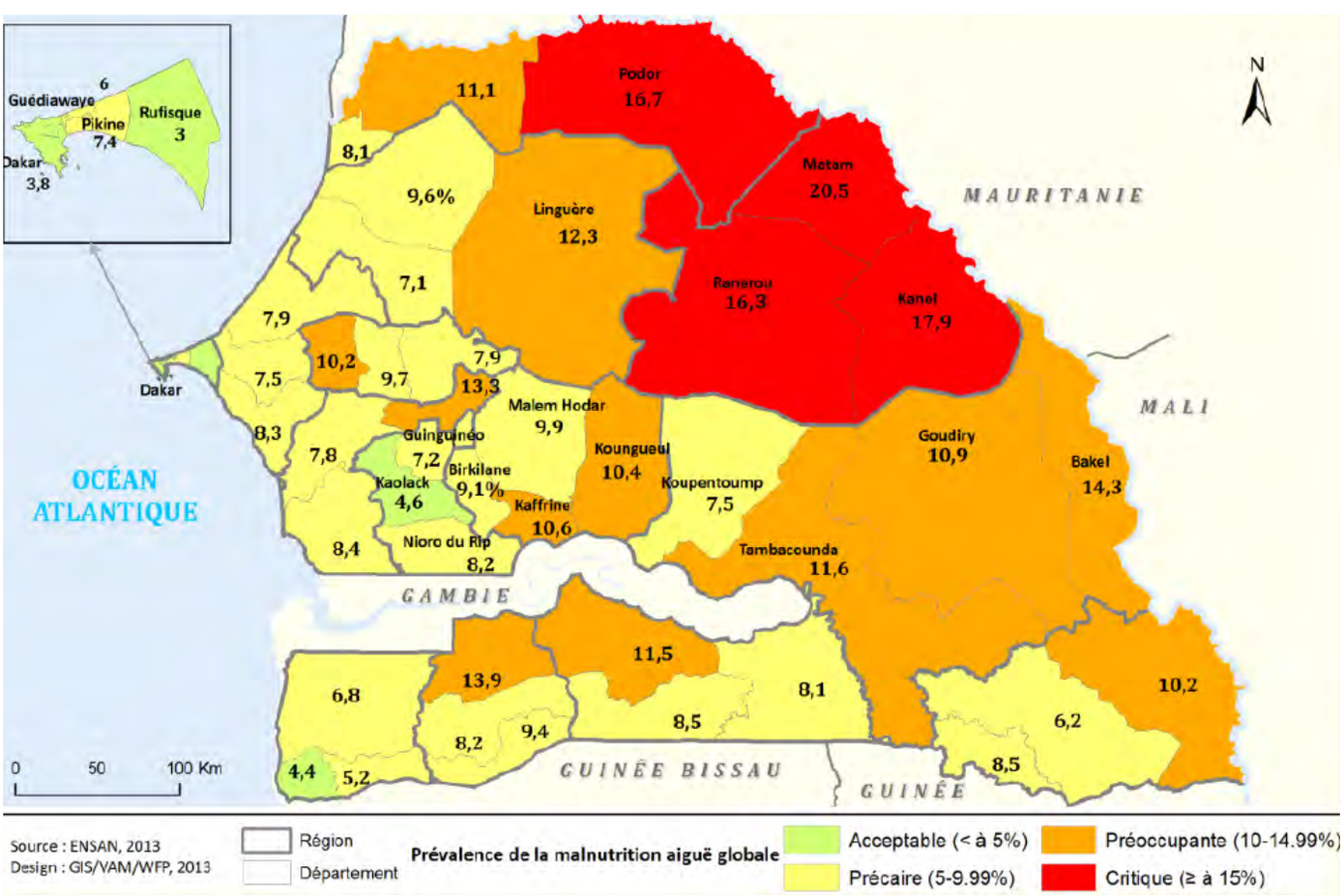
The distribution of transport assets over the territory also contributes to unbalanced population distribution. Major infrastructures are located in or close to the major urban centres and along the coast. For example, Dakar has a strategic port and international airport, and is connected to the historic capital of Saint-Louis by a major highway and a railroad. There are fewer major assets elsewhere in the country. As Figure 6 shows, airport and rail stations mainly follow the same unbalanced location, and the road network is denser in coastal areas.

Recent decentralisation reform is intended to promote the construction of dynamic urban centres to slow massive population movement to Dakar and create attractive alternative towns and cities for migrants. The growth of the urban centre of Touba is one example of this development, supported by the construction of a highway linking the town to Dakar.

These geographical disparities in assets and populations contribute to socioeconomic disparities. Coastal regions are more developed, with better access to health centres, hospitals and education. In Senegal, the urban population is mainly located along the coast, and is, on average, better educated and healthier. Mapping the multidimensional poverty index at the subnational scales confirms these territorial inequalities (OPHI, 2013; Pokhriyal et al., 2015; De Neubourg et al. 2010). The coastal zone is also less vulnerable to food insecurity, as Figure 7 shows.

Internal migration from rural to urban areas has been driven partly by the search for new economic opportunities after drought events. The coastal area contains fragile ecosystems, and high concentrations of assets, populations and activities exacerbate environmental issues in some areas. Coastal erosion, for example, is a serious issue along the Senegalese coast, threatening infrastructure, urban areas and the tourism sector in particular.

Figure 7: Prevalence of acute malnutrition



Source: WFP (2014b).

Urbanisation

The Senegalese population is still mainly rural. Half of Senegalese households are still involved in agriculture, their income relying mainly on rain-fed agricultural production. Some regions of Senegal have a particularly rural profile: Diourbel, Fatick and Kaffrine report 80% people working in rain-fed agriculture. Despite the 'traditional' agricultural profile of the Senegalese population, the main economic pattern of the past decade is growing urbanisation.

The population of Senegal is estimated at 13.5 million, of which approximately 45% now live in urban areas (ANSD estimations for 2015). Urban population growth rose from 2.86% in 2000 to 3.62% in 2013 (WDI database consulted in March 2015), with a noticeable increase in the five years to 2013.

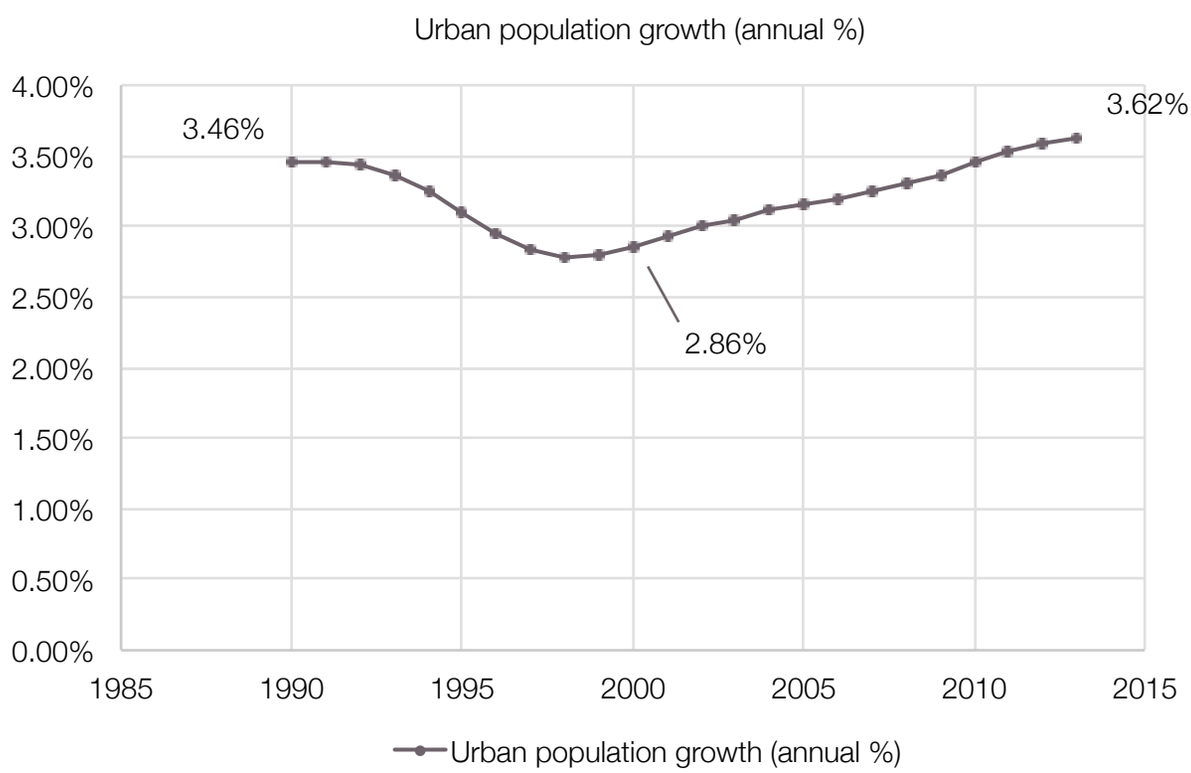
The last Senegal Census report published in 2013 confirms a 'rapid and uncontrolled' urbanisation (Figures 8 and 9). The urban population doubled from 2.9 million to 6 million between 1990 and 2013, and the urban population as a percentage of the total population also increased from 39% to 43%.

Urbanisation is concentrated in two important urban centres: Saint-Louis and Dakar. Dakar is densely populated and characterised by a strong urbanisation rate. Dakar covers just 0.3% of the overall national surface area, but holds one quarter (23%) of the population (ANSD, 2013). However, the urbanisation phenomenon is national and has led a growth of all city centres over all the country. It also corresponds to an increase of the coastal population.

The urban population is younger than the rural one (more than 50% of urban people are under 25 years old). Inequalities in urban centres are also larger and have more significant consequences for living standards and vulnerability than in rural areas (ANSD, 2014).

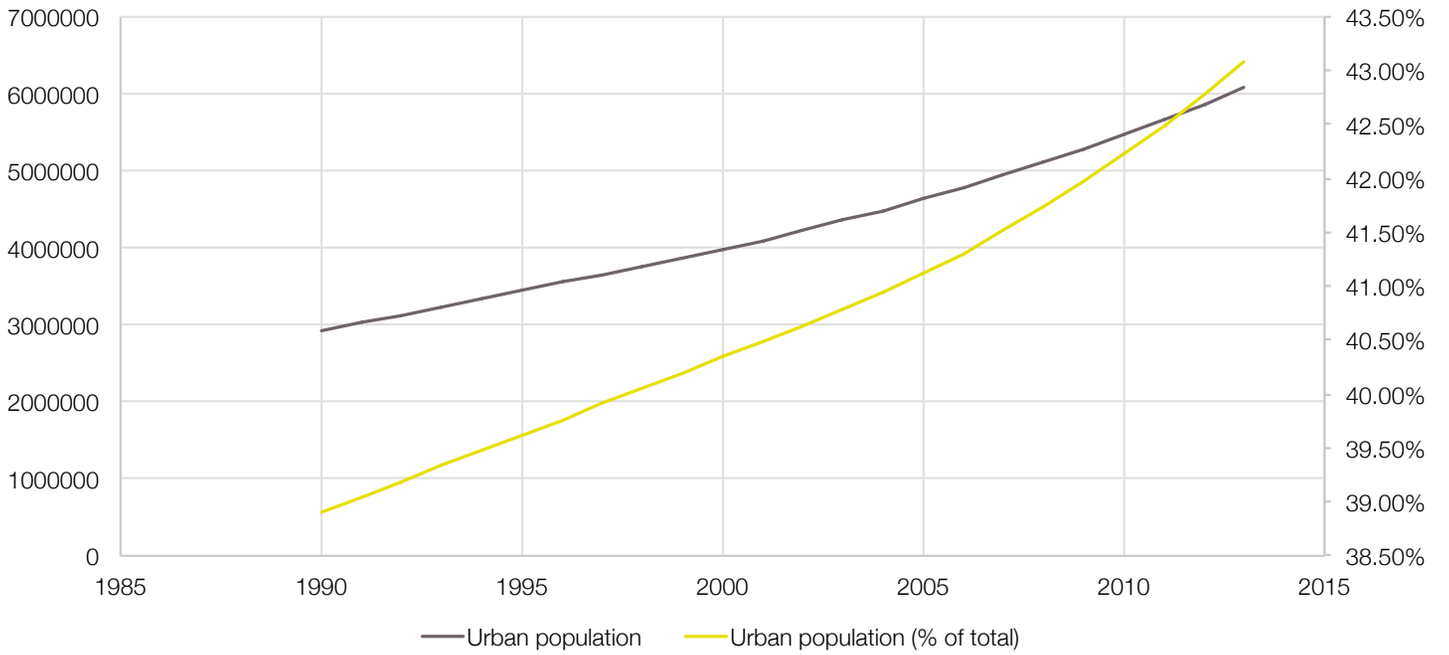
Urban centres are subject to specific climate risk. In Senegal, most losses owing to floods events are concentrated in urban centres (World Bank, 2014). Over recent years, extreme rainfall episodes have caused high levels of runoff, contributing to soil degradation, erosion and floods of low-lying areas.

