IMPACT OF CLIMATE DYNAMICS ON SOCIO-ECONOMIC ACTIVITIES AND NATURAL RESOURCES OF THE BENIN COASTLINE.

Abstract

Coastal safety, socio-economic well-being, and the water-resource needs on which coastline populations depend are largely governed by climate dynamics and by the management of coastal areas. This study analyses the impact of climate dynamics on socio-economic activities and natural resources in the coastal zone of Benin. The methodological approach combines documentary research, field observation, and a survey administered to 100 purposively selected individuals engaged in the targeted activities. the results of the analyzes were carried out with the PSIR model.The results show that agricultural production, fishing, salt production, sand extraction, and tourism are the main activities of the coastal zone, and that 92% of respondents report that these activities are affected by climate dynamics. The main climate-related risks affecting the natural and socio-economic systems of the Beninese coast include rising temperatures (from an average of 27.1 °C between 1953 and 1989 to 27.8 °C between 1990 and 2015), heavy rainfall accompanied by major flooding, human activities, recurrent dry spells during the rainy seasons, drought, high evaporative pressure, and violent winds. Faced with these risks, coastal populations have developed adaptation strategies inspired by their customs and traditions, which vary across the socio-cultural groups of the Benin coastline.

Keywords: Benincostline, climate dynamics, socio-economic activities, natural resources

Introduction

Climate has always been one of the main determinants of the organization of human societies and the dynamics of natural ecosystems, particularly in coastal areas, where the activities most sensitive to its fluctuations are concentrated (Boko, 1988). At the global scale, climate warming is reflected in an increase in hydro-climatic hazards (rising temperatures, disruption of rainfall patterns, sea-level rise), whose effects on the coastal areas of developing countries are considered among the most worrying (Dasgupta et *al*., 2009). The African continent, and its Atlantic seaboard in particular, remains one of the regions most exposed to these upheavals: its coastal ecosystems are fragile, its coastal population is growing rapidly, and its adaptive capacities remain limited (Boko et *al*., 2007).

The Gulf of Guinea, and the Benin coastline in particular, illustrates this vulnerability well. Bordered by a loose, heavily anthropised sand barrier, this coastline is experiencing continuous shoreline retreat, driven by the combined effect of climate dynamics and human interventions such as port development and uncontrolled sediment extraction (Laibi et *al*., 2014). According to Ozer et *al*. (2017) measured a reduction of the Togolese and Beninese coastal strip of nearly 6% between 1973 and 2005, under the combined effect of sea-level rise, coastal erosion, and human activities; this trend has continued over recent decades. This portion of the national territory nonetheless concentrates the bulk of the country's socio-

economic activities: fishing, salt production, flood-recession farming, sand extraction, and coastal tourism, which constitute major sources of income for riparian populations.

Climatological studies conducted in Benin also agree on a clear warming trend and a disruption of rainfall patterns since the mid-twentieth century (Amoussou et *al*., 2016; Oyede et *al*., 2022). These climatic changes do not spare the coastal area, where they worsen flood risks, dry spells, and evaporative stress, weakening production systems already under strong anthropogenic pressure. A recent study conducted along the southwestern Benin coastal strip also highlighted the significant socio-economic and environmental implications of these hydro-climatic risks on the livelihoods of riparian populations (Lodouhoué et *al*., 2022).

Despite the relative abundance of work devoted to coastal erosion and climate variability in Benin, few studies have analysed, in an integrated way, the impact of climate dynamics on the full range of socio-economic activities along the coastline (agricultural production, fishing, salt production, sand extraction, and tourism) and on the natural resources that sustain them, while also documenting the adaptation strategies developed by local populations.

1.**Presentation of the study area**

The area covered by this study is between 6° 15′ to 6° 25′ North latitude and 1° 37′ to 2° 48′ East longitude (Figure 1).

