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Living on an ever-changing coast: French Guiana populations facing coastal mobility

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Abstract This article examines how the populations of French Guiana have, since the colonization period until today, inhabited the coast, in particular the cheniers close to the coast, whereas these spaces are subject to intense changes—colonization and destruction of the mangrove ecosystem, erosion, modification of the estuaries—which have significant consequences for living conditions and access to natural resources. The interdisciplinary approach brought together historians, geographers, geomorphologists, ecologists and anthropologists. Three contrasted areas were studied: Awala-Yalimapo, a Kali'na Amerindian village located at the Maroni estuary, the savannas region, between Sinnamary and Iracoubo where the Creole peasantry flourished, and finally, the particular case of the city of Kourou, built from the 1960s by the sea to house the engineers and technicians of the Guiana Space Center. This paper aims to propose a reflection on mobility and adaptability of the traditional habitat of the Amerindian and Creole populations, based on the collective appropriation of the land, and what could be described as a light approach to development. On the contrary, Kourou was built with a relationship to the sea largely imported from

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metropolitan France at a time when private property became the norm in French Guiana. The city is now facing serious erosion problems. As we question how to inhabit the coastline at a time when global change is likely to bring rapid transformations, knowing this history can be a valuable source of reflection for future coastal management strategies.

Keywords French Guiana · Coastal change · Adaptability · Vulnerability · Amerindians · Creoles

Introduction

The extreme mobility of the Guiana Shield coastal environments has been described scientifically in French Guiana since the 1940s (Choubert, 1948) and at the regional level since the 1960s. Toorman et al. (2018) proposed a synthesis of recent knowledge. The coast between the Amazon and Orinoco rivers is characterized by a very high morphological instability linked to the migration of large mud banks. This is due to the huge suspended-sediment discharge of the Amazon River. A part of which is transported northwestward alongshore as mud banks. The passage of these mud banks causes important morphological changes of the coastline. The phases of siltation alternate with phases of erosion. During the phases of accretion (siltation), the coast is protected from the waves and the mangrove colonizes the mudflats, while the departure of the mud banks leads to a rapid disappearance of the mangrove and sometimes causes episodes of intense erosion with a retreat of the coastline that can reach several tens of meters in a few months or several kilometers in a few years. This shifting and difficult to access coastline was probably one of the causes of the weakness of the French colonization. The low number of easily accessible harbours likely played a role in the poor equipment of the colony, as well as in the lack of manpower (Mam Lam Fouck, 2002).

In recent years, public authorities have become increasingly concerned about the mobility of the coastline. The geological and mining research office has produced summary reports on the subject (Moisan, 2011; Moisan and De La Torre, 2014) and an Observatory of Coastal Dynamics (ODYC) bringing together the various actors involved (local authorities, state services, scientists, NGOs, specialized consultancies, etc.) was set up in 2015 (Longueville & Aertgeerts, 2018).

From the point of view of the inhabitants of the coast, mangroves, mud banks and cheniers (sandy beaches over mud) appear and disappear, the sea is sometimes visible and close, sometimes invisible and difficult to access, and landscape can undergo drastic changes in just a few years, sometimes even in a few months as the coastline moves. This unique coastal-system dynamic equilibrium and the way that local populations adapt to these changes raises several questions for social sciences. How did past populations and how do current populations of the coastal plain live when faced with these changes? How did they adapt in the past to the constant changes of their environment? Nowadays, is this environmental mobility synonymous with vulnerability, or have these population maintained their ability to adapt?

Among the countries of the Guianas coast, French Guiana has a special place: in contrast to Suriname and Guyana, where many polders have been built near the sea, as well as a dike (the Seawall) in Guyana, resulting in the disappearance of the mangrove (Anthony & Gratiot, 2012), the coastline remains relatively "natural" in French Guiana. French colonists preferred to use the highlands for agriculture and even if there have been several attempts to adapt the polder technique, like on the Approuague river in the eighteenth century or near Cayenne in the nineteenth century, most of the coastal plain hasn't undergone any major transformation. But this doesn't mean that the littoral is not inhabited. Traces of the arauquinoid tradition—in particular, raised fields—dating from 650 to 1650 AD have been found by archaeologists in the cheniers and savannas of the coastal plain (Rostain, 2008; Collomb and Tiouka, 2000; Stier et al., 2020), and after the abolition of slavery (1848 in the French territories), the Creoles began to build a system of peasantry (Mintz, 1983) in the same spaces (Jolivet, 1993; Stier et al., 2020).

Over the last few decades, French Guiana has experienced a significant demographic increase, from approximately 30,000 inhabitants in the 1940s to more than 290,000 nowadays (INSEE, 2020). The towns are growing, partly in a planned manner, and partly as the result of informal construction. Most of the population is concentrated in the

coastal areas: according to INSEE data about the legal population of the municipalities, in 2018, 86% of the inhabitants[1] were living in the coastal areas, *i.e.* in municipalities situated in the coastal plain or in estuaries.

French Guiana, as the other countries of the Guianas area, is also characterized by its multiculturality. Several authors described the complex history of settlement and the way the different populations live together (Mam Lam Fouck, 2002, 2013; Jolivet, 1997; Collomb & Jolivet, 2008; Piantoni, 2009; Piantoni, 2011; Collomb and Mam Lam Fouck, 2016). Seven native Amerindian groups, four Maroon groups resulting from the resistance to slavery in Suriname in the eighteenth century (Price & Price, 2003), and the Creole population of mixed slave ancestry live in French Guiana.