Figure 8: Annual growth in urban population, 1985-2015 (%)



Source: Authors' calculations from WDI (2014), http://data.worldbank.org/data-catalog/world-development-indicators.

Figure 9: Urban population changes, 1985-2015



Source: Authors' calculations from WDI (2014), http://data.worldbank.org/data-catalog/world-development-indicators.

Diversification of the economy: focus on tertiarisation through tourism

Senegal is one of the most economically diversified Sub-Saharan countries. This diversification is the result of a sectoral shift from agriculture to services, including telecommunications and financial services.

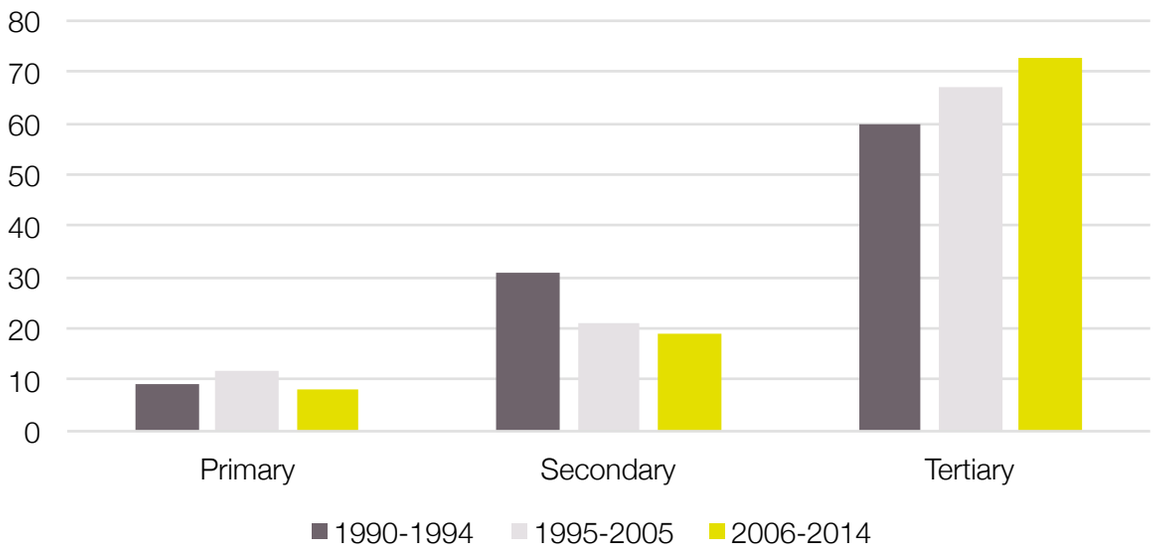
Tertiarisation of the economy

In 2013, real GDP economic growth was estimated at 3% (World Bank, World development indicators database). This value is mainly from the services sector (6.4%). The weakness of the secondary sector (-1.5%) and the poor primary sector (-8.3%) explain weak economic growth in 2013, which reflects a decrease in cereal production in a poor crop year.

While the industrial sector is almost nonexistent in Senegal, the primary and tertiary sectors shore up the economy through their production and the employment they generate. The primary sector is driven mainly by agricultural performance (and fisheries). The tertiary sector is characterised by a diversification of activities from trade, information and communications technologies (ICTs) and tourism.

The Senegalese economy has diversified over the past decade, with a reduced proportion of GDP generated by agriculture and a large increase in the tertiary sector. Over the period 2006-2014, the primary sector contributed just 8% to GDP growth, down from 12% a decade earlier. By contrast, the contribution of the tertiary sector to growth rose from 67% to 73% (Figure 10). Primary sector employment experienced a drop from 63% to 55% of employment between 1980 and 2012. Over the same period, the tertiary sector generated 62% of GDP and employment grew from 22% to 33%. Since currency devaluation in 1994, economic growth has owed mainly to construction, telecommunications, chemical industries, tourism and trade business, with declining relative contributions from agriculture (République du Sénégal, 2014).

Figure 10: Sectoral contribution to GDP growth (%)

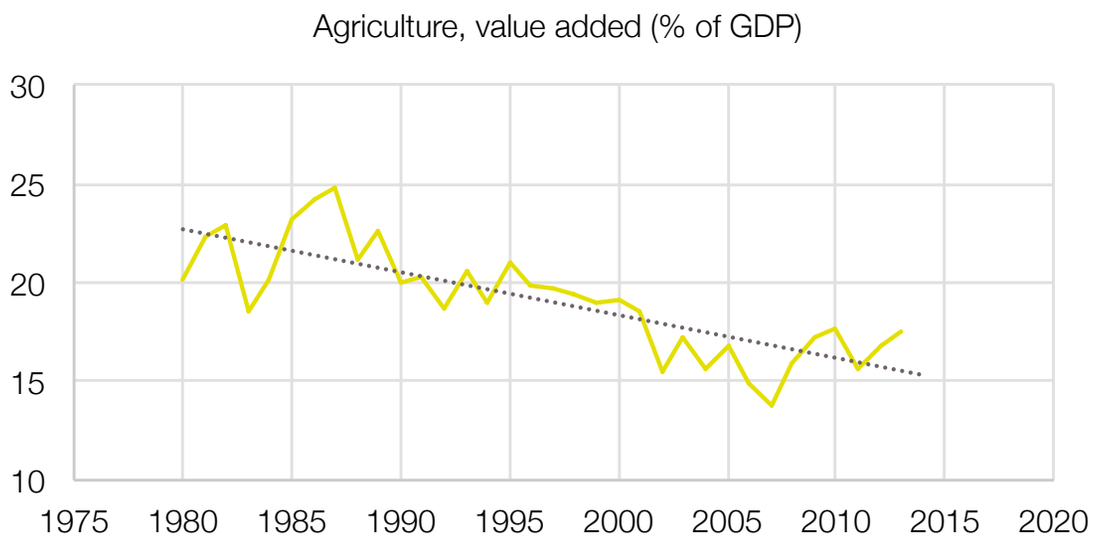


Source: Authors' calculations based on ANSD (2014) data, http://www.ansd.sn/index.php?option=com_content&view=article&id=134&Itemid=262; and World Bank (2014).

Although the economic weight of the agriculture sector is declining, it remains the largest single source of employment and has an important role in food production and food security. Poor harvests lead to critical periods of food insecurity and greater reliance on food imports, and agricultural performance is highly weather-dependent. Variable rainfall and climate extremes, particularly drought, are common causes of poor harvests. The contribution of the primary sector to economic growth is irregular and vulnerable to rainfall volatility (Figure 11). This high sensitivity of the primary sector, and erratic year-on-year performance, owes mainly to agriculture that is largely non-irrigated, rain-fed and unindustrialised, and that is highly dependent on the rainy season (Figure 12). However, industrialised agriculture, especially peanut production, is also dependent on rainfall (Fall et al., 2013). Over the past decade, all years of low agricultural performance are correlated with low rainfall levels (ANSD, 2014). This high correlation is not uniform over the territory, with areas of irrigated agriculture showing a lower correlation.

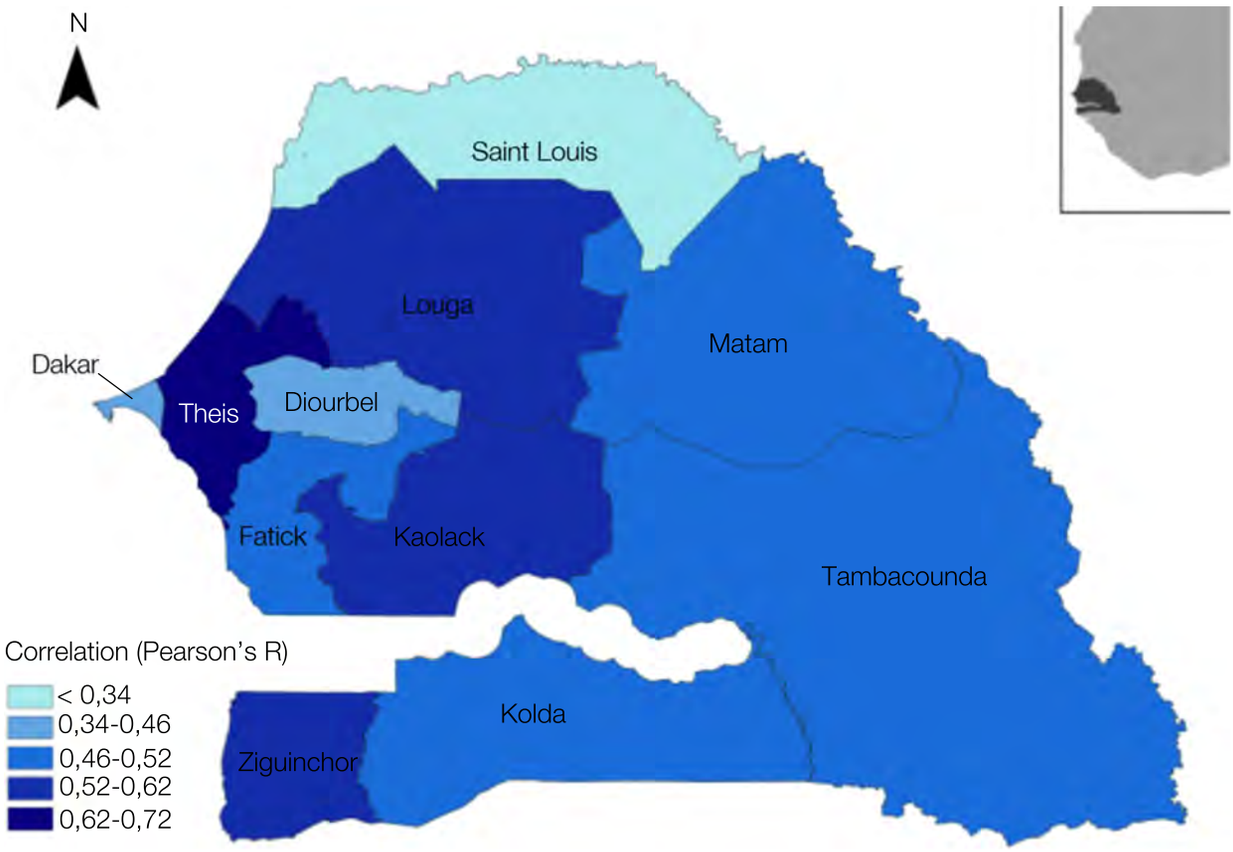
The tertiary sector represented the biggest percentage of Senegal GDP in 2013, estimated at 59.3%, a performance in line with the historical trend in this sector, which is growing every year.

Figure 11: Trends in agriculture's contribution to GDP, 1980-2012 (% of GDP)



Source: Authors' calculations using WDI (2014), http://data.worldbank.org/data-catalog/world-development-indicators.

Figure 12: Correlations between cereal production and seasonal rainfall at region level, 2000-2012



Source: WFP (2014a).

Senegal's profile as a developing country vulnerable to climate extremes and change, with a diversifying economy based in the primary and tertiary sectors, is a useful case to explore issues of climate-resilient economic development. Based on a robust macro and micro economic theory, this case study considers whether economic diversification improves national economic resilience to climate change and extremes. More specifically, we set out to test assumptions about the role of the tourism sector in strengthening economic resilience.

Tourism sector

Since the end of 1970s, Senegal's tourism sector has been supported with the help of the World Bank, so as to diversify the economy, reduce economic dependence on agriculture and mitigate the impact of droughts. Tourism was first developed in coastal areas, especially on the Petite Côte between Dakar and Mbodiene, areas previously dominated by agriculture and fisheries. The Society for the Management and Promotion of the Coasts and Tourist Zones (SAPCO) was created in 1975 to support development tourism, and by 1990 the Petite Côte was one of the main tourism destinations in Sub-Saharan Africa.

Today, tourism is a key sector for the economy. Senegal's tourism product has some diversity (see Appendix), but seaside (beach) tourism dominates the sector. In 2000, Saly village, the main touristic village of the Petite Côte, hosted 22% of the overall tourists in Senegal, and the Petite Côte as a whole hosted around one-third. Most tourists are from European countries, particularly France and Spain, and the sector has a marked seasonality, with peaks in January-March, during European winter.