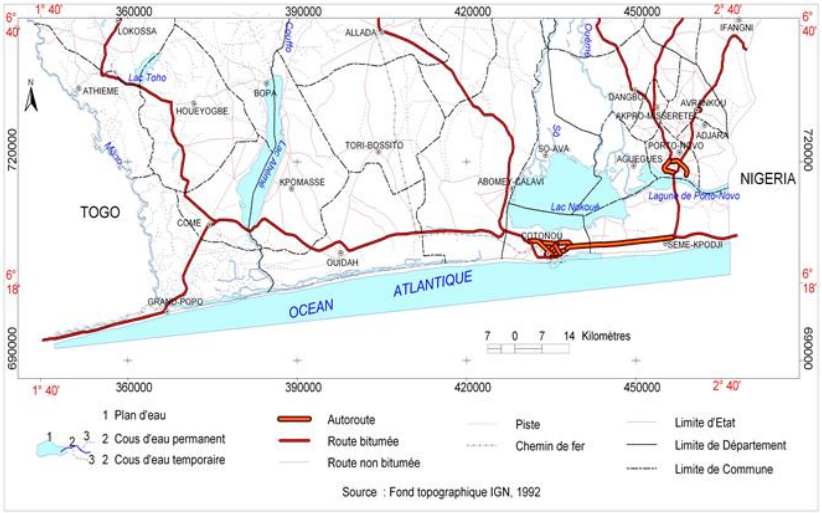

Figure 1 : Geographical location of the Benin coastline

It is part of the marginal-coastal zone that extends from the shoreline to the contact with the lowland plateaus of Lower Benin on one side, and from the Niger border (Kraké) to the Togolese border (Hilla-Condji) on the other. Its unique climatic and socio-economic characteristics justify the actions implemented to sustainably manage its natural and socio-economic resources.

2. Material and methods

Documentary research made it possible to compile bibliographic references from general and specific scientific documents related to climatology and to the environment of the Benin

coastal area, primarily at the UAC library, the LACEEDE Laboratory, the MCVT, the ABE, the INStaD, and the town halls of the municipalities of Cotonou, Ouidah, Grand-Popo, and Porto-Novo. The socio-anthropological investigations were based on the Participatory Active Research Method (Méthode Active de Recherche Participative, MARP). A climate-data recording sheet and a digital camera for photographing instantaneous field events were used. An interview guide for the socio-economic surveys, conducted among a purposively selected sample of 100 people using a questionnaire addressed to community intellectuals, economic operators, leaders of farmers' organisations, elders and notables, tourism stakeholders, environmental technicians, and officials in charge of coastal management, made it possible to gather information on socio-economic activities (fishing, salt production, farming, sand extraction, and tourism) and on climate dynamics along the coastline. Field observations also focused on fishing, salt production, farming, sand extraction, and tourism activities carried out along the coastline, the impacts of eco-climatic dynamics, and the endogenous and technological systems used to manage the Benin coastal area. GPS was used to record the geographic coordinates of the coastal area.

3. Results

3.1. Characterisation of socio-economic activities of the Benin coastline

In the context of this study, the main socio-economic activities most affected by climate impacts along the Benin coastline were identified by 100% of respondents (Table 1).

Table 1: Socio-economic activities along the Benin coastline linked to climate dynamics

Climatic seasons / Socio-economic activities											
	J	F	M	A	M	J	J	A	S	O	N	D
Agricultural production												
Fishing												
Salt production												
Sand extraction												
Tourism												

Source: Field survey, November 2025

Table 1 shows that agricultural production, fishing, salt production, sand extraction, and tourism are the five seasonal activities at the heart of the Benin coastal economy. The monthly calendar it summarises shows that none of these activities is carried out continuously throughout the year: each follows its own rhythm, set by the alternation of rainy and dry seasons. Agricultural production thus occupies the two rainy seasons (April to July and October to November) for rainfed crops, then the long dry season (December to March) for flood-recession crops. Fishing, salt production, and sand extraction follow the opposite pattern and are concentrated mainly in the dry season, when receding waters and lower rainfall make production sites accessible. Tourism, finally, occupies the same dry windows (November–March and August–September), which places it in direct competition with salt production and sand extraction for the use of the same coastal space during the same period. This calendar overlap explains why the slightest disruption to the rainfall regime affects several activities simultaneously.