Until the 1970s, Creoles were the majority population. Today, they remain one of the largest groups and hold political power through local elected officials, while the Europeans from metropolitan France are predominant in State administrations. From the 1970s, the migratory movements have grown. The majority migrant groups are Haitians, Brazilians and Surinamese, but many migrants also come from other countries of South America. Hmongs from Laos are also present, as well as Chinese, who hold an important part of the local shops.

Given this complexity, understanding how people live and used to live on the coast, how they dealt with the coastal changes that have occurred in the past, and what coastal changes are of greatest concern today, are very broad issues that would require long-term research. However, this paper presents the results of exploratory research that begin to provide some answers to the following questions:

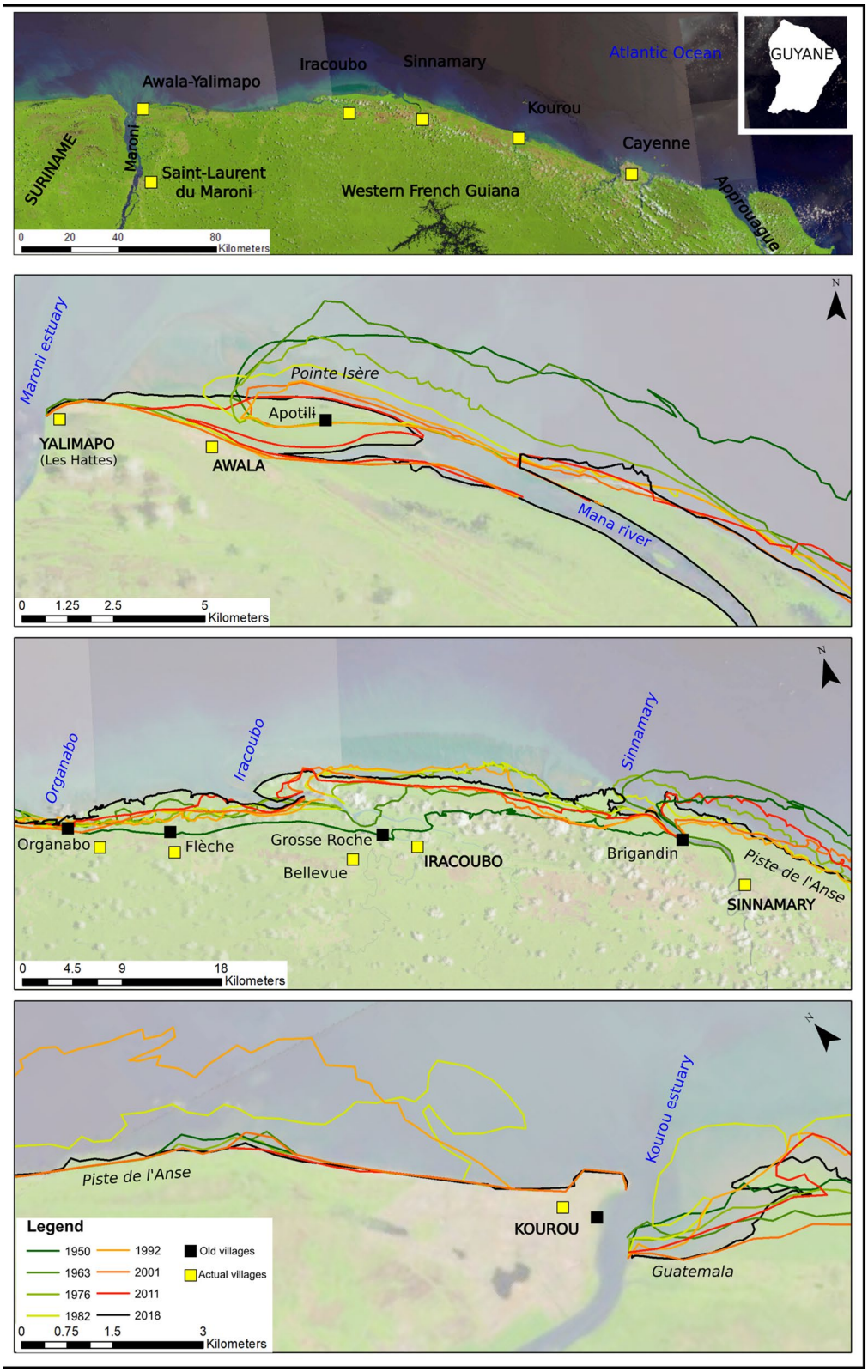
- How has human occupation of the coastal territory evolved since the beginning of the colonization in the seventeenth century? Where did people used to live in the past and where do they live now?
- What relationship did the populations used to have with the marine environment, the mangrove swamp and the coastal environment as a whole, and what is this relationship today? Do they take resources from these environments?
- What are the major coastal changes that people remember? How have they adapted to these changes?
- What are the main problems faced by people today with regard to coastal change and what are the questions associated with this?