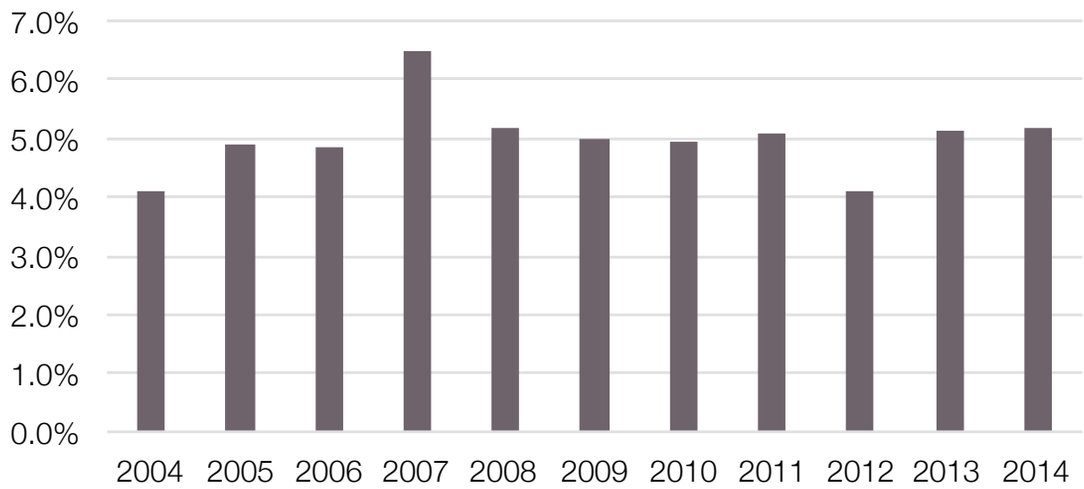
Tourism development is supported by national infrastructure and international investments, notably the highway from Dakar to M'bour (Wold Bank, 2014). The new Blaise Diagne International Airport is deliberately located between Dakar and Saly in order to increase access of international tourists to the Petite Côte.

One of the characteristics of the tourism sector is the socioeconomic spillovers that have accompanied the development of the sector. The Ministry of Tourism is now developing the Tourism Satellite Account in order to analyse in detail all the aspects of goods and services linked to visitor activities.[3] Economic activities generated by industries such as hotels, travel agents, airlines, passenger transportation services, restaurants and leisure industries are directly supported by tourists, and other activities also benefit from tourism. The total contribution to GDP of tourism was estimated at 11.9 % in 2014, representing FCFA 937.2 billion (WTTC, 2014). It is forecast to rise by 4.2% to FCFA 1,419.9 billion by 2024 (11.2% of GDP). As presented in Figure 12, the direct contribution to GDP of tourism constitutes 5.3%. Moreover the

[3] Methodology established by the World Travel and Tourism Council (WTTC) in collaboration with Eurostat, the Organisation for Economic Co-operation and Development (OECD) and the UN.

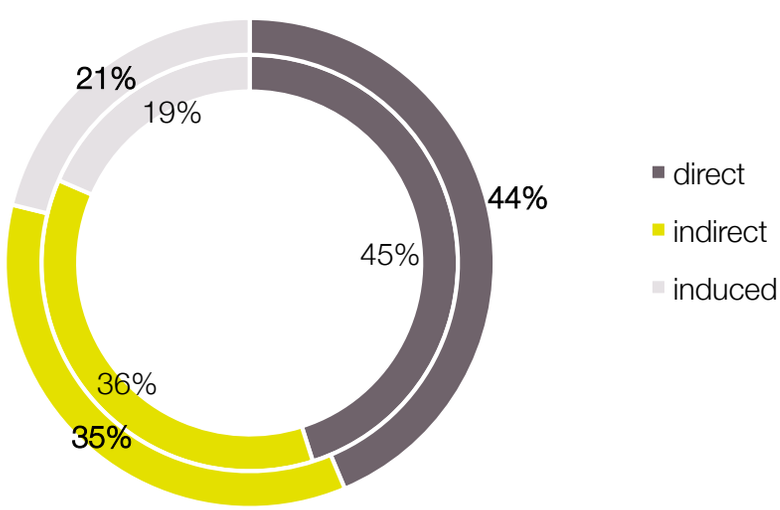
sector is source of formal employment, representing 10.2 % of the overall employment (WTTC 2014). The sector also constitutes the main source of foreign currency for Senegal, a key parameter for a country with a large external debt. Figure 14 summarises direct, indirect and induced contributions of the sector.

Figure 13: Direct contribution of travel and tourism to GDP, 2004-2014 (%)



Source: Authors' calculations using WTTC (2014).

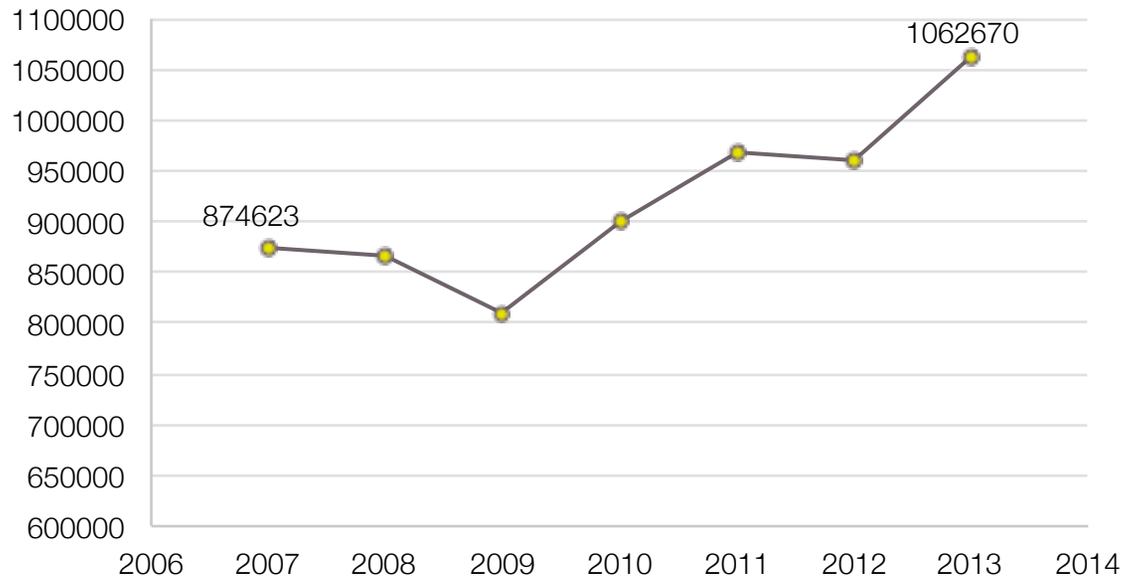
Figure 14: Direct, indirect and induced contributions of transport and tourism to GDP and employment, 2014 (%)



Note: Direct, Indirect and Induced contributions of transport and tourism to GDP are in italic and indirect and induced contributions of transport and tourism to employment are in bold.

Source: Authors' calculations based on WTTC (2014).

Figure 15: Number of tourist entrances, 2007-2014



Source: Authors' calculations based on compilation of the Aviation, Transport and Tourism Ministry statistics and annual reports available in 2014.

Senegal has natural assets such as a subtropical climate along the coastline, sand beaches and proximity to European markets. The sector has always seen an important number of entrances. However, tourism in Senegal faces several challenges, and tourist arrivals are sensitive to a range of factors, including some beyond the control of domestic policymakers. Domestic issues and challenges include the need for policy reforms (high taxes, lack of public investment, mismanagement) and the loss of beaches (beach erosion), which undermines the quality of the tourism product. There is undeniable evidence that the erosion of beaches, the most attractive Senegalese tourism asset, has caused a severe decline in the tourism industry in recent years.

Recent impacts on tourism arrivals of the Ebola crisis in West Africa and the Malian conflict has highlighted the importance of external shocks and stressors on tourism. The proximity of countries affected by the epidemic or in conflict discourages tourists, who tend to avoid or to postpone their journey to Senegal. At the time of fieldwork, no clear data on the effects of the Ebola crisis were available, but all interviewees agree on a massive impact of these two events on the sector during 2014 and 2015.

2.3 Summary

- Internal migration and urbanisation are important socioeconomic development patterns in Senegal. These changes indicate people responding to economic incentives, migrating from drought-prone areas where incomes are highly dependent on variable agriculture performances towards urban coastal regions. Migration provides more diversified activities, and income is less correlated with rainfall (drought). At the same time, urbanisation and higher population densities in coastal areas have led to unequal subnational development.
- The economic diversification of the country has spread risks. More specifically, the development of the tourism sector development over the past 30 years has diversified national sources of income source. National and international authorities supported this sector, which has constituted a key component of recent economic growth. This strategy led the development of highly concentrated beach areas now exposed to coastal erosion. However, as this diversification strategy itself was highly concentrated in one area – tourism – this has not removed the vulnerability to shocks, as evidenced by the impact of the Ebola crisis or Malian conflict (although this shock is not climate-induced).
- The next section analyses the resilience 'budget' of these changes, looking at how they have led to a shift in the climate vulnerability profiles of the country. It assesses how the current economic transformation has respectively affected exposure and sensitivity to the climate and adaptive capacity.

3. Analysis: impacts on resilience

3.1 Geographic patterns: migration and tension between rural/urban and inland/coastal areas

Rural–urban migration has accelerated in Senegal over the past decade. Dakar is both the centre of national economic activity and the main destination for migrants. As discussed in Section 2, internal migration in Senegal is characterised by a desertion of the interior and unplanned and uncontrolled urbanisation in coastal zones. As a consequences, assets, infrastructure, population and economic activities are unequally distributed over Senegal, with concentrations in coastal zones. This uneven development has led to specific geographic characteristics and climate risks. Coastal urban centres experience floods and storms, while the rest of the country is more exposed to drought. This section investigates how these population dynamics have altered the climate vulnerability of the population.

Geographic patterns and exposure

Senegal has historically experienced large inter-annual and inter-decadal variations in rainfall. High levels of climate variability are seen in periods of high rainfall years as well as drought years. Future projections of climate change for the region indicate that this variability is likely to continue, and could potentially increase, although there is high uncertainty with the future projections (Niang et al., 2014)

In addition, urban centres located along the coastline are periodically exposed to floods, highlighting issues related to land use in cities. These events arise from heavy precipitation associated with rainfall variability (above), but also coastal wind-storms and storm surges. The latter exacerbate underlying natural processes of coastal erosion – that is, from wind and wave action. There are, however, some additional anthropic factors (coastal artificialisation, dams that decrease sediment supply, sand mining and extraction from beaches) aggravating the issue.

These coastal areas are at potential risk from a future sea level rise and the associated changes in terms of erosion, inundation, storm surges and so on. Climate change, and the associated rise in global mean temperature, is projected to accelerate the sea level rise over the 21st century. Projecting the sea level rise is, however, complex, and a range of uncertainty is usually given in projections (Church et al., 2013).

The global mean sea level rise for 2081-2100 relative to 1986-2005 will likely be in the range of 0.26-0.98 m (IPCC, 2014), reflecting different future emission scenarios, climate model warming and sea level response. This can be compared with historic rates: global mean sea levels rose by 0.17±0.02 m (Church et al., 2013) over the past century, with higher rates over the past few decades (from 1993 to 2010 the global mean sea level rise increased by 3.2 mm/year).

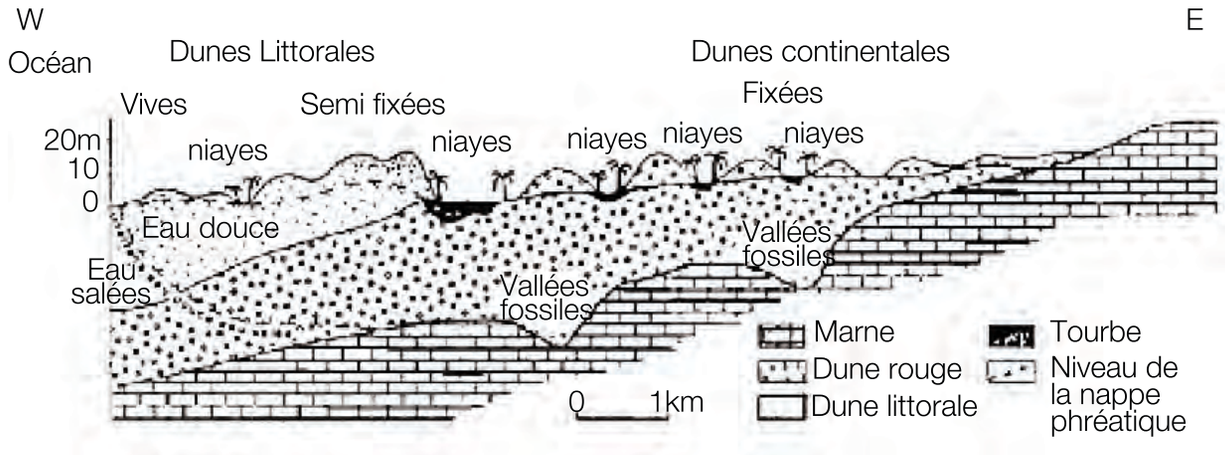
Senegal's rural to urban migration implies a desertion of rural areas, which are most significantly affected by droughts. Although drought can affect almost the whole country, as people leave inland areas (sometimes because of drought events), internal migration reduces population exposure to major events of low rainfall.

Urbanisation is aggravating flood risks. Hardening of roads and surfaces concentrates water runoff in urban areas, especially in formal built-up areas. Several actors and publications have confirmed the problem of drainage channel sizes and insufficient infrastructure capacity to cope with intense rainfall (interview, researchers from the National Institute for Agronomic Research of France (INRA)). Dakar and Saint-Louis are both already affected by run-off flooding (World Bank, 2013). On 26 August 2012, the area of Fann received 146 mm in less than one hour. This was the second largest rainfall event on record in Dakar (Institute of Research for Development (IRD) databases). Following the event, the area of Fann was completely flooded and inaccessible for several hours. Interviewees identified both recent increases in heavy rainfall events and urbanisation as being responsible for the increasing frequency of flood events. However, there is little evidence that heavy rainfall is increasing, as historic records document these events and high variability in the observations makes detecting any recent trends difficult.