►Agricultural production

The Benin coastal area is home to rainfed crops such as maize (Zea mays), cowpea (Vigna unguiculata), groundnut (Arachis hypogaea), and sweet potato (Ipomoea batatas), among others; flood-recession or market-garden crops such as tomato (Solanum lycopersicum), pepper (Capsicum annuum), and onion (Allium cepa), among others; and perennial crops such as cassava (Manihot esculenta), coconut palm (Cocos nucifera), and oil palm (Elaeis guineensis), among others. The rainy seasons (April to July and October to November) are favourable periods for agricultural production, which occupies the coastal sand ridges, the lagoon banks, and the lateritic soils of the low plateaus. Flood-recession crops, meanwhile, are grown mainly during the long dry season, between December and March, on the coastal plains (Plate 1).


1

2

Plate 1: Rainfed farming (1) and off-season farming (2) along the Benin coastline
Photographs: Bamisso, November 2025

Plate 1 illustrates the contrast between the two cropping systems described above. The first photograph shows a maize field in full growth, with a few cassava plants at the edge of the plot, under an overcast sky typical of the rainy season: this is rainfed farming as practised on

the coastal sand ridges between April and November. The second photograph, taken on a market-garden plot bordered by a concrete-block wall, shows aligned seedbeds and a localised irrigation system, an arrangement typical of off-season crops grown in the dry season, when water must be supplied artificially. The juxtaposition of the two images reflects the ability of coastal farmers to switch their production system from an extensive rainfed regime to a more intensive irrigated one, depending on water availability. This flexibility is itself a form of adaptation to seasonal climate variability, even before any more structured strategy is implemented. It also explains why farming remains possible almost all year round along the coastline, unlike activities such as salt production, which remain strictly confined to the dry season.

Furthermore, because of the rainfall contrast between the south-west (less rainy) and the south-east (rainier), the eastern sector of the coastline has developed a distinct agricultural profile, at the expense of the other sectors (central and western), which are more favourable to salt production.

►Salt-production activities

The low rainfall of the western and central sectors of the coastline, compared with the eastern sector, favours the development of salt-extraction activities on the coastal plains and along the banks of the coastal lagoon in the localities of Comè, Grand-Popo, Ouidah, Abomey-Calavi, and Kpomassè. Salt extraction depends on seasonal climate variations and takes place mainly in the dry season, between December and March, after the lagoon waters recede from the flood plains, leaving salt pans exposed. These are worked by salt producers to make fire-evaporated or solar salt. Intensive, profitable salt production in this part of the coastline depends on factors such as the recession of rainfall, strong sunshine, high evaporative pressure, and rising temperatures. Thus, in the context of global warming, and the accompanying sea-level rise, tidal action promotes the propagation of saline fronts into the lagoon, which benefits salt producers.


1

2

Plate 2: Scraping the soil to obtain salt crusts, carried out by salt producers (1), and preparing fire-evaporated salt (2), in Djègbadji
Photographs: Bamisso, November 2025

The two photographs in Plate 2 document the two successive technical stages of salt production described above. In the first image, several salt producers scrape by hand the salt

crust that has formed on the soil surface after the lagoon waters recede, work carried out in the open on the dried flood plains. The second image shows the next stage, boiling: the brine obtained from the scraped soil is brought to the boil in large metal basins set over a wood fire, until fire-evaporated salt is obtained through the evaporation of the water. Moving from one stage to the other takes several hours of work and a substantial quantity of firewood, making this a labour- and time-intensive activity. Both photographs also show that production remains artisanal and manual, with little mechanisation, which makes it directly dependent on daily weather conditions: insufficient sunshine or an early return of rain can compromise several days' harvest of salt crusts.

The salt produced is sold at the production site to local, international, and regional tourists, to the riparian population, and to market vendors.

►Fishing

Along the Benin coastline, fishing activities are most intense during the dry season (December to May). Seasonal variations in rainfall and temperature drive changes in biological parameters (phytoplankton, photosynthesis) and physicochemical conditions in aquatic environments, which affect the ecology of fish species in the rivers and water bodies of this part of Benin. During the rainy season, from June to October, when water temperatures and salinity are lower, fish species migrate to the bottom of water bodies and rivers to spawn, taking advantage of the nutrients carried by inland water currents. In the dry season, between November and May, with rainfall-hydrological, thermal, physicochemical, and biological conditions reversed relative to the rainy season, and therefore ecologically unfavourable, the species move back up to the surface. This period is therefore favourable to fishing activity. The variation in climatic parameters and in the spatio-temporal distribution of fish species thus governs the planning of activities according to the fishing calendar. It should be noted that climate dynamics affect not only the spatio-temporal distribution of fish species but also the fishers' livelihoods.