Materials and methods

To conduct this research at the interface between man and environment, a team made up of three geographers, two geomorphologists, two anthropologists, a historian and an ecologist was formed. Three fieldwork areas were chosen, all located in the western part of French Guiana (Fig. 1a), because of their interest and complementarity:

- Awala-Yalimapo (Fig. 1b1), located at the western tip of French Guiana, is a municipality where the majority of the population is composed of Kali'na Amerindians. Its territory is bordered to the west by the estuary of the Maroni River and to the north by the Atlantic ocean. Very significant changes occurred there in last ten years: colonization by a mangrove in front of the village of Awala and intense erosion in front of the village of Yalimapo with a marked retreat of the coastline: up to 100 m since the 1950s in the central part of the Yalimapo beach (Jolivet, Anthony, et al., 2019);
- The savannas region, characterized by grasslands occasionally including more or less isolated trees and shrubs, located in the communes of Sinnamary and Iracoubo (Fig. 1b2), and that are today far from the sea: a mangrove of several kilometers wide separates the coastal plain from the ocean. But until the 1950s, this region was bordered by large beaches that played an important role in the lives of the Creole and Kali'na inhabitants;
- The new town of Kourou (Fig. 1b3), nicknamed "*ville spatiale*" (space city) was built at the end of the 1960s to house the engineers and technicians of the French space base. Located facing the ocean, while the old village of Kourou was along the estuary of the Kourou river (Fig. 3), the new city was severely hit by coastal erosion in 2015

[1] 237,641 inhabitants for a total population of 276,128 inhabitants in 2018. See INSEE, "recensement de la population", https://www.insee.fr/fr/statistiques/5005684.


Awala-Yalimapo
Iracoubo
Sinnamary
Atlantic Ocean
GUYANE
Kourou
Cayenne
SURINAME
Maroni
Saint-Laurent
du Maroni
Western French Guiana
Approuague
0 20 40 80 Kilometers
Maroni estuary
Pointe Isère
Apotili
YALIMAPO
(Les Hattes)
AWALA
Mana river
0 1.25 2.5 5 Kilometers
Organabo
Iracoubo
Sinnamary
Organabo
Flèche
Grosse Roche
Bellevue
IRACOUBO
Brigandin
Piste de l'Anse
SINNAMARY
0 4.5 9 18 Kilometers
Piste de l'Anse
Kourou estuary
KOUROU
Guatemala
Legend
1950
1963
1976
1982
1992
2001
2011
2018
Old villages
Actual villages
0 0.75 1.5 3 Kilometers

◂**Fig. 1** Situation map (**a**) and maps of the fieldwork areas, with the main evolutions of the coastline between 1950 and 2018 (**b**). Coastlines from 1950 to 2011 adapted from Walcker, 2015 and actualized for the year 2018 with a numerized coastline based on landsat satellite photographs

and 2016, causing damage in exposed coastal neighborhoods.

The investigations took place in 2017 and 2018. Given the exploratory and interdisciplinary nature of the research, we wanted to combine a large variety of methods, and therefore a wide variety of materials were collected. For the three sites, we put together reconstructions, by geomorphologists, of the past movements of the coast and studies of the current movements, historical research in archives and collection of various documents (*e.g.* photos, press reviews), ethnographic field research, semi-directive interviews, and the setting up of workshops in each of the three sites.

Geomorphologists used aerial photos and satellite images to produce diachronic maps showing for each of the three areas shoreline fluctuation since the 1950s (Fig. 1b). In Yalimapo and Kourou, where intensive beach erosion was the prior concern of local residents and authorities, regular photogrammetric surveys based on ultra-light aircraft orthophotography were conducted in order to quantify short-term fluctuations in the beach sediment budget.

The team's historian examined local archives of French Guiana in Cayenne, the national overseas archives in Aix-en-Provence and the French military archives in Vincennes. He collected maps of the three sites from the seventeenth century to the present, as well as notes accompanying these maps and numerous ancient texts and stories about the coastline. He also gathered photos from private collections.

The three field sites were visited by the entire team and ethnographic research was conducted by one or two researchers on each site. We also capitalized on the long-standing experience that some researchers had on these sites.[2] Classic methods were used: long stays or regular visits, observation of the daily life of the inhabitants and of their use of the coastline and its resources, conversations and various informal exchanges, visits to sites particularly affected by erosion in the company of inhabitants. Semi-directive interviews of two types were conducted: on the one hand, with institutional actors such as agents from different State services, local authorities or non-governmental organizations involved in local development dealing or not to with coastal change, and on the other hand with inhabitants of the three sites. The interview guide for institutional actors includes questions about the agent him/herself, the institution and its role in relation to the coastal environment, urban development, the history and memory of coastal change, coastal environments, and the vulnerability and adaptability of populations. For the inhabitants, the guide has been adapted to each site and its particularities. It includes questions about the individual him/herself, his/her habitat, his/her activities on the coast, what he/she knows about the history and memory of coastal change and, finally, his/her assessment of the present situation. We have chosen not to ask about risks, because one of our assumptions was that inhabitants don't think of changes in terms of "risks". Nine interviews were conducted with institutional actors, 41 with inhabitants of Awala-Yalimapo, 22 with inhabitants of Sinnamary and Iracoubo and 48 with inhabitants of Kourou. These semi-directive interviews allowed us to collect qualitative data (Taylor et al., 2015), the analysis of which is presented in the "Results" section.

Finally, in November 2018, the research team organized a workshop in each of the three sites, held at the town halls of Awala-Yalimapo, Sinnamary and Kourou. Local elected officials and residents were invited. The research team presented its first results and engaged in a discussion with those present on their interpretation and on the next steps to be taken in the research work.

[2] Ethnographic field research was conducted:

- for Awala-Yalimapo by Gérard Collomb and Marquisar Jean-Jacques in 2017 and 2018. Gérard Collomb also draws on multiple stays over the past thirty years. Marquisar Jean-Jacques conducted a research assignment from January to May 2018.