Urbanisation has, however, driven construction in areas more frequently affected by and exposed to natural hazards. In Saint-Louis and Dakar, it has resulted in the occupation of flood-prone areas. In Dakar, the historical centre, called Plateau, is 10 m above sea level and experiences few flooding events. Recent construction has concentrated in areas more exposed to floods, called the Niayes – geological formations north of Dakar along the coast that are low-lying areas between dunes that function as flood channels (Figure 16).

Usually unoccupied, and officially areas in which construction is prohibited, the Niayes are now fully integrated in the urban zone of Dakar, given the city's expansion of informal settlements. The municipalities prohibit informal settlements, but very few initiatives

Figure 16: Niayes description



Source: Pezeril et al. (1986).

exist to enforce regulations and enact development controls. During heavy rainfall, the water table rapidly rises because of infiltration, and this reduces drainage and exacerbates flooding from runoff. Several deaths in these areas have occurred in recent heavy rainfall events, with six people dying during floods in 2012.

Coastal flooding is also a risk along the Grande Côte. In Saint-Louis, exposure to flood risk is significantly affected by the risk of coastal flooding, and will be further affected by the future sea level rise, especially where buildings are close to 0 m above sea level. Recent flooding events illustrate growing population exposure to floods, mainly resulting from the recent occupation of flood-prone areas (World Bank, 2013). More than 50% of the coastline is already considered at high risk of storm surges, particularly along the Grande Côte.

The World Bank (2013) analyses coastal land use occupation and assesses the exposure dynamics of the coastline, projecting that urbanisation (share of building occupation) in the Petite-Côte region will grow by 49% (coverage of building areas) between 1990 and 2030, representing the most significant change in exposure to climate hazards over the coastline. Over the 2005-2030 period, the study estimates, changes in coastal land use will accelerate. Coverage of urbanised areas is projected to increase by 16% over the coastline (following the coastal definition of the World Bank from 143.3 km of urban land use in 2005 to 166.5 km in 2030), to the detriment of agricultural and natural areas (Figure 17). This urbanisation implies a greater exposure of assets and population to coastal climate events.

Internal migration has lead to the construction of assets and infrastructure that are directly affected by flood and coastal erosion. The coastline is facing the consequences of unplanned land use and development. In turn, accelerating coastal erosion deteriorates and destroys private and public infrastructure and dwellings located in this area (World Bank, 2013). For instance, traditional fishing communities in Rufisque and Bargny underlined that sea encroachment had been present for many years but had intensified greatly over the past decade. It is characterised by coastal flooding and storm surges; rough seas with waves of more than 2 m damage seafront buildings (World Bank, 2013).

Figure 17: Evolution of coastal occupation with respect to the baseline situation, 1990-2030

	1990 (km)	2005 (km)	Diff.	1990-2005 (%)	2030 (km)	diff	1990-2030 (%)
Urban	127.0	143.3	16.3	13%	166.5	39.5	31%
Agricultural	260.8	249.0	-11.9	-5%	236.4	-24.5	-9%
Natural	126.7	122.3	-4.4	-3%	111.7	-15.0	-12%

Source: World Bank (2013).

Nonetheless, these areas remain economically valuable compared with inlands zones, with land prices and markets remaining high and strong in both urban and rural coastal areas. Exposure to floods, erosion and sea level rises does not yet seem to be affecting the value of stationary assets such as houses and land. Despite the risks, individual investors still regard coastal property as desirable, and assets in urban and coastal areas remain more valued than those in rural areas. In terms of the labour market, urban and coastal areas are still considered important place for employment: indeed, the desertion of inland rural areas is making it difficult for farmers to find workers (interview, INRA researcher).

Governments and ministries are sensitive to the issue of increasing exposure to floods and coastal erosion, and regulations related to urban planning and coastal development, although not yet adopted, are intended to reduce this exposure. Policy decisions at local and national level are increasingly taking growing exposure to flood risk into account and trying to identify measures to improve prevention. An independent ministerial secretariat is developing an early warning and emergency response system to reduce flood risk. Nonetheless, policy decisions and actions often lack coordination and coherence. The Coastal Act is another illustration of the interest of the government in the problem, although it has been waiting to be passed into law since 2009. The draft law is creating many expectations, as it is supposed to regulate the real estate market and establish rules for construction and creating protected areas in coastal zones. The recent PSE aims to balance population distribution and economic activity location by future investments, for example by favouring local and regional airports. To date, planned national infrastructure investments are located mainly in focus areas of economic development (as illustrated by the future airport aiming at reinforcing the link between Dakar and the south coastal area). If national public investments are not constructed in exposed areas, their location can reinforce asymmetries and drive population movements.

Rural to urban migration has been an important demographic phenomenon over the past 10 years in Senegal. Driven by economic factors, migration has led to two population distributional aspects: growth in existing urban centres and a strengthening of coastal urbanisation. Migration has changed the population's exposure to natural disasters – reducing populations in drought-prone inlands while increasing the number in coastal and flood-exposed zones. Economic assets and activities are also mainly located in coastal and urban areas. National investment has always been asymmetric between rural and urban areas, but recent rapid urbanisation has reinforced this. Nonetheless, recent policy decisions such as the PSE and Coastal Act indicate a political desire to reduce this exposure and vulnerability by (i) better managing coastal and urban occupation; and (ii) improving decentralised investments in order to slowdown the migration pattern.

Geographic patterns and sensitivity

Internal migration and seasonal population movements can be understood as a behaviour that reduces exposure (if the migration is permanent) or sensitivity (especially for seasonal migration) to drought. Seasonal migration helps households diversify their income sources. Then, working in tertiary sectors during the dry season, the household's income is less dependent on the rainy season and the agricultural harvest.

Reducing drought sensitivity is complex. Water infrastructure, such as for irrigation, is a costly investment. Especially in inland areas (semi-arid and Saharan regions), irrigation is not necessarily an appropriate option, given the crops cultivated and the behaviours of households. Diversifying sources of income to non-agricultural activities is one of the best options for households to reduce their drought sensitivity. Permanent and seasonal migration responds to this reduction of sensitivity, and young people often cite work conditions and income variability as departure drivers (ANSD, 2013; 2014). Migration reduces the overall sensitivity of the population to drought by lessening the dependency of the population on climate-sensitive activities (agriculture and livestock). But migration and urbanisation also raise potential new sources of sensitivity to climate risk.

Urban and coastal areas are places of economic activity less sensitive to certain climate extremes than agriculture, such as trade, information and communication technology industries, transport, construction, and public services). However, urbanisation increases other kinds of sensitivity because of surface hardening and poorly-adapted construction. Urbanisation increases flooding during storms and heavy rain sensitivity. Floods that affect urban areas have important economic consequences. In particular, Saint-Louis and Dakar are sensitive to the phenomenon. The situation is critical in Saint-Louis, a city that is highly sensitive to flooding from the Senegal River. The World Bank (2013) assesses the main damage from future climate change's impact on flooding at FCFA 1,550 billion/year in coastal areas (sea level rise and inundation, coastal erosion and river floods) by the 2080s. This is about 25% of GDP in 2010 and 35% of GDP in coastal areas. Saint-Louis is projected to experience half of the estimated damages.

Moreover, migration patterns exacerbate the inequalities of sensitivity. Poor people do not have the means to migrate (which is costly) and so usually stay in rural areas, employed in climate-sensitive activity. The poor urban population is often locked into informal settlement areas that are particularly exposed and sensitive to natural hazards. Saint-Louis riverside and Dakar have large areas of low-lying informal settlements. These zones are more at risk and land planning of these areas is a recent concern. Flood sensitivity is important for informal settlements and informal commercial activities based in these areas. All informal economic activities stop completely during severe floods in Saint-Louis (interview, university researchers). These findings are confirmed by a loss assessment of the 2009 flooding in Dakar, which mostly affected formal and informal trade: losses in the sector were estimated to be FCFA 1,305 million (République du Sénégal, 2010). Informal trade took up 75% of these losses. The discharge capacity of urban canals was judged to be insufficient in most city centres (World Bank, 2014).

Finally, urbanisation raises another potential problem in areas such as Dakar: the population's sensitivity to water shortages, especially during dry periods. Data from the National Water Company (SONES) shows half of Dakar's supply comes from surface waters channelled from Lake Guiers and the other half from boreholes. Increasing aridity – resulting from a combination of factors – is increasing the risk of water deficit in the short term for all the other urban areas along the coastline. While Senegal experiences periods of higher and lower rainfall, there does seem to be a recent trend of reducing global annual rainfall contribution, with a reduction from 176 billion m^3 to 132 billion m^3 since 1970, a loss of almost 25% of annual rainfall (Ndiaye, 2009). Along the coastline, the sea level rise will add additional pressures. Although this is not yet a limiting economic performance, it is likely to be a growing problem in the future (World Bank, 2014). Potential decreasing rainfall in the upper Senegal River catchment, increases in evaporation owing to higher temperatures and heightened competition for water and demand from urban areas could lead to much more demanding conditions for the management of Lake Guiers. Moreover, the hydrological balance of all the water tables is currently in deficit, and has been since the 1960s in Dakar. This situation, combined with deterioration in surface water quality owing to overexploitation, means there are no obvious options for mobilising alternative water sources.

State and municipality authorities are more and more concerned by sensitivity to floods in urban area and informal settlements. In Dakar, recent initiatives undertaken by the government aim at reducing the flood risk during the rainy season (drainage channels). Previous large national investment supported by the World Bank to reduce flood impacts in informal settlements in Dakar also illustrates policymakers' awareness of the issue. The development of early warning systems (EWS), national disaster planning and a secretariat ministry specially dedicated to flood risk illustrates capacity development at the national level to manage this growing risk. Urban drainage to reduce sensitivity to floods is recognised as important, and this is reinforced by plans for further investment. For example, the Plan Jaxaay requested FCFA 50 billion between 2006 and 2012 in Dakar to construct flood defences.

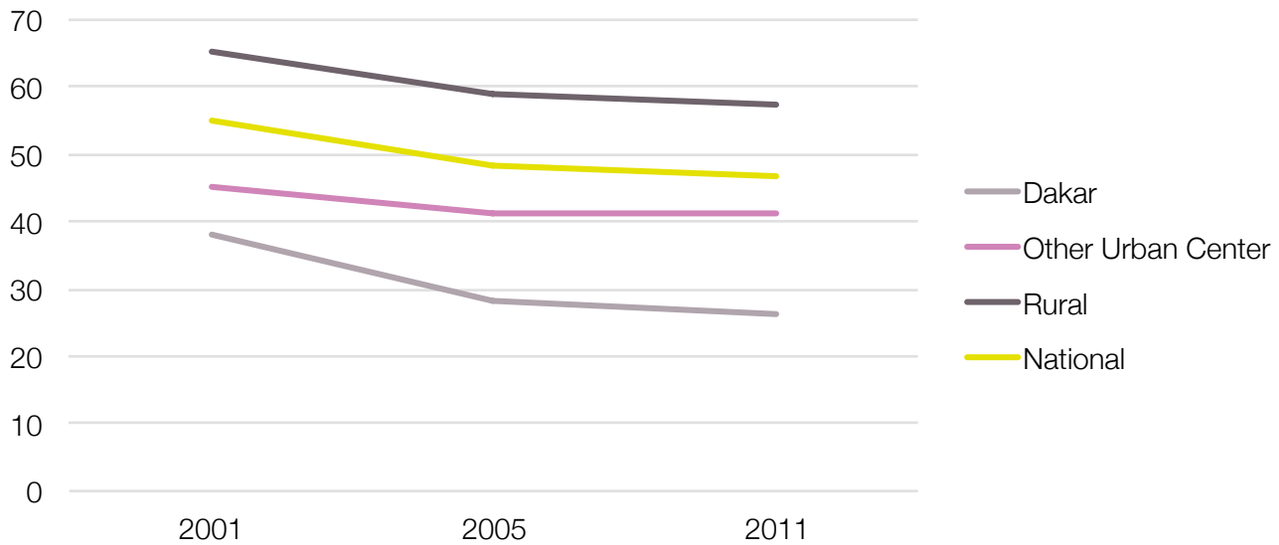
Nonetheless, we find it important to highlight that this political awareness must be aligned with rigorous disaster risk management planning. Historic attempts to manage flood risk have not always been successful, despite political willingness. In Saint-Louis, the breeching of the Langue de Barbarie to manage river floods has had serious negative consequences (see the Appendix), which it is important not to repeat. Disaster risk management decisions, to be effective, need a combination of political will and good EWS but also long-term planning that takes account of environmental consequences.

Geographic patterns and adaptive capacity

Senegal's geographic pattern of growth is mainly one of infrastructure development along the coastal areas and a population movement from inland to urban coastal cities. This development has influenced adaptive capacity in various ways.