►Sand extraction of the Benin coastline

According to 98% of respondents, the extraction of sand from the coastal sand ridges is a near-permanent activity, but is more intense during the dry season, when construction work proceeds more easily. The inaccessibility of extraction sites during the rainy season makes sand removal difficult, owing to the sandy-clay, hydromorphic nature of the soils. From east to west, the various sites of coastal sand extraction in Benin are located in the localities of Abomey-Calavi, Sô-Ava, Cotonou, Ouidah, Sèmè-Kpodji, Grand-Popo, and Porto-Novo (Plate 3).



Plate 3: Coastal sand-extraction site in the Porto-Novo lagoon (1) and at Dèkoungbé (2 and 3)

Photographs: Bamisso, November 2025

Plate 3 shows the technical equipment used for sand extraction along the coastline. The first photograph shows a floating dredger fitted with a mechanical arm that draws sediment directly from the bottom of the lagoon, a technique considerably more productive than the manual extraction still practised at some sites. The second photograph, taken a little further along the same site, shows the scale of the volumes extracted: vast mounds of grey sand stretch along the bank, awaiting removal to construction sites. The herbaceous vegetation still present in the foreground, immediately next to the sand stockpiles, gives an idea of the pressure this activity places on the banks and riparian ecosystems. These images concretely illustrate the mechanism described above: the more mechanised and intensive the extraction, the greater the sediment deficit in the coastal system, with knock-on effects on shoreline stability discussed further below. They show, very directly, the friction point between an activity of major economic importance to riparian populations and its contribution to the environmental vulnerability of the coastline.

The presence of these coastal sand ridges and of the water bodies and rivers allows the extraction of grey sand, which is highly sought after by the population for building infrastructure, roads, and houses.

►Tourism activities

Variations in climatic factors and parameters strongly influence tourism activities in the Beninese coastal area. The dry periods (November–March and August–September) are favourable times during which tourism activities intensify, such as nature watching, sunbathing, visits to historical sites, and walks along the beach.

3.2. Impacts of climate dynamics on socio-economic activities and natural resources

The impact of climate dynamics on the socio-economic and natural systems of the Benin coastal area was assessed through the climate risks affecting the different systems and an analysis of their vulnerability. Surveys carried out among 92% of the population engaged in socio-economic activities made it possible to identify the main impacts of climate dynamics along the Beninese coastline. Table 2 presents the various manifestations of climate dynamics according to climatic season.

Table 2: Sensitivity matrix for hydro-climatic risks

Exposure units	Climatic risks							
	Violent winds	Evaporative pressure	Drought	Recurrence of dry spells during rainy seasons	Human activities	Heavy rains/Flooding	Rising temperatures	**Exposure index (%)**
Natural system								
Coconut groves	1	1	1	1	3	1	2	**28 %**
Mangroves	1	1	1	1	5	3	3	**42 %**
Marshes	1	3	3	2	3	1	3	**45 %**
Coastal grasslands	1	3	3	2	3	1	3	**45 %**
Water resources	1	2	1	3	4	4	3	**51 %**
Soil fertility	1	4	4	2	4	1	4	**57 %**
Fish resources	1	3	4	4	4	1	4	**60 %**
Coastal morphodynamics	5	1	1	2	3	4	5	**60 %**
Human system								
Salt production	2	1	1	2	2	5	1	**40 %**
Infrastructure and human development	3	1	1	1	1	5	3	**42 %**

Tourist visits	2	3	2	2	1	5	2	**48 %**
Household income	2	2	2	3	1	4	3	**48 %**
Population health	2	2	4	4	3	3	4	**62 %**
Crops	3	3	4	4	1	5	4	**68 %**
Impact index (%)	**37 %**	**42 %**	**45 %**	**47 %**	**54 %**	**61 %**	**62 %**	

Scale: 1 – Low ; 2 – Fairly low ; 3 – Medium ; 4 – Fairly high ; 5 – High
(0-19 %) (20-39 %) (40-59 %) (60-79 %) (80-100 %)