- for the savannas region (Sinnamary and Iracoubo) by Marianne Palisse in 2017. Marianne Palisse also drew on several research studies conducted in the same region since 2012.

Footnote 2 (continued)

- for Kourou by Bettie Laplanche and Marianne Palisse, from April to June 2017, then from April to June 2018.

Results

What can be learned from the history of the three sites?

Each of the three sites has its own particular history with respect to coastal change.

Awala-Yalimapo

Awala-Yalimapo is located between mouths of the Maroni and Mana estuaries (Fig. 1a, b1). The Kali'na were historically spread over a vast area stretching from the Orinoco, in present-day Venezuela, to Kourou. The Maroni area was a refuge zone until the end of the eighteenth century for the populations living on the margins of the French colony: Amerindians and Maroons. Neither the Dutch nor the French colonization had reached this region before the mid-nineteenth century (Léobal, 2020) and ancient maps mention several Kali'na villages in the estuary area, on both sides of the Maroni river, but also along the Mana river and other smaller rivers. Their traditional way of life is based on a pluriactivity whose essential components are hunting, fishing, gathering and the practice of "abattis", *i.e.* slash-and-burn agriculture (Collomb & Tiouka, 2000). It goes hand in hand with mobility, which may be temporary or permanent (Filoche et al., 2017), as the villages can move to new resources (opening new plots of land for agriculture, finding new hunting and fishing areas), but also for various other reasons: splits linked to quarrels or young generations becoming independent, messianic reasons, etc.

From 1852, the French penitentiary colony was established in Saint-Laurent du Maroni, and numerous smaller penitentiary institutions were set up at various points along the coast. One of them is located at Les Hattes (Fig. 1b1), the site of the present Yalimapo.

The recent history of these villages is linked to coastal change. At the beginning of the twentieth century, the Mana River estuary became very close to the Maroni River estuary. North of the Mana estuary, an alternative mud and chenier progradation had extended and deflected the river estuary westward. It was called La Pointe Isère. Jolivet, Gardel, et al. (2019) have retraced the geomorphological dynamics of this coastline since 1950 using aerial photographs. A village was established on the Mana river bank, on the south side of these cheniers (Fig. 1b1, Apotili). The location of this village was not unusual: many observers of the Amerindian villages were surprised to see some of them settled directly on the beaches. Indeed, this location ensures easy access to the resources of the sea, including frequent fishing trips at sea or on surrounding rivers.

In the middle of the twentieth century, following the formation of a mud bank, a mangrove forest developed along the Pointe Isere preventing the inhabitants from reaching the sea with their canoes. The inhabitants finally crossed the Mana River estuary and settled in Awala (Fig. 2.3). The Hattes prison was abandoned in 1953, as well as the entire penal colony, and a Kali'na village was established in Yalimapo. Some families also came from Organabo, between Iracoubo and Mana (Fig. 1a, b2). They settled at the mouth of the Organabo river, and were also forced away by the growth of the mangrove.

For some 50 years, the two villages have lived closely connected to the marine environment. Fishermen used dugout canoes to go out to sea. From the 1970s, scientists came into the village to study the sea turtles that lay eggs on the beaches, particularly leatherback turtles (*Dermochelys coriacea*), as well as tourists who came to observe them. The collection of these eggs was banned by France in 1991 and a nature reserve, the Amana reserve, was created in 1998, creating among other issues conflicts over the consumption of turtle eggs by the Kali'na (Collomb, 2009). But turtle tourism was also a resource for the village: some guest houses and restaurants opened, locals became guides, and tourists also bought handicrafts. In 1989, the two villages became a commune, Awala-Yalimapo, which separated from the commune of Mana. The Kali'na have more recently been experimenting with a compromise between municipal management and management by customary authorities (Filoche, 2011).

The environmental situation changed again in the early 2000s. After a continuous phase of erosion, a breach appeared around 2005 at the Pointe Isère mud cape. One consequence of this coastline retreat was that this breach created a new outlet for the Mana river and separated Pointe Isère from east bank land. The old estuary of the Mana river was progressively abandoned by the estuarine flow resulting in the formation of mud banks. Then, over the period