As the previous section showed, coastal development has led to asymmetric development in terms of infrastructure between rural and urban areas, with roads, investments and airports concentrated mainly in coastal areas. This development has consequences for human and institutional capacity in the coastal zone. Dakar and Saint-Louis are now just three hours' drive apart, and infrastructure along the whole coastal zone facilitates migration as an adaptive strategy. Seasonal and permanent migration plus intra-household funds transfer are ways of coping with shock by diversifying the sources of risks. For instance, several hostel managers underlined that their seasonal workers came from rural areas and typically migrated during the dry season. In Dakar, a significant number of workers are single men transferring their incomes to their family in rural areas to supplement agricultural activities. At the same time, this has helped connect agricultural areas and producers (especially in horticulture) in coastal areas with urban centres, guaranteeing demand and more stable prices. However, the asymmetric development of infrastructure has left behind remote and interior rural areas. The adaptive capacity of these areas benefits from the development of urbanisation only

Figure 18: Poverty incidence changes, 2001-20011 (%)



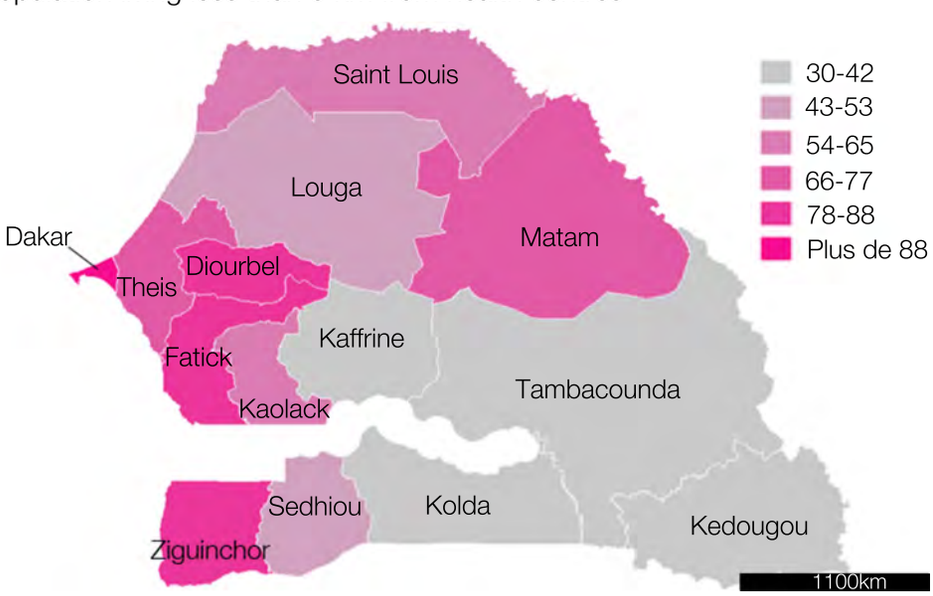
Source: ANSD (2011a).

through funds transfer and remittances.Incidence of poverty has seen the most important decrease in Dakar (from 38.1% to 26.2%); in rural areas it is still high (57.2% in 2011). Malnutrition prevalence follows the same pattern (interview, World Food Programme (WFP)). In the last Census, the literacy rate also showed clear unequal performances, from 28.4% in Matam to 68.6% in Dakar.

Interviews at the Ministry of Decentralisation also revealed high heterogeneity across municipalities in term of local receipts from taxes. Important urban centres (Dakar, Saint-Louis) seem more capable of relying on a stable fiscal basis and so fully benefit from the decentralisation reform; these capabilities are still very limited in rural municipalities (Figure 19).

School and health coverage also represent this imbalance. The rural population is more spread across the territory. The Millennium Drinking Water and Sanitation Programme (PEPAM) helps the government reach the Millennium Development Goals (MDGs) in terms of provisioning water. The share of the population with access to water in urban areas is almost complete (from 97% in 2009 to 98.7%); in rural areas improvements have been important (from 73.6% to 80.1%). But results for sanitation are still low, with average coverage of 34% in 2011 in rural areas and 63.3% in urban zones (IMF, 2013).

Figure 19: Share of population living less than 5 km from health centres



Source: ANSD website based on data from 2009 survey, http://sigstat.ansd.sn/sig_png/.

Urban centres create new risks in the form of floods, and the government appears well aware of these problems, even if urban use planning and disaster risk management need to be improved (especially post-disaster management). Individuals are still attracted by migration because of socioeconomic opportunities, and because the new risks they are exposed and sensitive to are less than the drought risks they are leaving or diversifying away from. For instance, we can imagine the trade-off calculated by a person now leaving in the Niayes in Dakar for whom the high vulnerability to flood is still positive compared with the risk and consequences of drought at home. Overall, people perceive the gain in term of health centre access, education and economic opportunities to be more important.

It is not clear whether migration to urban areas necessarily improves access to basic services. For instance, the last Census in Senegal (2012-2013), summarised in Figure 19, highlights good availability of basic health services in all Senegalese regions (an average availability of 75% for all basic health centres). However, access to public services is below average both in remote interior areas and in highly dense cities such as Dakar, Kaolack, Kolda and Tambacounda (ANSD, 2014). This implies that, as rapidly growing urban areas struggle to provide high levels of service, they may not strengthen the adaptive capacity of migrants as much as might be expected.

Summary: impacts of geographic patterns on resilience

Over the past 10 years, rural–urban migration has coincided with a rise of new exposure. Drought exposure is still high for all the population in the country because this phenomenon determining is food availability. Drought also affects the whole population through water and food availability. Urbanisation and coastal land occupation have led to new exposure of assets and people to coastal erosion and floods, primarily driven by socioeconomic drivers. Private and public infrastructure loss is already noted along the coast, and the exposure of people and infrastructure to floods and coastal erosion is expected to become more important in future decades.

Urbanisation and rural–urban migration are reducing existing drought sensitivity by diversifying income sources and risky likelihoods. Cities are places of income diversification, and are also providing economic activity and compensating for drought sensitivity. Migration implies funds transfer to the region of origin, helping mitigate drought consequences, even though the new economic activity in coastal and urban areas exposes people to flood risks. The net change in risks from these changes is unquantified, but it is likely to lead to a net reduction risk, at least in the short term (or a reduction in future risks of climate change). Moreover, government infrastructure to face floods and sea level rises aims to reduce the overall sensitivity of the economy.

High levels of urbanisation have coincided with important economic growth in the country. Urbanised areas are centres of various economic opportunities. Services provided in urban centres (schools, health centres and public transport) help reinforce the population's adaptive capacity. Urban centres are drivers of Senegalese economic growth; they host a population that is healthy and more educated than that in rural remote areas, where the prevalence of malnutrition is still high. Moreover, rural–urban migration provides an opportunity to compensate for and cope with drought events by enabling diversified sources of income (through seasonal migration or funds transfer between household members). However, it is still important to note that, although this helps in coping with drought shocks, it is also leading to rural desertion, which leaves the agriculture sector with fewer workers. Moreover, migration has also led to disequilibrium in terms of public and private investments and political attention: it is important to underline this to prevent a socioeconomic abandonment of rural areas.

3.2 Sectoral pattern: tourism as example of economic diversification and tertiarisation

This section focuses on development of the tourism sector. Tourism has been a key part of economic diversification away from agriculture at the national level, and we consider how the tourism development pattern is an adaptive strategy to climate. Tourism has numerous economic advantages in the Senegalese economy: it has an important share of formal employment, is a foreign currency provider and has spillovers into other economic sectors that include trade, transport and handicrafts and retail.

In Senegal, tourism development has been a way to diversify the economy and to develop sectors less vulnerable to drought. However, the high concentration of the sector has led to some new forms of vulnerability.

Senegal's economy is mainly exposed to drought and floods events, but the tourism sector is particularly vulnerable to coastal flooding and sea level rises, and the consequences of coastal erosion. Tourism sector development is supported by important public infrastructure including road networks and airports, and most of the main public and private touristic infrastructure is concentrated in the Petite Côte, where it is highly vulnerable to coastal erosion. Some hotels have already closed in Saly, a main tourism destination. This high exposure and sensitivity of the sector has already had physical and economic consequences. At the same time, the importance of the sector and its exposure and

sensitivity to coastal erosion have helped raise political awareness for the issue.

There is little data on how current climate variability or future climate change will affect the tourism sector. Data related to tourism in Senegal are mainly confidential and not available for sharing and evaluation. There is also apparently no regular public survey of levels of touristic satisfaction. There is no clear correlation between the tourism decline and beach erosion, because of lack of data, although sector specialists have noted that this is a contributing factor.

Sectoral patterns and exposure

International tourism in Senegal relies largely on beach tourism. Tourism arrivals in the future could be affected by changes in seasonality owing to temperature increases, or by changes in environmental conditions and risks resulting from climate change (Bigano et al., 2008).

The changes in climate could affect the attractiveness of the climate for beach tourism. This change is usually captured through a metric called the Tourism Climate Index (TCI). The TCI is a composite measure aiming to assess the climatic elements influencing the quality of the tourism experience. The index was first defined by Mieczkowski (1985); since then, the definition and the composition of the index have changed but the purpose is to assess physical climate dimensions that could influence tourism activity. A change in this index regarding climate change projections could impact future touristic attendance in Senegal, although changes need to be seen in the context of other changes globally given the international dimensions of the sector.

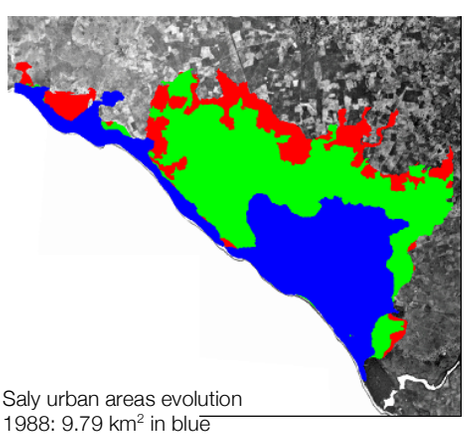
Senegal's tourism sector is also potentially vulnerable to environmental changes in the coastal area. As described in the previous section, coastal beach tourism is the main contributor to the tourism sector. Beach zones are particularly exposed to coastal flooding, erosion, and in the future, sea level rise. The Petite Cote and also Dakar is already suffering from coastal erosion, and projections made by the World Bank (2014), expect an increasing vulnerability of all coastal areas in the future.

Touristic infrastructure is concentrated in the Petite Côte, which stretches from Bargny to Pointe de Sangomar. Beach tourism is mainly concentrated in 90 km of coastal zone from Bargny to Joal Fadiouth, with around 20 villages and urban areas. Saly, which hosts the majority of beach tourism near Dakar, was a fishermen's village in the 1970s. All the available land is now covered by hotels or residential buildings, and land occupation by buildings rose from 10% to 25% between 1978 and 2011 (Figure 20). Saly has 15 different hostels and 23 holiday homes intended for rental, many of which were supported by the Senegalese government between 1980 and 1990 through SAPCO with the support of World Bank funds. Many touristic buildings are located close to the shoreline, and the unplanned and uncontrolled nature of construction has both exacerbated coastal erosion and led to high exposure to coastal flooding.

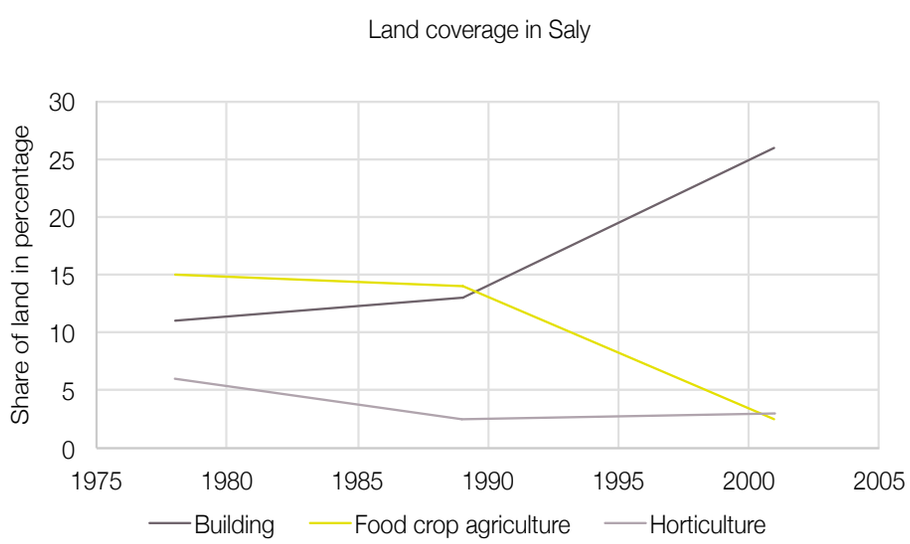
Most hotels managers interviewed in Saly have already seen their beaches reduced or disappear and hard infrastructure destroyed (Figure 21).

Some hotels experiencing high levels of coastal erosion cite this as a main reason for their poor performance in recent years.

Figure 20: Change in the land occupation in the area of Saly



Saly urban areas evolution
1988: 9.79 km^2 in blue
1999: 19.37 km^2 in green
2002:23.38 km^2 in red *(CSE 2010)*



Source: Authors' calculation based on CSE (2010).