Source: Field surveys, November 2025

Table 2 shows that the various risks linked to climate dynamics affecting the natural and socio-economic systems of the Benin coastline concern rising temperatures, heavy rainfall accompanied by major flooding, human activities, recurrent dry spells during the rainy seasons, drought, high evaporative pressure, and violent winds. These various risks affect the different natural and human systems of the coastal area to varying degrees. Violent winds have a fairly low impact on the various systems, whereas human activities, recurrent dry spells during the rainy seasons, drought, and high evaporative pressure have intermediate (medium) impacts. Rising temperatures and heavy rainfall accompanied by major flooding, meanwhile, are risks with fairly high impacts. According to 96% of respondents, the rainy seasons, marked by flooding in the coastal area, are periods during which, apart from agricultural activities, most socio-economic activities slow down, with effects on household incomes.

As for exposure units, the table shows that coconut groves have the lowest index (28%), confirming their relative resilience to the climate hazards identified. Crops, by contrast, show the highest exposure index (68%), followed by population health (62%), and then, tied, fish resources and coastal morphodynamics (60% each): these four components therefore concentrate the vulnerability of the coastal system. Between these two extremes are moderately exposed systems, such as mangroves, marshes, and coastal grasslands (42–45%), salt production (40%), and infrastructure (42%). On the risk side, rising temperatures and heavy rainfall accompanied by flooding show the highest impact indices, at 62% and 61% respectively, compared with only 37% for violent winds, confirming their secondary role, as already noted. This numerical ranking corroborates the earlier qualitative analysis: the systems that combine strong dependence on fresh water with direct exposure to thermal and

rainfall variation are also those for which climate risk translates most directly into economic loss for households.

3.3. Evaluation of adaptation and management measures along the Beninese coastline

The evaluation of coastal management measures was carried out through the adaptation measures adopted by socio-economic and natural systems in response to climate dynamics. According to 100% of respondents, various measures have been implemented, on the one hand by communities, and on the other by institutions, whether governmental or non-governmental, in order to manage the coastal area as effectively as possible and to reduce socio-economic and environmental vulnerability to the risks posed by current climate dynamics. Table 3 presents the various management measures for the Benin coastal area.

Table 3: Management measures for the Benin coastal area

		Dry season	**Rainy season**
Community management measures	Agriculture	Invoking the deity Hêviosso in times of drought for rain, calling on rainmakers, economic diversification	Farming practices that are mainly rainfed
	Fishing	- Establishment of customary rules for the joint management of water and fish resources (ban on destructive fishing techniques, gear, and practices affecting aquatic ecosystems)	Agricultural and other activities
	Salt production	- Very favourable period for salt production - Salt production by physical evaporation (using wind and sun to gradually heat the brine).	Construction of clay-silt embankments mixed with household waste to prevent flooding of the salt pans.
	Coastal sand extraction	Period very favourable for selling sand	Period less favourable for selling sand,
	Tourism	Favourable weather for tourism activities: nature	Unfavourable period

		watching, sunbathing, visiting historical sites, and walking.	
Institutional management measures	Agriculture	Hydro-agricultural development in flood plains for off-season crops	- Water conservation techniques in soils through agroforestry - Development of alley cropping
	Fishing	- Development of valleys, dales, and flood plains, for fish farming	- Development of lagoon enclosure fish farming, river cage fish farming, fish farming in groundwater-fed pond-type fish pits
	Salt production	Development of brine-exposure basins	Economic diversification

Source: Field surveys, September 2025

The vulnerability of ecosystems and socio-economic activities along the Benin coastline leads local populations to develop a two-tier adaptive system, which Table 3 clearly distinguishes. The first tier consists of community-based measures rooted in local knowledge and beliefs: invoking the deity Hêviosso and calling on rainmakers in times of drought for agriculture, establishing customary rules restricting destructive fishing gear and techniques, and building clay-silt embankments to protect salt pans from flooding during the rainy season. The second tier corresponds to more technical, institutional measures carried out by the State or supporting organisations: hydro-agricultural development of flood plains for off-season crops, the development of fish farming in lagoon enclosures, river cages, or ponds fed by groundwater, and the development of brine-exposure basins for salt production. These two registers are not mutually exclusive; they combine according to the season, with community measures dominant in situations of immediate climatic emergency and institutional measures relating to longer-term land management. It is also observed that economic diversification recurs as a response, both for salt production and for agriculture, reflecting a form of occupational flexibility among coastal households in the face of seasonal irregularity. These reactive or preventive measures ultimately depend on the intensity of the phenomena, their

consequences, and the endogenous knowledge specific to each socio-cultural group along the coastline.