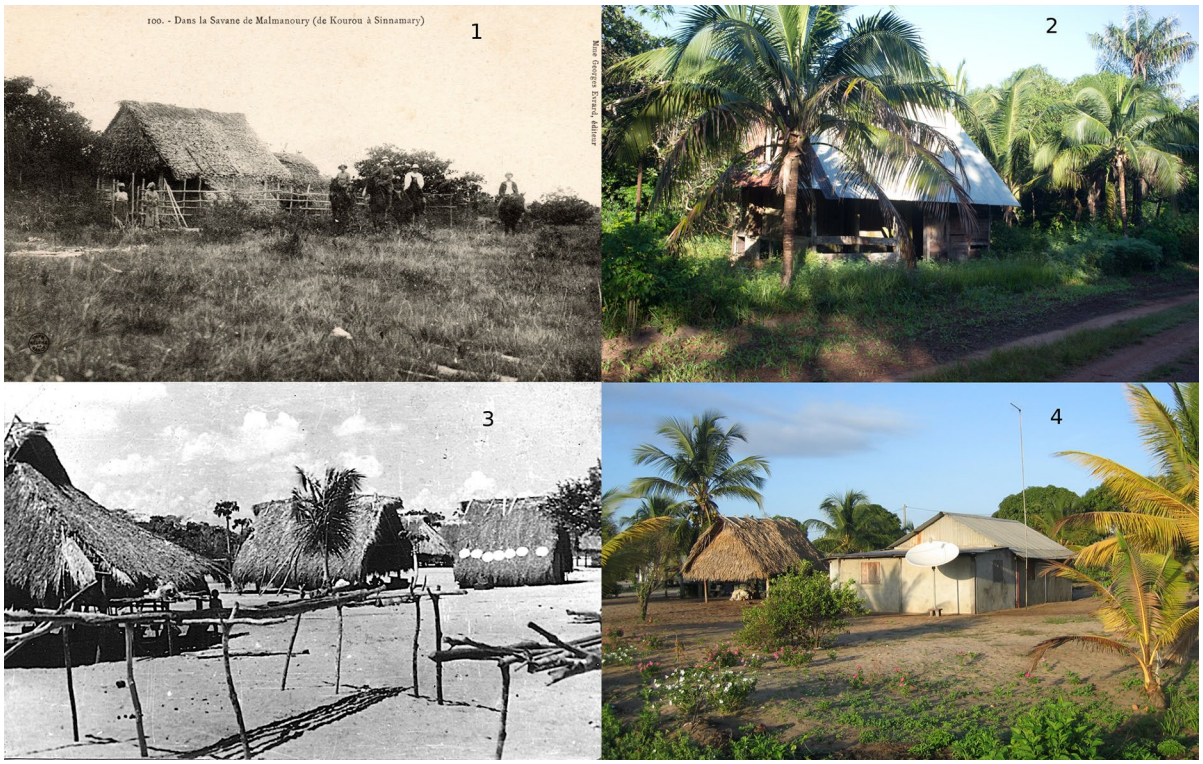


Fig. 2 Creole "petites habitations" and Amerindian villages on the seashore yesterday and today. 1 and 2 Creole dwellings: 1 Malmanoury, postcard published by Mrs Georges Evrard around © Fonds A. Heuret, all rights reserved; 2 Chemin de l'Anse, 2017, photo by Denis Lamaison; 3 and 4 Dwellings of the kali'na village of Awala: 3 Anonymous photograph, around 1950, © Fonds A. Heuret, all rights reserved; 4 2007, photo by Gérard Collomb

2011–2015, these very active sediment dynamics led to the joining, in the vicinity of Awala village, of the remnant part of the mud cape to the terrestrial shoreline, downdrift of the former mouth of the Mana River (Jolivet, Gardel, et al., 2019).

The village is now separated from the sea by a thick mangrove. A new mud bank, crossing the new Mana estuary and transported by longshore drift along Pointe Isère, settled in the 2010s between Awala and Yalimapo. The length of the beach decreased enormously, from 4 to 1.5 km. This had two consequences: fishermen could no longer put their dugout canoes in the water and so abandoned sea fishing and, because a large part of the sandy beach is sequestered behind the mud bank, the turtle nests were less numerous, leading to a drastic decrease in nesting and related tourism activities (De Zwart, 2017).

On the other hand, strong erosion took place in front of the village of Yalimapo that reached 100 m in the western part of the beach (Jolivet, Anthony, et al., 2019). In October 2019, due to an exceptionally long wave episode, the sea reached the road and the houses.[3] The municipality is now questioning the necessity to move the village, which is complicated because it is built on a narrow sandy strip between the ocean in the north and swamps in the south.

The inhabitants interviewed expressed their sadness about the disappearance of a beach they loved, and the prospect of having to leave their current place of life. However, it is striking that they do not speak in terms of hazard or danger in the interviews. For them, the movements of the coast are a constraint to which they have to adapt, but against which they cannot fight (Jean-Jacques, 2018). In particular, unlike the inhabitants of Kourou, they do not ask the public

[3] See articles in local media: https://la1ere.francetvinfo.fr/guyane/meteo-plage-yalimapo-ravagee-fortes-marees-766263.html, and https://www.franceguyane.fr/actualite/environnement/alerte-jaune-maintenue-sur-l-ouest-guyanais-460011.php, consulted on 18 Jan 2021.

authorities to stop erosion by heavy means such as dikes.

Finally, for most inhabitants, even if they are familiar with the work of scientists on coastal change, the explanation for the changes can be found in a spiritual reading of these types of events. Human behavior is thought to have displeased the spirit of the sea, *tunakɨlɨ* in kali'na language, and the coastal erosion is believed to be the result of the anger of the latter.

The savannas region

The savannas region is one of the places where Guianese Creole culture developed (Fig. 1b2). In 1764, the expedition known as "de Kourou" was a failure that led to the death of thousands of settlers. A few hundred settlers from Acadia (a French territory located in present-day Canada), however, managed to settle in the region of Sinnamary and Iracoubo (Cherubini, 2008), with a model of small peasantry. After the abolition of slavery, many freedmen looked for land on which to establish small farms. They wished to become landowners and conduct food-producing agriculture (Mintz, 1983) and they invented a model called "*la petite habitation*" (small plantation) in French Guiana (Jolivet, 1993). The coastal cheniers were then abandoned by the settlers because the soils were considered unproductive and the roads connecting this zone with inner areas were cut-off in the rainy season.

These cheniers are, however, interesting for those who are looking for a place at the interface between different environments. The pluriactivity of the Creoles was quite similar to that of the Amerindians: they practiced hunting, fishing, gathering and slash-and-burn agriculture, but they also raised livestock (Jolivet, 1993; Palisse, 2014). They used different environments: they practiced slash-and-burn agriculture in the "*grand bois*" (big forest), but also had plots in the savannas, they hunted in the forest and in the swamps, they fished in the marshes, small rivers, estuaries, or from the beaches. From the eighteenth century until the beginning of the twentieth century, there were many beaches between Kourou and Organabo. Iracoubo, whose location has not changed since, was then by the sea. The inhabitants fished in dugout canoes built according to the Amerindian technique. Turtles and turtle eggs were also collected and sometimes sold on the markets of Cayenne.