Figure 21: Example of coastal erosion impact on the touristic areas in Senegal (south of Dakar)

Source: Intac (2011).

Urbanisation and touristic buildings have accelerated the erosion process and probably exacerbated their own vulnerabilities to coastal risks. Moreover, poorly planned actions by the private sector have also had negative consequences. For instance, in Saly, each hotel has built its own breakwater to reduce beach losses (see pictures). However, lack of planned coordination and reliance on *ad hoc* construction has led to an overall acceleration of erosion.

Around Saint-Louis, some hotel camping areas were exposed to flooding and erosion during the Langue de Barbarie breach (see Appendix 2). No clear assessment has been made of the costs to the tourism sector resulting from the losses of the camping settlements in this area, but private actors recognise that, similar to the beach in Saly, this erosion has damaged a particularly attractive part of their tourism offer.

Over-urbanisation and the concentration of tourism activities in a sensitive and fragile environment have exacerbated erosion. Today, more than a third of the tourism sector is directly affected by coastal erosion, and infrastructure is already being undermined and damaged (authors' assessment). In turn, high levels of erosion are increasing exposure to storm surges, coastal floods and, in the future, sea level rise. The PSE and the Tourism Development Plan for the period 2014-2018 recognise the high exposure of the tourism sector to coastal erosion and support an integrated approach with a systemic environmental cost benefits analysis in new touristic area development in the future.

Sectoral patterns and sensitivity

Senegal has always experienced high levels of rainfall variability. However, there are some observed changes in rainfall patterns and anecdotal reports of increasingly erratic rainfall, heavy rainfall and shortening of the rainy season. These reports must be treated with caution, given the region's characteristic inter-decadal variability, but local experts link these changes to poor agricultural performance in various crops (e.g. CSE, 2010). In particular, erratic rainfall and shortening of the rainy season is blamed for poor crop development and low agricultural yields.

In some areas, soil salinisation has led to dramatic impacts on rice cultivation, and cultivated areas in Kaolack, Ziguinchor and Kolda have been abandoned owing to soil salinisation. Salinisation is also affecting horticulture in Gandiol in the Niayes. It has been estimated that, by 2025, cereal production in Senegal could be reduced by 30% owing to the reduction of agricultural lands (Funk et al., 2012). Inland salinisation owes to both saltwater intrusion (especially in the Saint-Louis region, with the breech in the Langue de Barbarie) and poor water and bad crop management elsewhere along the coast.

Against this background, the tourism sector is an opportunity to reduce the exposure and sensitivity of households and the national economy to drought. Drought periods have a direct impact on the economic performance of the country through reducing yields from agriculture and livestock production. Drought is costly for the Senegalese economy and has numerous consequences, as most agriculture is rain-fed. The economy is directly affected by a bad rainy season, which is highly correlatedwith low production (but all poor production years do not owe only to the rainfall). These events happen frequently, and some areas suffer food insecurity as a consequence.

These shocks often force households to temporarily reduce their consumption. This situation – even when transitory – can force poor households to sell their assets to compensate for the loss of revenue. Droughts can also affect negatively the production capacity of households over several seasons and over the long term. This has a chronic or persistent impact on their

future situation (Dercon and Christiansen, 2011; Jalan and Ravallion, 1998; 2001; Morduch, 1999; Rosenzweig and Binswanger, 1993a; Rosenzweig and Wolpin 1993a; 1993b). Even if most of these studies are not specifically focused on Senegal, they report general findings that are applicable, especially given that insurance coverage is very low in Senegal, particularly for poor rural households. Drought is therefore responsible for a vicious poverty circle (Lokshin and Ravallion, 2000; Sarris and Karfakis, 2006). These lock the household into a low equilibrium. Long-term consequences are especially visible in low human investment in, for instance, education (Duryea et al., 2007) or health care (Jacoby and Skoufias, 1997). Beegle et al. (2006) show how, in Tanzania, economic shocks are directly related to child schooling, and Hoddinott and Kinsey (2001) confirm the important impact of drought on child health and malnutrition in Brazil (through the economic channel). Furthermore, a poor state of health and low education have important consequences for future productivity and wealth in adulthood (Barker, 1998). Long-term impacts of fragile health in childhood cannot be underestimated (Alderman, 2011; Dercon and Hoddinott, 2003; Ferreira and Schady, 2009; Strauss and Thomas, 2008). Drought is also a factor exacerbating the poverty and insecurity of households (Morduch, 1995). The overall consequences for Senegal are high, although there is a low base of empirical evidence. The shift to tourism therefore will change risks.

The tourism sector has several spillovers on the economy. Tourism generates taxation revenue for the government through airport taxes, residential taxes, sales taxes and other sources. Second, the sector creates jobs directly in activities such as hotel employment and guiding. Third, it creates demand for goods and services from others sectors such as handcrafts, transport and food. Peak tourism corresponds to the period of January to March, which is the low agricultural activity period. With this timing, tourism activity raises the demand for horticultural products during the dry period, creating incentives for irrigated agriculture. As such, the tourism sector is a source of diversified income during the slack agricultural period, and contributes to reducing the sensitivity of the overall Senegalese economy to drought.

During fieldwork, several tourism stakeholders confirmed the importance of activity during the dry season for income diversification at the household level. In touristic areas, it is common for families to develop a tourism-related activity to complement the agricultural main source of income. Typically, young people are employed as touristic guides and women develop a handcraft activity. Some households have also changed their crops in order to respond to demand from hotels and restaurants. For instance, a hotel manager in Saly mentioned a significant improvement in the regional/local supply over the past decade to meet the higher standards expected by tourists. Farmers interviewed talked about the choice they had made to reorient their production in line with hotel demand. For instance, some of them have abandoned chicken production for rabbit or quail farms.

In Saly, partly because of increased demand as a result of urbanisation and tourism, there is increased competition over land and water resources, and this is translating into increased sensitivity to climate change. At the local level, actors mentioned some tension regarding water use by hotels and leisure activities in Saly. For instance, irrigation of golf courses with recycled water is a source of tension between local people and farmers and the tourism sector.

Tourism is highly sensitive to water management in the area. Swimming pools, golf courses, fountains and irrigated garden/parks are all seen as key parts of the hotel package. During the past 10 years, the tourism sector has benefited from a discount in its water utility bill. Water supplies in the area are mobilised from groundwater, and the abstractions currently exceed recharge levels. This has not yet translated into water shortages in Saly and touristic areas. However, a prospective report on future climate change (World Bank, 2014) notes that erratic rainfall and rises in temperature in the next years combined with the current bad water management of the sector could provoke important consequences for Saly and more specifically the tourism sector.

In term of reducing sensitivity to natural hazards, various private or national infrastructures have been constructed, although their impacts on disaster risk reduction have been variable. Numerous breakwaters along the coast, especially south of Dakar, have accelerated coastal erosion. In order to protect their property, some hotel owners have built protection dikes in front of their establishments. However, this has intensified erosion in other areas. Lack of cooperation between public and private initiatives is also a problem. In collaboration with the World Bank and Global Environment Fund finance, the government has planned to construct several breakwaters after cost-benefit analysis and environmental assessment.

It is finally important to mention that tourism is sensitive and vulnerable to non-climate risks. The political stability of the region and Ebola are both factors that explain the recent slowdown in tourism arrivals. More generally, Senegal's image in source markets is the main driver for the demand in tourism. This perception and reputation is sensitive to multiple and diverse dimensions, both positively and negatively. For instance, the country's long period of political stability is regarded as one reason for tourist consumer confidence in Senegal.

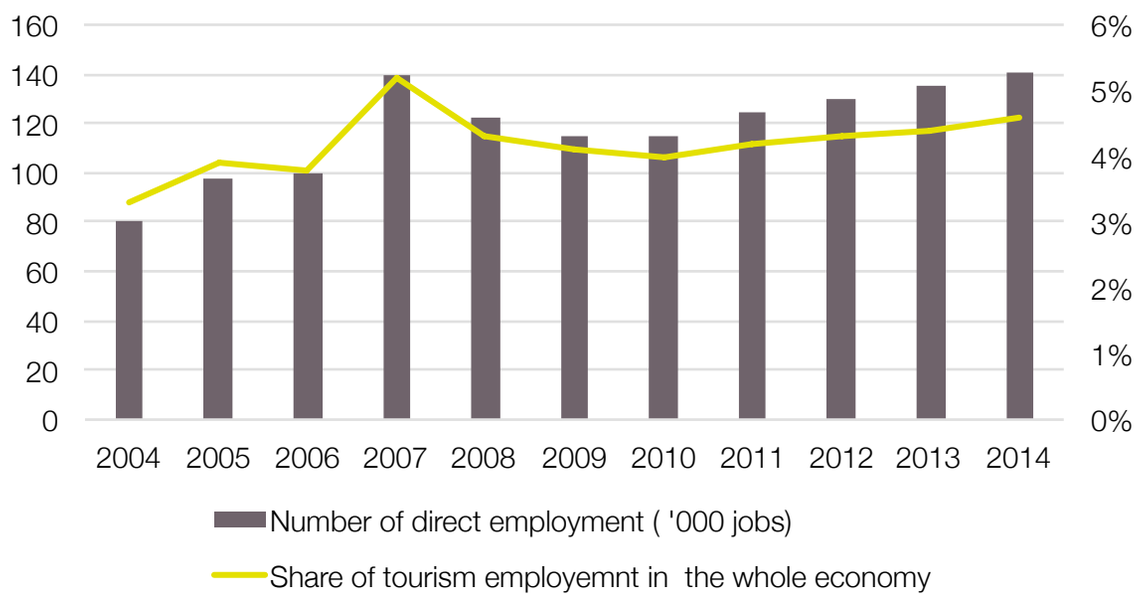
Sectoral patterns and adaptive capacity

The tourism sector has contributed to the diversification of Senegal's economy at all scales. Spillovers from tourism have supported socioeconomic services such as financing services, health care and schools in touristic centres. Senegal's adaptive capacity has clearly benefited from the development of the tourism sector in various ways.

First, through its contribution to the national economy, the tourism sector constitutes a new source of income, and this income helps strengthen resilience. The total contribution of travel and tourism to GDP in Senegal is twice as large as its direct contribution (WTTC, 2014). The resulting taxation and revenue is an important part of the wider economy. The shift towards tourism in the Senegalese economy has definitely been a strategy diversifying national and household revenues and contributing to the national income. Foreign currency earnings also constitute a way for the country to reimburse its debts and to ensure an international source of income.

Tourism is important for direct and indirect employment in the country and especially in touristic areas. As Figure 22 shows, tourism generated 134,000 jobs directly in Senegal in 2013, representing 4.5% of total employment (WTTC, 2014).

Figure 22: Direct contribution of tourism to employment in Senegal, 2000-2014



Source: Authors' calculations based on WTTC (2014).

Tourism activities have also helped accelerate the formalisation of the economy. In Saly, 65% of the population has an activity directly related to tourism and 54% of employment in hotels is formal (Intac, 2011). This share is higher than the national average, as only 10% of employment is formal in Senegal. WTTC (2014) estimates that tourism contributes to 4.5% of direct and indirect employment, and tourism can be considered as a route to formal employment in Senegal. As most tourism infrastructure is both international and formal, the sector's development has supported the formalisation of the wider economy. This has allowed the government to tax the private sector and enlarge its tax base.

Since 1980, productivity and quality of services have improved in the areas where tourism has been developed. Interviews with major hotel managers in Saly confirmed that tourism had attracted new services. Before the 1980s, no bank or health care facilities existed in Saly, for instance. Development of the sector has encouraged hospitality, schools and training development in Dakar and also at a decentralised level in M'bour. During interviews, managers confirmed that qualified national workers for hospitality services were now easy to find at national and local level, a marked change from what was the case in Saly during the 1980s. Some interviewees mentioned the tourism sector as a key factor in higher levels of education. Interviewees in Saly also said sanitation infrastructure – triggered by the growth of tourism – had improved school attendance. Provision of basic services is also

accepted as key to reducing the prevalence of malaria and malnutrition in the region (CSE, 2010). In general, touristic areas have higher levels of public health services and school coverage compared with the national level, and higher rates of employment and educational qualification The tourism sector has also encouraged a form of informal international development cooperation. In her thesis on tourism in Saly, Hayat (2006) notes that repeat tourists (guests who visit Senegal each year) are often involved in cooperation organisations and non-governmental organisations (NGOs) in touristic destinations such as Saly. These NGOs support initiatives that provide opportunities for development, often health centres, schools and social infrastructure. They also provide a source of long-term, independent financial investment that could have dramatic consequences for the economic development of an area. Saly is one of the municipalities benefiting the most from tourism (interview, Ministry of Tourism). A small majority of households (51% of Saly's population) identify tourist friends in their social and financial networks (Intac, 2011).

The tourism sector has also played a direct role in the financing of infrastructure for managing environmental risk. In Saly, this experience has been quite negative, with private initiatives by hotels constructing an *ad hoc* and non-harmonised series of breakwaters that have exacerbated coastal erosion. Nonetheless, the tourism sector has also supported private–public partnerships for climate change adaptation. The Hotel Sindone in Saint-Louis in partnership with the Regional Inspectorate of Forestry has constructed windbreaks and planted casuarina trees to fix coastal dunes, reducing erosion (REPAO, 2010). Here, the tourism sector has supported the public sector and strengthened adaptive capacity.