3.4. Analytical model of the links between climate, socio-economic activities, and natural resources

The results of this study were analysed using the PSIR model (Pressure–State–Impact–Response) (Figure 1).

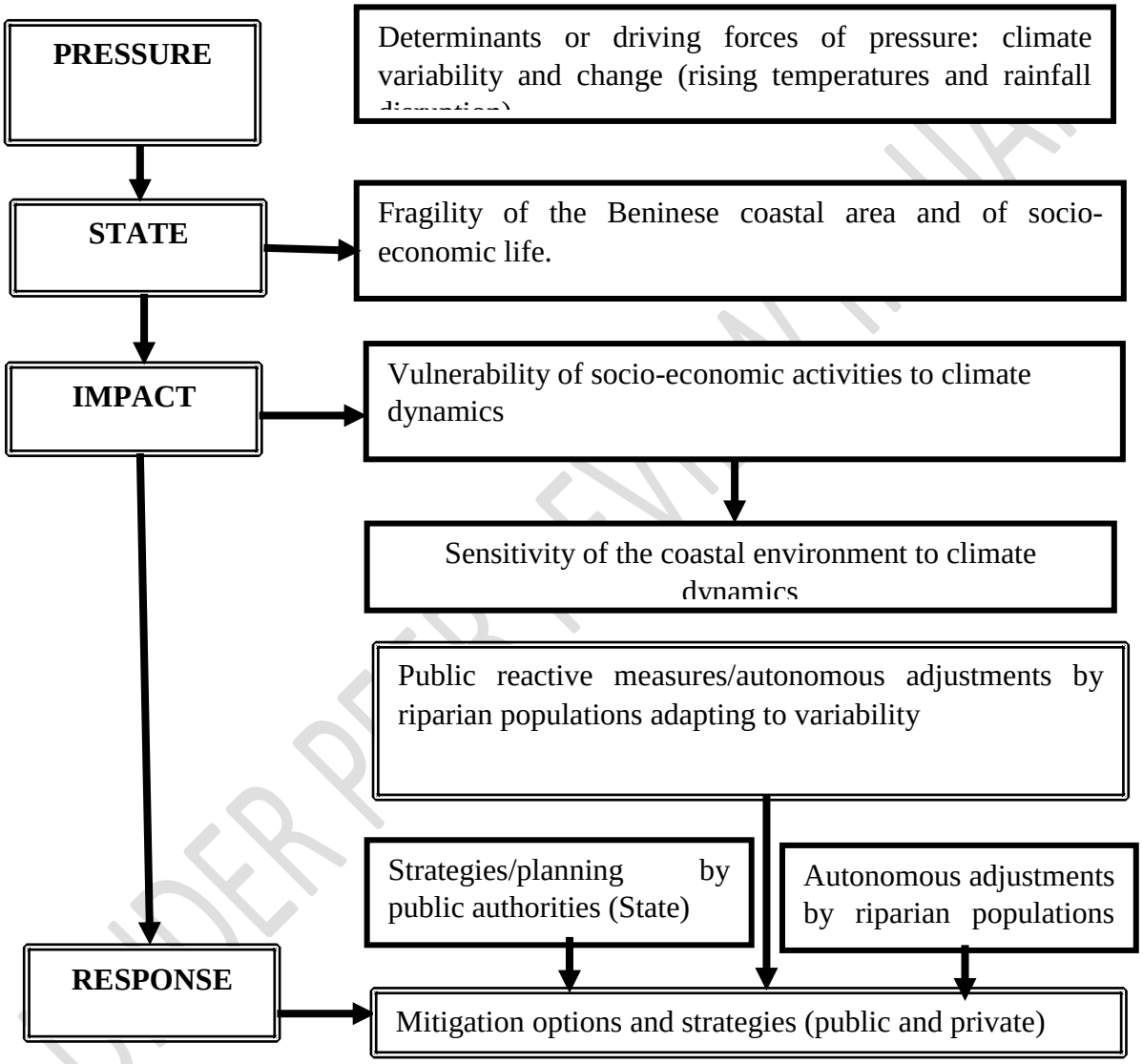

Figure 1: Analytical model of the links between climate, socio-economic activities, and natural resources