Archives and interviews show that periods of mangrove establishment alternated then with periods of erosion and required frequent adaptations. For example, the path that linked Kourou and Sinnamary by the coast, named Le Chemin de l'Anse (The Cove Path) (Fig. 1b2-b3), was sometimes described as being bordered by the mangrove, and sometimes as running along the beach. It was frequently destroyed by the sea. Travelers reported that they had to pass through the savanna, where they had to cut their way through the vegetation and suffered insect attacks.

Dwellings and hamlets near the sea sometimes had to be moved. Several elderly people related how their parents or grandparents had to move up into the savannas because of erosion or, on the contrary, because of the arrival of the mangrove. This was made easier by the fact that the houses were built using lightweight materials, with walls of woven wooden slats and palm roofs (Fig. 2.1). The architecture was different from the the more massive one used in the villages. The whole unit could be easily moved.

From the 1940s onwards, the formation of a massive mud bank caused widespread silting of the coast. A thick mangrove gradually colonized the mud. The mangrove sequestered the chenier, which became isolated from the sea. A witness of the time, living in the hamlet of Brigandin, located on a rocky point in Sinnamary, wrote:

> "In 1946, I was ten years old. […] With the formation of mud banks and the growth of mangroves, our beaches disappeared. [...] Under the constraint of these natural elements - mud and mangroves -, in about ten years, the mouth of the river had been modified. It moved away from the beaches of my peninsula. It is with great bitterness that I experienced the distance separating the banks of my river from the beaches of my peninsula. With return of mangrove swamp, the few people living along the coast at that time retreated inland to the heights of the more wind-exposed dry savanna."[4]

[4] "en 1946, j'avais dix ans. […] Avec l'installation des bancs de vase et la poussée des palétuviers, nos plages disparurent. […] Sous la contrainte de ces éléments naturels -, vase et palétuviers -, en une dizaine d'années, l'embouchure du fleuve fut modifiée. Elle s'éloigna des plages de ma presqu'île. C'est avec beaucoup d'amertume que je vécus l'éloignement des rives de mon fleuve, des plages de ma presqu'île. Les quelques riverains d'alors, avec le retour de la mangrove, se retirèrent vers l'intérieur des terres, sur les hauteurs de la savane sèche, plus ventilées." (Létard 2007).

As we can read in this passage, the obligation to move to higher ground was not experienced as a tragedy. The author evokes his bitterness at the disappearance of the beaches of his childhood, but the reaction of the inhabitants seems at first pragmatic. The site has now lost its attractiveness due to the impossibility of access to the sea and the proximity of the mangrove that breaks the wind and shelters many biting insects. The inhabitants therefore left in search of a better location.

Beyond the Creole "petites habitations", all the inhabitants of the savannas region were affected by the arrival of the mangroves in the 1940s and 1950s. To the west of Iracoubo, several Kali'na Amerindian villages were established at the sea front, using the same model as Awala and Yalimapo (Hurault, 1963). The largest of these were called Grosse Roche and Flèche (Fig. 1b2), but there were also smaller villages, including one at the mouth of the Organabo river. With the arrival of the mangroves, families moved to other villages along the rivers, or to the savannas. Michel Lohier was then made responsible for Amerindian affairs by the prefecture. He wrote about Grosse Roche:

> "They lived there for a few years, happy with their fate, when nature came to play a negative role. The beautiful beach was overrun by mangroves, which sheltered insects and vampire bats. The village was gradually abandoned. They scattered as before, choosing the places that were most convenient for them."[5]

Several families finally settled in the Yanou savanna and created a village that would later be called Bellevue (Fig. 1b2). The history of the savannas region is interesting because the disappearance of the beaches represented a major change in the landscape, but also in the access to resources for the people who lived near the coast. However, we can see that these populations have adapted, mainly by moving. Their response to coastal movement has been to move themselves.

[5] "Ils y vécurent quelques années, contents de leur sort, lorsque la nature vint jouer un rôle néfaste. La belle plage fut envahie par les palétuviers, refuges d'insectes et de vampires. Le village fut peu à peu abandonné. Ils s'éparpillèrent comme avant, choisissant les endroits qui leur convenaient le mieux. […] » (Lohier, 1972).

Kourou

The city of Kourou was built as part of an industrial project managed from metropolitan France. In 1962, after the independence of Algeria, France was forced to abandon the Hammaguir space base, in the Sahara Desert. A new site was sought and Kourou was chosen from among fourteen proposals. The reasons for this choice are numerous: the proximity to the equator facilitates launches, there are no cyclones, the risk of earthquakes is very low, the proximity of the sea allows launching over water and limits the risks and, finally, the low population density on the chosen site makes it easier to expropriate the inhabitants (Polidori, 2020).

Previously, about 650 people lived in Kourou, part in the town, located inside the estuary of the Kourou River, and part in the "*petites habitations*" on the coast towards Sinnamary. To build the base, the inhabitants were expropriated, thus accelerating the end of the way of life described above. The inhabitants were rehoused in Sinnamary and the new city being built in Kourou. Since most of them had no property title, they were rehoused in small houses that did not correspond at all to their former way of life. To farm, they were given small plots of land on the other side of the river, in a place called Guatemala (Fig. 1b3). But in doing so, the authorities seemed to want to force them to switch to intensive agriculture, pretending to ignore that they practiced slash-and-burn agriculture, along with other important activities such as hunting, fishing and livestock raising (Jolivet, 1982).