Although tourism actors are not well organised in Senegal, their voices are often listened to at the national level given the sector's importance in the national economy. For instance, the strong reaction of tourism operators to a changing national visa policy led to its cancellation after several months (Rodriguez, 2015). As the sector is highly preoccupied by the coastal erosion issue, their advocacy has raised policy interest on issues of coastal erosion and vulnerability to coastal flooding and longer-term sea level rises.

The concentration of tourism in areas such as Saly also has potential perverse effects. Several interviewees mentioned changes in fisheries and agricultural production in response to demand from hotels and tourism. In Saly, fisheries have become more selective in response to demand from hotels. Agricultural production has shifted from subsistence to niche production, making smallholders highly dependent on the touristic season. During interviews in Saly, hotel managers mentioned cancelling contracts with regular local food suppliers owing to the recent slowdown in tourism arrivals. Tourism in Saly is also associated with sexual tourism, which can have serious negative implications for human capital.

The development of tourism has strengthened adaptive capacity both directly and indirectly. By generating and diversifying income, tourism has contributed created opportunities and resilience for people and businesses. The sector has induced the development of supporting services, and contributed to better coverage of basic services in touristic areas. As it is highly vulnerable to environmental risks, the sector has also initiated both policy awareness and investment in defensive infrastructure. Nonetheless, some negative externalities should be highlighted, including rising inequality and perverse behaviour aiming at rent capture, which underlines the importance of appropriate supporting policies. A stronger legal framework and economic support for tourism development would help constrain the potential negative externalities of such a kind of development and maximise the adaptive opportunities.

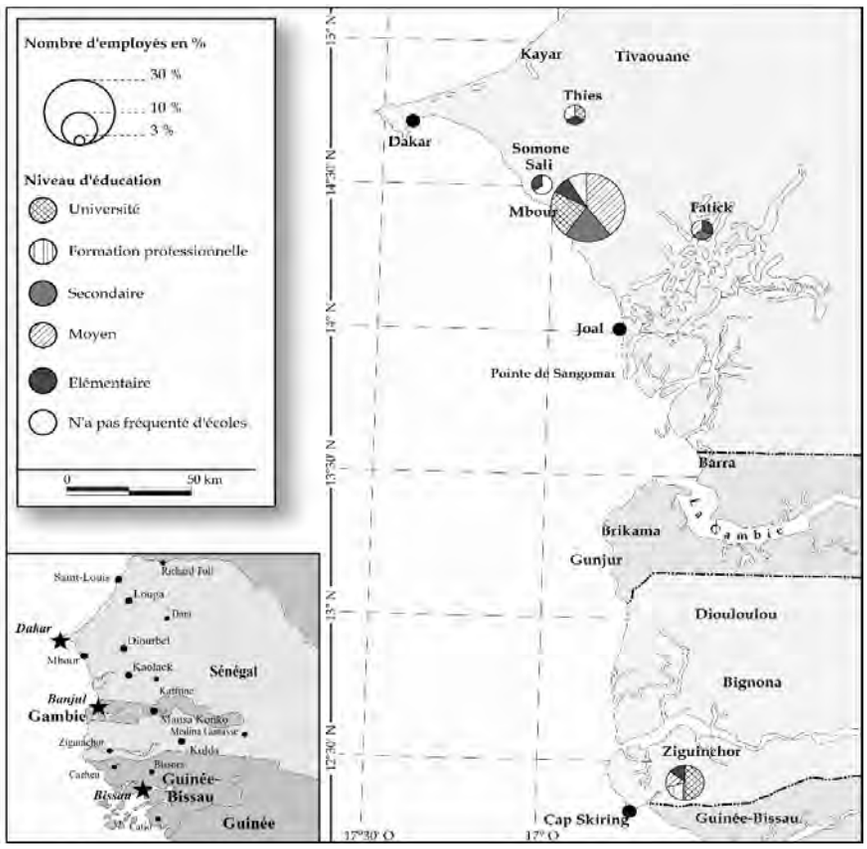
Summary: impacts of sectoral patterns on resilience

The development of beach tourism is highly concentrated and unplanned and has led to a clear and important exposure of the sector to coastal erosion. The sector already suffers high consequences of erosion, with loss of beaches and damage to infrastructure. Hotels in the Petite Côte have been highly exposed to and affected by this phenomenon.

Tourism has provided opportunities for income diversification at all levels of the economy, from the national to the household. However, the sustainability of the tourism sector and this diversification is conditional. Tourism is highly dependent on the availability of water and, as competition for water and climate uncertainties both increase, reforms to water management will be crucial to reducing risks from drought.

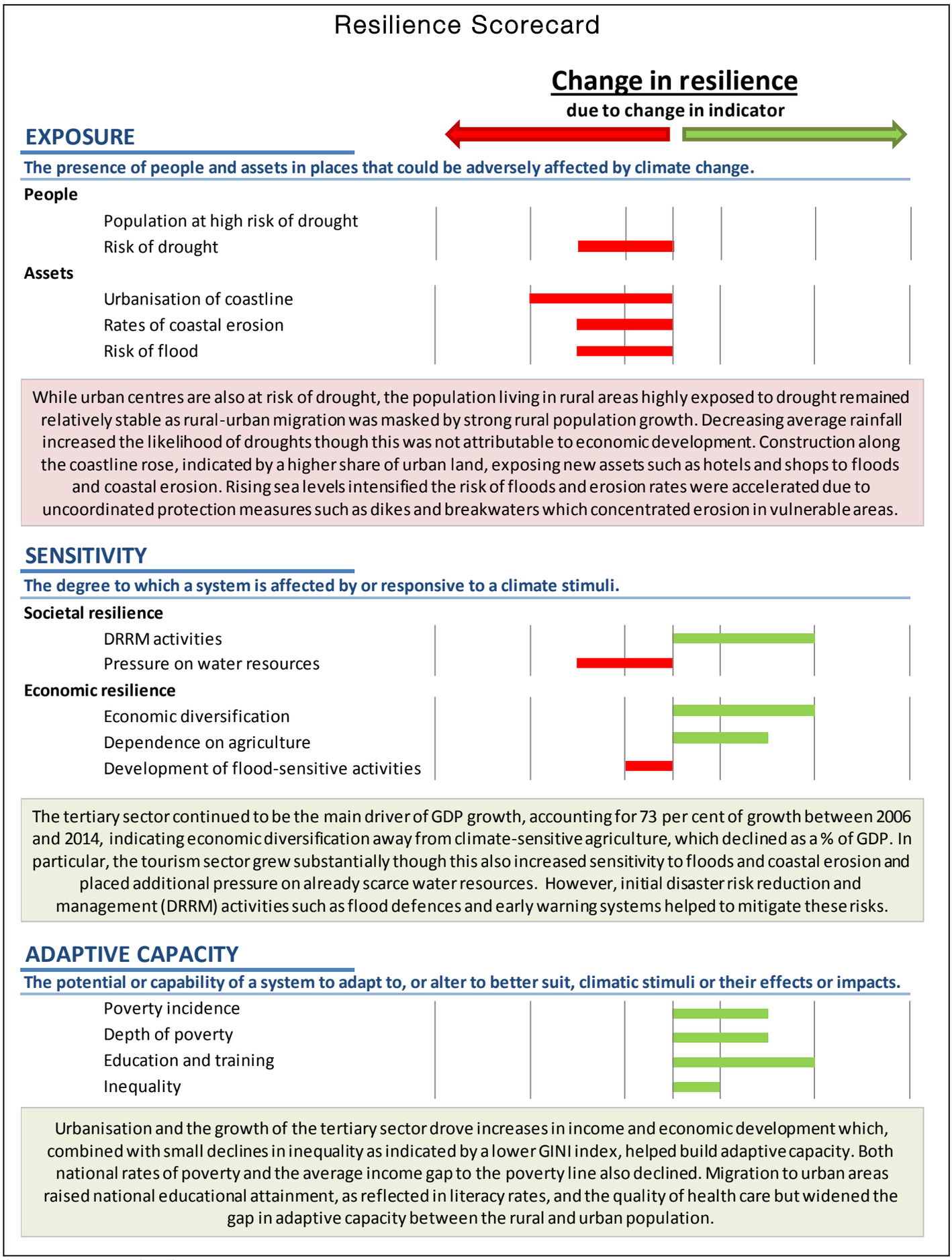
Development of the tourism sector has also had important spillovers in term of socioeconomic development. Tourism has been an opportunity for the development of satellite economic activities (e.g. transport, handicrafts), providing new and diversified sources of income to people and localities. Demand from tourism has also driven new crop and production choices in agriculture. The sector has led a better welfare on average, with the provision of health and education services. Hotels and restaurants have also contributed to the construction of protective infrastructure, with various results. If, on average over the Senegalese economy, tourism has strengthened adaptive capacity, these benefits need to be weighed against the perverse consequences of concentrated beach tourism in the Petite Côte.

Figure 23: Employment and qualifications in touristic areas



Source: Dehoorne and Diagne (2008).

Figure 24: Impacts of sectoral and geographical patterns on resilience-building



Source: Durand et al. (2010).

4. Discussion

4.1 Distributional impacts of economic change on resilience

Economic development has enhanced the immediate climate resilience of Senegal's people. In particular, those people who have migrated or adopted non-agricultural or non-pastoral activities have reduced their sensitivity to drought – the country's major climate risk. This reduction has relied on three important patterns: urbanisation, 'coastalisation' and diversification of the economy.

These socioeconomic transformations have also led to shifts in climate vulnerabilities. Specifically, they have led to higher vulnerability to flooding and, in the long term, to sea level rise. Climate risks are also not distributed equally among social groups:

- Some groups of particularly poor and/or marginalised people may not be able to take advantage of migration opportunities. In particular, the migration of males to seek employment means women and children remaining in rural areas bear the brunt of drought risk. Remittances can provide an income and help women and children cope with drought risks but – as shown in the previous section – malnutrition and poverty prevalence remain high in these rural and remote areas. Moreover, the migration of young workers reduces the labour force available for agriculture.
- In urban centres, vulnerability to flooding is also unequal. In general, poor and informal areas are more exposed and sensitive to flood events. By contrast, the formal and planned areas in the historic centre of Dakar are not as exposed to flood risks.
- Finally, seasonal and casual workers in agriculture and tourism are more sensitive to drought and flood events, and they also have the least job security. If drought reduces harvests, then there is less demand and employment for seasonal workers. Similarly, low tourism arrivals during 2013 meant some hotel managers did not hire their usual seasonal workers. These workers are therefore extremely vulnerable to a range of shocks and stresses on the economy, including climate events.

These findings suggest the distribution of climate vulnerability is skewed towards people exposed to other sources of socioeconomic vulnerability. The most vulnerable people – in terms of their exposure and sensitivity to climate risks – also have insecure sources of employment and income (economic vulnerability), and are more likely to live in informal settlements and be engaged in informal activities (legal vulnerability).

4.2 Policy drivers of economic patterns

The expansion of tourism in Senegal has been driven by a political determination to reduce drought sensitivity through diversification of the national economy and supported by direct and indirect investments from national and international stakeholders. Policy decisions and investments have also contributed to the sector's geographical concentration in the coastal area. Combined with reduced financial and political support in recent years, these patterns of concentrated investment are also partly responsible for the tourism sector's current exposure and sensitivity.

The changes in the political interest in the tourism sector of national and international actors have driven investments and financial support responsible for both the expansion and the decline of the sector. Development of the tourism sector was driven primarily by policy decisions at the end of the 1970s and funded by national investments and World Bank support. Economic theory supported this choice of sectoral investment. As the sector needs infrastructure, particularly transport infrastructure, to grow, investments have contributed to sectoral development and economic diversification.

At the start of the 2000s, however, the sector lost political interest and support. Private touristic agents interviewed for this study all agreed on this loss of interest by previous governments: 'since the time when the Ministry of Tourism was directed by Jacques Baudin and then Tidjane Sylla, no real tourism development strategy has been carefully identified, planned and implemented in Senegal. The country has suffered a constant change of ministers responsible' (Rodriguez, 2015). This lack of interest and investment for a sector relying on subsidies (for integrated camping areas) and national transport investments such as roads and airports has contributed to the current poor performance. The sector has not made sufficient investments in maintenance or upgrading of important physical assets, and this has affected the quality of its products. Thus, most of the investments (hostels and restaurants) in M'Bour and Petite Côte have never been renewed and are now considered old and expired. The high vulnerability of the sector described above is also the

result of a succession of political decisions. First, development of the tourism sector has been too concentrated both spatially and in terms of the supply of services. SAPCO and authorities have concentrated their efforts and investments in small coastal areas entirely dedicated to tourism. This choice was made without any risk assessment. This first decision would have had no impact if the industry had benefited from a constant political interest pushing the sector to diversify its offer and its location. However, as the sector has been politically neglected in recent years, its vulnerability has increased. No longer receiving public support, private actors took uncoordinated decisions to optimise and protect their own interests and infrastructure. For instance, individual breakwater buildings have exacerbated the erosion of coastal touristic areas.