The PSIR model organises the study's findings into four linked stages forming a causal chain. Pressure is identified as climate variability and change, that is, the rising temperatures and rainfall disruption measured in this study. This pressure weakens the state of the Beninese coastal area and of its socio-economic life, a state that translates concretely into two types of

impact distinguished in the model: the vulnerability of socio-economic activities, on the one hand, and the sensitivity of the coastal environment, on the other, two dimensions confirmed respectively by Table 1 on activities and Table 2 on the sensitivity matrix. Faced with these impacts, the model finally distinguishes three types of response, which correspond exactly to the measures identified in Table 3: public strategies and planning, autonomous and endogenous adjustments by riparian populations, and mitigation options combining public and private actors. This chain of reasoning shows that the impacts observed along the Benin coastline do not stem directly from climate alone, but from the pre-existing fragility of an area already subject to strong anthropogenic pressure, a point developed further in the discussion. These potentialities, like the survival of the population itself, thus remain threatened by the effects of climate variability, whose influence on socio-economic activities and natural resources is clearly apparent.

4. Discussion

The results of this study confirm and complement those of previous work on the climate vulnerability of the Benin coastline. The temperature rise recorded between the two periods considered (from an average of 27.1 °C between 1953 and 1989 to 27.8 °C between 1990 and 2015) fits within the general warming trend documented at the national scale by Oyede et *al*., (2022), who established a significant rise in average annual temperatures across Beninese territory over recent decades. This warming, combined with rainfall irregularity, largely explains the recurrence of dry spells and episodes of high evaporative pressure identified by respondents as risks of medium to fairly high intensity for the coastal socio-economic systems.

The sensitivity matrix in this study reveals strong exposure of fish resources, coastal morphodynamics, population health, and crops to climate risks. This finding is consistent with that of Boko et *al*., (2007), for whom coastal systems and the livelihoods that depend on them are among the most vulnerable components of the African continent to climate change. Lodouhoué et *al*., (2022) reach a similar conclusion along the south-western Benin coastal strip: hydro-climatic risks there affect fishing, agricultural, and salt-production systems across the board, with direct repercussions on coastal household incomes. These results, obtained across distinct but adjoining sections of the national coastline, convergeon the idea of a structural climate vulnerability affecting the entire Beninese coastal front.

This phenomenon is not solely of climatic origin: according to Anthony et *al*. (2016), it results from an interaction between natural hydrodynamic processes (longshore drift, swell) and human disturbances such as port development, which disrupt the sediment balance of West African sand-barrier coastlines. This finding sheds light on the results relating to sand extraction, an activity that 98% of respondents consider to be near-permanent along the coastline. The sensitivity of fishing activities to seasonal variations in temperature and salinity, described in the results, echoes the observations of Chaigneau et *al*. (2020) on Lake

Nokoué, where global change disrupts the physicochemical dynamics of the water and, in turn, the spatio-temporal distribution of fish species and the productivity of lagoon fisheries.

Finally, this study aligns with the conclusions of Adjakpa et *al*., (2019), who, writing on climate change in West Africa, stress the need to tailor adaptation policies to local socio-economic realities rather than replicate generic models poorly suited to local specificities. The Pressure-State-Impact-Response model used here helps capture this articulation, linking climatic pressures, the state of natural resources, the observed socio-economic impacts, and populations' adaptive responses.

These results should nonetheless be interpreted with caution, given the relatively small sample size (100 people) and the partly qualitative nature of the perception indicators used. Further studies incorporating long climate series and quantitative biophysical data on the evolution of fish, salt, and agricultural resources would help consolidate understanding of the interactions between climate dynamics and socio-economic activities along the Benin coastline.

5. Conclusion

The observed climatic deterioration results in an ecological imbalance detrimental to the rural economy of the coastal plain. As a result, Benin's coastal region is marked by a dysfunction of its socio-economic system.
Socio-economic activities based on fishing, salt production, agriculture, and sand extraction are considerably disrupted by eco-climatic changes. The impacts of climate variability on the rural economy of the Beninese coastline are reflected in weak fish and agricultural yields and, correspondingly, in falling incomes. The coastal socio-economic sector's adaptation strategies in the face of climate hazards are characterised, on the one hand, by recourse to deities (a matter of social anthropology) governing the availability and use of natural resources and related activities, and, on the other hand, by economic diversification into agro-pastoralism and aquaculture.