The new town, called "*la ville spatiale*" (the space city), was built at the pace of space projects, giving an important place to the presence of the sea, according to a pattern imported from the French mainland, and according to a plan strongly marked by social hierarchies, as it is often the case in company towns (Borges and Torres, 2012). The construction of Kourou can be linked to the history of company towns, since it was a question of housing workers for an industrial project, but also to that of the French "Villes nouvelles" and of Brasilia, which were built at the same period (1960s). Kourou is however specific because of the particular context of French Guiana, a colony recently transformed into an overseas department, in which the colonial management methods are still present. The location is chosen among three proposals.

It is not in the estuary like the Creole village, but on the seafront, in the sandy cove. The designers of the city believed that the proximity of the sea was a factor of attractiveness on several levels: wind exposure, landscape, access to seaside leisure activities. A large villa was built for the director of the Guiana Space Center on a rocky outcrop of bedrock (Fig. 3a "Les Roches") overlooking the bay. Beside it, six other villas were built for the top executives of the launching-base. Then, the town plan followed a strict social hierarchy: villas for metropolitan executives were built not far from the sea, then buildings for Guianese and metropolitan supervisors a little further south, then buildings for Guianese workers, and finally, between the new town and the old village, barracks to house foreign workers who have come to work temporarily on the site. However, some populations remained outside this urban project. The Amerindians and Maroons, whose forest knowledge was used for land clearing, were left free to build their own villages on the edges of the new city. Finally, the city was surrounded by enclaves, each of them built with its own logic: the old Creole village, in the estuary, the Amerindian village, built on the sea front, based on the model of the western French Guiana Amerindian villages described above, and the Saramaka village, in the mangrove on the bank of the Kourou River, which housed several groups of Maroons (Fig. 3a). The resulting heterogeneous city has some similarities with Brasilia, which was built with the intention of escaping the urban problems of Brazilian cities, and in particular those generated by the existence of favelas. However, as in Kourou, the workers who came to build the city had to be housed, and the construction was accompanied by the establishment of temporary housing, but also by the construction of informal settlements by the workers themselves (Guiral Bassi, 2020).

The archives reflect the state of mind that prevailed at the time: the desire to conquer natural spaces in order to create a modern city. To build it, the relief was flattened, the sand from the sandbanks was used to fill in the swamps, and artificial lakes were created to collect water.

In the beginning, the city was built a little behind the beach. But in the 1980s and 1990s a mangrove barred access to the sea on the west side of the bay, and neighborhoods with buildings and individual villas were built very close to the coastline, which was made invisible by the presence of mangrove trees. The presence of the mangrove was not well accepted, and in the 1990s French Foreign Legion personnel were ordered to cut it down. Eventually, it disappeared at the end of the 1990s. 2 years in a row, in 2015 and especially in 2016, several neighborhoods of the city of Kourou located on the seafront—L'Anse, the Amerindian village and Les 205 (Fig. 3a)—experienced severe coastal erosion. In 2015, the beach gradually disappeared, and the coconut trees were washed away. In 2016, a small road that separated the beach from the houses was destroyed and about ten private houses were damaged (Fig. 3b1–2). Recent measurements (2017–2019) revealed 7 m (Est of Anse) to 10 m (205) of coastline retreat and 28,300 m^2 of volume erosion, with a maintained erosion tendency, even with a new mud bank phase since 2018.

These events provoked various reactions among the population (Laplanche, 2018). The inhabitants of the sea-front villas, many of them being metropolitan French, formed an association and demanded intervention by the public authorities. They read scientific studies and learned about possible solutions: dikes, breakwaters, etc., and even carried out study trips, which they financed themselves, to visit sites concerned by this type of development in mainland France. In October 2016, they organized a demonstration during which they met with the mayor of the city and the president of the territorial authority of French Guiana. Questioned on this matter, the Creoles recall the memory of the "petites habitations" along the coast and their expropriation, which left a bitter memory. For them, the designers of the city should have paid more attention to the knowledge of the former inhabitants, which would have avoided them building in an area that, fundamentally, belongs to the sea. The Amerindians, as described for Awala-Yalimapo, made a spiritual reading of these events and evoked the lack of respect for the spirits of the sea, as demonstrated by the acts of cutting mangroves, or dredging sand out of the Kourou River estuary, or in disrespectful individual behavior of people who come to bathe on the beach (particularly women during menstruation).

The local elected officials tried to respond to the most urgent needs. A dyke made of sandbags was hastily erected during the events (Fig. 3b3). An appeal was made to the State services to seek solutions. Initially, to meet a strong social demand, municipal