More generally, and for the three patterns of economic development considered in this report, it appears that Senegal's economic development has not always been accompanied by a strengthening of the social and legal frameworks. Economic incentives or major national investments have led to the concentration of people, activities and the sector in climate-sensitive areas, increasing their exposure. This has owed particularly to a lack of legal constraints regulating buildings and land use. The absence of adequate urban planning at national and local level and the lack of economic and institutional means of decentralised authorities have also contributed to the development of vulnerable infrastructure (exposed to climate risk).

New important policies could mitigate these vulnerabilities or avoid their repetitions in the future year.

The Plan Senegal Emergent

Years of neglect by policymakers meant Senegal's tourism sector risked stagnation. However, the PSE treats the tourism sector as an important component of the national economic development plan, backed up by state investment and accompanying policies. In the PSE, the Senegalese government supports diversified tourism reinforced by climate-sensitive investments, which should reduce both the exposure and the climate sensitivity of the sector. At the same time, a reinforcement of human and financial capacities in the sector and a better exploitation of the tourism spill-overs as planned by the PSE would help reduce climate sensitivity and shape national adaptive capacity.

In the PSE, Senegal aims to become a leading tourism destination with 3 million arrivals by 2023. The plan identifies two to six new areas on which to focus tourism development and aims to redevelop existing sites with new activities. This includes diversifying tourism with new products in the seaside, ecotourism, culture and history, business and religious niches.

The Plan for Integrated Tourism has a proposed budget of FCFA 165.8 billion, intended to cover land management, development of touristic sites and regional airports. It is also supporting infrastructure investment, including in the Blaise Diagne International Airport building in 2015 and in regional airports in 2018.

It is important here to underline that the areas for integrated tourism are still concentrated. These cities must not reproduce the vulnerabilities visible in Saly, for instance. Nonetheless, through diversification, the tourism sector should be less affected by shocks such as climate change but also conflict or Ebola. The geographical diversity of touristic locations and the heterogeneity of customer profiles will reduce the exposure of the sector to covariate shocks. For instance, the plan highlights the importance of small and integrated units in rural areas, two important factors for the future success of the tourism sector. Diversifying tourism away from the basic product of beach holidays for Europeans should reduce the sector's exposure to one kind of shock (coastal erosion) and demand (European tourists), which would help the sector be more efficient in the case of demand- or supply-side crisis.

Contrary to the past, future development will be based on integrated tourism plans that take into account coastal defences in building design and touristic activity implementation. These decisions should reduce the current and future exposure of tourism infrastructure. The World Bank and the Global Environmental Fund are also supporting new defence projects to try and improve environmental decision-making and investment in order to deal with some of the consequences arising from past mismanagement.

The PSE also highlights the importance of better integration of touristic areas with their hinterlands and preventing their emergence as economic enclaves. Improved local supply chains for food and systematic professional training for young people should encourage positive externalities for touristic area development. The plan also includes a financing tool for developing tourism activity, strengthening human resources and capacity, improving the legal framework, and protecting the environment. Thus, the tourism sector's adaptive capacity can be reinforced through financing, an integrated value chain and strengthened human resources (training and professionalisation of national workers).

Support to activities such as cultural and handicraft businesses related to the tourism economy aims to better exploit all the potential externalities of tourism in other sectors. In the same way, the PSE also plans to develop Dakar has a regional multiservice hub supported by the tourism sector. This strategy and investment in the new airport are in line with the perspective of sectoral stakeholders that intend to make

tourism the driver of economic growth, employment and foreign currency receipts. Investment in the new airport and the search for new income sources relying on tourism spillovers would reduce the sensitivity of the economy by attracting new forms of receipts less correlated with climate shocks.

Institutional capacity

Many of the challenges identified here result from insufficient institutional capacity. These issues go beyond the presence of legal frameworks and policies and encompass the capacity and ability of government offices to implement programmes.

For example, Senegal's climate adaptation plan is implemented through sectoral policies. However, because of a number of constraints, these rarely translate at the territorial level. In principle, decentralisation reforms should support implementation of climate adaptation policy at the local level. Following reform, there will also be local management of touristic activities, with more responsibility given to the municipalities in terms of land management, environmental management, tax-raising and management of public expenses. In practice, there are likely to be significant challenges with improving performance. Human, technical and institutional capacities are likely to find implementing such a diverse new range of complex responsibilities very difficult.

Similarly, the lack of integrated coastal planning law and institutions has exacerbated an existing environmental problem. High rates of erosion now threaten both public and private infrastructure. Developing the Coastal Act will be an important first step; this has been awaiting approval since 2009. Implementing the new legal framework will then require institutional, human and technical capacities to address the challenges of coastal management and risk reduction. The low political attention paid to the Coastal Act raises a question as to whether these capacities will ever be put in place.

4.3 Vulnerability lock-in

In both geographic and sectoral terms, lack of a legal land use framework is an important barrier to a resilient climate development. Legal land use could help in avoiding informal settlement, preserving fragile coastal zones and preventing unplanned construction contributing to climate vulnerability. Economic patterns have also led to a lock-in related to water use.

The historical development of Dakar for economic purposes was to the detriment of Saint-Louis. Dakar is a deep-water port and has been a hub of international trade since construction of the railway to Bamako. Saint-Louis' location prevented it from fulfilling this economic role, especially in term of sea trade. Yet Dakar's position on the Cap-Vert Peninsula places severe constraints on its demographic development, largely because of the city's topology. Limited space pushes newcomers and new informal development into flood-prone areas, constrains traffic access into and out of the city and means water supplies are unable to meet high demand. The geographyis simultaneously an economic driver and a bottleneck in the city's development, and also indicates a possibly unsustainable lock-in of assets and investments. A lack of integrated land and water use planning to manage these geographical constraints is likely to become increasingly costly in the coming decade.

The tourism sector's development is also highly vulnerable to the constraints on water supply. Although the supply does not currently seem to be a problem, increased competition for water between tourism and other sectors – particularly if coupled with increasing variability or reductions in water supply – could be a significant source of risk.

Water risk and geographic lock-in can be considered consequences of the historical patterns described in Section 3. Future risks could be reduced or even avoided in the future through proper urban development planned at the national level and recognition of the water management issue for social but also economic purposes (public and private sector).

5. Conclusion

5.1 Key findings

We have studied the current development pattern of Senegal from two dimensions. From a geographical perspective, the country sees important internal migration from the rural inlands to urban coastal areas. From an economic point of view, Senegal is in the process of horizontal transformation. Senegal's tertiary sector is developing quickly, and this study has focused on analysing tourism as symbol sector of this economic tertiarisation.

Focusing on these two aspects, Senegal's development has raised new issues related to exposure in urban centres and coastal areas. Changes often correspond to economic incentives and have contributed to mitigating sensitivity by diversifying income sources and risk exposure. The trends analysed indicate that, as the economy has grown, better life conditions and welfare have contributed to stronger performance in relation to indicators of adaptive capacity. The picture described here is more precise than in the ND-GAIN index calculated at the national level, but trends in terms of exposure, sensitivity and adaptive capacity illustrate well the changes operated by these pathways.

Looking at the issue more in detail, though, current economic development has also resulted in inequalities in terms of exposure and sensitivity to climate. This owes mainly to unbalanced economic development.

Analysis of the tourism sector also underlines the limits of horizontal transformation for resilient development. The objective of diversifying tourism is one opportunity to increase resilience. The tourism sector in Senegal currently concentrates exposure and sensitivity in one type of product; a more diversified offer is likely to be more robust. Sectoral diversification can strengthen economic resilience, but if combined with diversification of products and markets it is more likely to be effective and sustainable. The recent impacts of the Ebola crisis and the Malian conflict on tourism in Senegal illustrate the limits of an over-concentrated tertiary sector and tourism offer.

5.2 Policy implications

Our analysis has raised several policy implications, some of which are already integrated in future Senegalese policy plans. We think it is important to underline the following:

- A clear legal framework on land use is essential to square rapid and sometimes erratic economic development.
- Economic diversification and horizontal transformation represent a good opportunity for mitigating climate impacts, although new activity development always implies new risk exposure.
- Economic diversification that is not fully developed could be dangerous in terms of risk exposure. High concentration of assets and activity should be systematically accompanied by a climate risk assessment of their location.
- In terms of planning of urbanisation in coastal areas, some policy recommendations formulated by the World Bank (2013) should help improve climate resilience:
    - Strict ban on sand collection along the coastline;
    - Run-off management for new neighbourhoods or urban rehabilitation operations (planning laws imposing non-aggravation of downstream flow rates);
    - Drafting of master plans for sanitation, taking into account the new rainfall pattern and sea level assumptions;
    - Implementation of waste collection in order to improve the efficiency of the storm water drainage network;
    - Training to reinforce the awareness-raising programme focusing on self-protection, with particular attention to communication methods and the technological means of implementation;
    - Reinforcement of the information regarding natural risks, to be offered to the population, economic stakeholders (industries, businesses, services) and the administration.

The government of Senegal recognises in part the implications of these policies. Adoption of the Coastal Act and application of the PSE should support the climate-resilient development of the country.

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Appendix 1: Typology of Tourism in Senegal

No formal tourism typology exists in Senegal. Based on our interviews, we broadly distinguish three kinds of tourism, as defined below.

Beach tourism is the main contributor to the tourism sector. It is concentrated particularly in M'Bour department south of Dakar. La Petite Côte hosts all the important hotels, which have sea access, swimming pools and daily excursions to the surrounding area. Tourism is organised through big tour operators and charter flights. The main clients are French and Spanish. It is highly seasonal, with a peak during the European winter.

More recently, there has been an increase in year-long weekend tourism by the rich of Dakar. This weekend tourism constitutes an important opportunity for development of and complementarity in the sector. Beach tourism is currently slowing, because of Ebola and regional insecurity but most of all coastal erosion. The development of short-term tourism from Dakar is an opportunity to compensate for the loss of European tourists.

Urban tourism in Dakar and Saint-Louis is mainly for conferences. Last year, Dakar held important regional events (e.g. the Rencontre de la Francophonie). The city has benefited from regional instability to raise its status as a regional hub (a position traditionally held by Abidjan). Most of the touristic investment in Dakar is oriented towards conferences and regional tourism (e.g. building of a conference hall in 2016). However, the return of stability and international institutions in Abidjan will mean the sector needs a new type of offer. The sector and the PSE are promoting cultural and historical tourism: Saint-Louis, for instance, could further exploit its historical patrimony to this purpose.

Integrated tourism and ecotourism, occurring in Senegal in the 1990s, especially in Casamance, was tourism managed at the community level. Public authorities, through primary investment, helped communities to welcome tourists in their village. All benefits went to the community funds. Communities offered guiding tours, eating and handicrafts to the tourism. This kind of activity has been abandoned in recent years because of the need for more public investment. Moreover, tensions in Casamance blocked the further development of this kind of tourism.

Integrated tourism is a source of income that could constitute an excellent form of diversification. Unfortunately, the sector has been vulnerable to political instability and lack of sustainability. The PSE aims to apply this kind of integrated approach in the beach zones. The recent development of an ecotourism lodge in the Saloum islands region has also been deemed a renewal of integrated tourism activities. Village tourism is located mainly in Saloum and Casamance, which have recently doubled their ecotourism infrastructure.

Appendix 2: Breach of Saint-Louis and its consequences

In Saint-Louis, following a small but dramatic flood in 2003 that contrasted with previous years of drought, the Langue de Barbarie was breached to allow the Senegal River to run more freely into the sea and reduce the risk of river flooding.

OMVS, the agency responsible for managing watersheds in Senegal, had forecast severe floods. Memories of recent events and political pressures (fear of dramatic consequences) led to the decision to breach the long, thin, sandy peninsula separating the river from the sea. The decision was taken without ecological or risk assessment, and implementation had significant impacts on the shoreline. The initial canal of 4 m has grown into an immense breech of more than 6 km, which is increasing the vulnerability of Saint-Louis and nearby estuaries to coastal flooding from the sea, among other impacts (Durand et al., 2010),

The left side of the river has become salinised, with important economic consequences for tourism and agriculture. Horticultural in particular has suffered, and some hotels have lost camping areas on the breach. Local people have also reported reductions in mangrove surfaces in the Gondolas area and land losses in Dounbaba Dieye following the breach.

In attempting to reduce the risk of river flooding, the breach led to major ecosystem changes and raised Saint-Louis city's sensitivity to coastal flooding and, in the long term, sea level rise (World Bank, 2014). This example illustrates the key role of disaster risk management agencies and the need for comprehensive assessments of risk management decisions.

Evolution of the Barbary breach

Notes: From top-left to bottom-right: (i) breach just after opening (4 m long); (ii) two days after, 80 m; (iii) three weeks after, 330 m; (iv) eight months after, 800 m.

Source: Durand et al. (2010).

PRISE
Overseas Development Institute
203 Blackfriars Road
London SE1 8NJ
United Kingdom

Tel. +44 (0)20 7922 0438

www.prise.odi.org

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