This study confirms that climate dynamics weigh heavily on the organisation and vulnerability of socio-economic activities and natural resources along the Benin coastline. The adaptation strategies developed by coastal populations will nonetheless remain insufficient unless they are backed by public policies better tailored to local realities: integrated coastal zone management, erosion control, and the safeguarding of livelihoods linked to fishing, salt production, agriculture, sand extraction, and tourism. Further research, drawing on long climate series and quantitative biophysical indicators, would help consolidate these results and support public decision-making for the sustainable management of the Benin coastal area.

Bibliographic References

Adjakpa, T. T., Chekou Kore, E. M., Abdou Bagna, A., Bio Bigou, B. L. (2019). Climate change and adaptation opportunities in West Africa. *Geography review of Ouagadougou*, special number

Amoussou, E., Totin Vodounon, H. S., Vissin, E. W., Mahé, G., Camberlin, P. (2016). Climate evolution of Benin from 1950 to 2010 and its influence on surface waters. *XXIX^e* Colloquium of the International Association of Climatology, Lausanne-Besançon.

Anthony, E. J., Almar, R., Aagaard, T. (2016). Recent shoreline changes in the Volta River delta,West Africa: the roles of natural processes and human impacts. *African Journal of Aquatic Science*, 41(1), 81-87.

Boko, M. (1988).Climates and rural communities in Benin: climatic rhythms and development rhythms.State Doctoral thsesis ; Université de Bourgogne, Dijon.

Boko, M., Niang, I., Nyong, A., Vogel, C., Githeko, A., Medany, M., Osman-Elasha, B., Tabo, R., Yanda, P. (2007). Africa. In *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the IPCC's Fourth Assessment Report).Cambridge University Press.

Callo-Concha, D. (2018). Farmer Perceptions and Climate Change Adaptation in the West Africa Sudan Savannah: Reality Check in Dassari, Benin, and Dano, Burkina Faso. *Climate*, 6(2), 44.

Chaigneau, A., Stieglitz, T. C., Okpeitcha, V., Assogba, A., Sohou, Z., Peugeot, C., Morel, Y. (2020). Impact of global change on lagoon systems in West Africa::The case of Lake Nokoué in Benin. Weather and Climate Info, 79, 2-3.

Dakpo, P. C., Ahonnon, A., Abalot, E. J., Boko, C. G., Houngan, C., Okou, C. (2015). Socio-environmental impact of marine sand mining on sustainable human development in the commune of Grand-Popo, Benin.Journal of Scientific Research of the University of Lomé

.Dasgupta, S., Laplante, B., Meisner, C., Wheeler, D., Yan, J. (2009). The impact of sea level rise on developing countries: a comparative analysis. *Climatic Change*, 93(3-4), 379-388.

Laibi, R. A., Anthony, E. J., Almar, R., Castelle, B., Sénéchal, N., Kestenare, E. (2014). Longshore drift cell development on the human-impacted Bight of Benin sand barrier coast, West Africa. *Journal of Coastal Research*, SI 70, 78-83.

Lodouhoué, K. F., Ogouwalé, R., Djafarou, A., Vissin, E. W. (2022).Socioeconomic and environmental implications of hydro-climatic risks in the coastal strip in Southwest Benin.*International Journal of Progressive Sciences and Technologies*, 34(2), 90. DOI: 10.52155/ijpsat.v34.2.4423

Ozer, P., Hountondji, Y.-C., De Longueville, F. (2017).Socioeconomic and environmental implications of hydro-climatic risks in the coastal strip in Southwest Benin. *Geo-Eco-Trop*, 41(3), 481-492.

Oyede, M. I., Hounzime, S., Agbokou, I., Alhassane, A., Yabi, I. (2022). Spatio-temporal characteristics of climate variability in Benin (West Africa).*European Scientific Journal*, 18(29).

Roncoli, C., Ingram, K., Kirshen, P. (2001). Farmers' Perceptions of Climate Change and Agricultural Adaptation Strategies in Rural Sahel. *Environmental Management*, 32(1), 119-136.