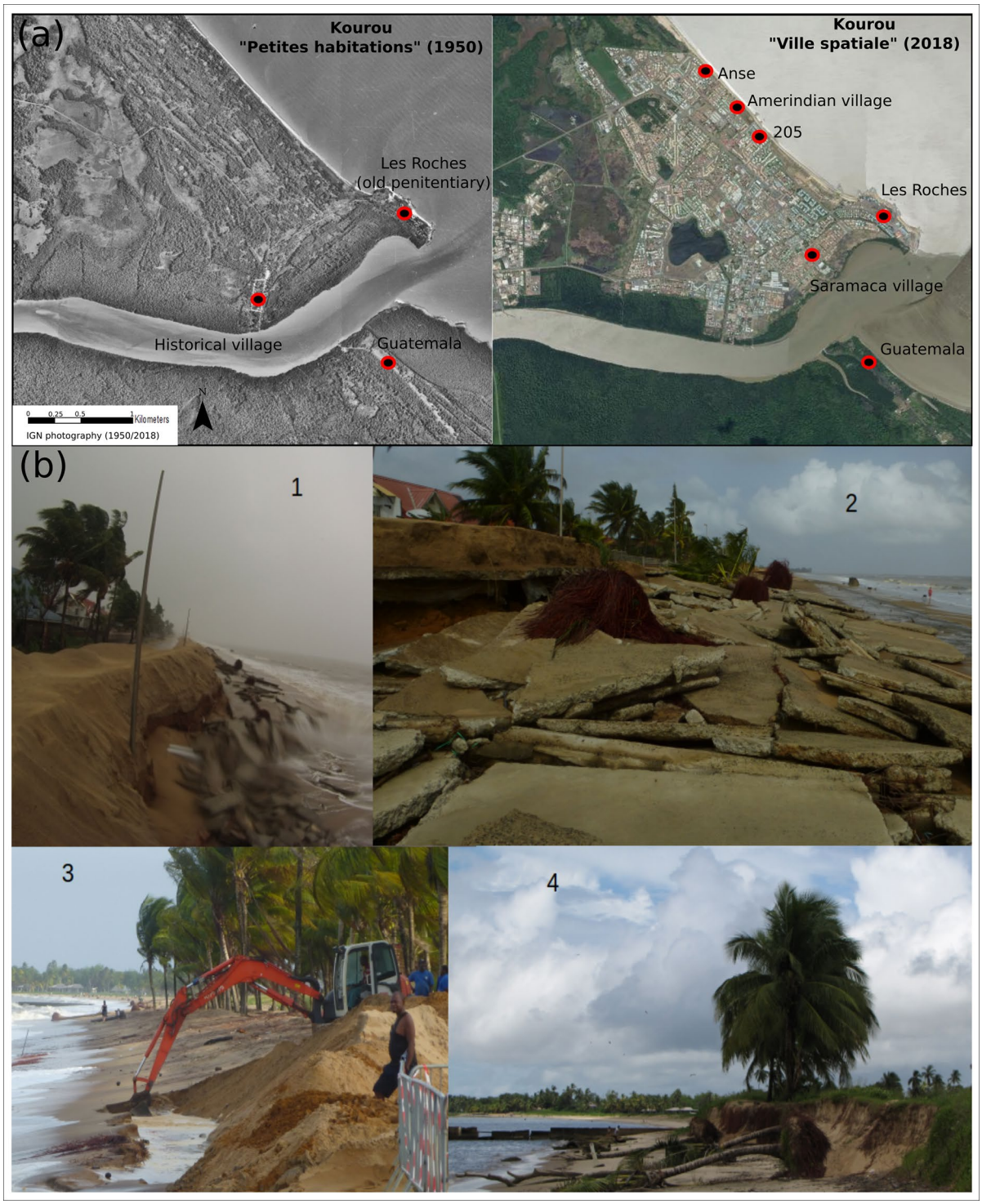


Fig. 3 Situation map of the concerned districts in Kourou (**a**) and photographs of the waterfront during coastal erosion episodes between 2012 and 2017 (**b**): 1 and 2 L'Anse, Association Kourou Littoral, January 2012, and February 2016; 3 The Amerindian village, Association Kourou Littoral, February 2016; 4 Les 205, Philippe Cuny, June 2017

officials considered mainly "hard" solutions. But the cost soon appeared to be too high, and the studies of the State services showed that coastal movement is inevitable. Finally, after much hesitation, the option of moving certain neighborhoods was then openly considered.

In the end, Kourou is the archetype of the great project implanted from the French mainland, with no real consideration for the way people used to live along the coast. The Creoles of the "*petites habitations"* were doomed to disappear in the face of modernity, and no one showed the slightest interest in their knowledge of the environment. A high price is now being paid for this lack of interest.

Discussion

Vulnerability, resilience, adaptability

Since the 1990s, the concept of environmental vulnerability has been widely used in the social sciences. The notion of vulnerability applied to environmental problems has become very popular, despite or thanks to its "polysemic, multiscalar and multidimensional" character (Becerra, 2012). D'Ercole (1994) defines the vulnerability of societies through their capacity to respond to potential crises, a capacity that depends on situational (hazard) and structural (social, economic, cultural, functional, institutional) factors.

Regarding natural hazards, whom analysis moved, during the 1980s and 1990s, from an approach that was much focused on the disastrous events, to an approach more oriented towards social dimensions of the vulnerability, which takes into account structural and functional factors of these societies exposed to hazards (Becerra, 2012; Foucher, 1982; Morel et al., 2006; Léone & Vinet, 2006; Veyret & Reghezza, 2006). Whilst the classic vulnerability-based approach measures the potential damage to goods and people and their repercussions on the economic environment, today it is rather the vulnerability of societies that is assessed. The use of the notion of vulnerability has also developed strongly over the past three decades in publications on the impacts of climate change (Adger, 2006; Gornitz, 1990; Kasperson et al., 2005; Klein & Nicholls, 1999; Nguyen et al., 2016). The vulnerability approach reflects the capacity of a social-territorial system in the diversity of its components—hazards, issues, management and representations—to overcome a crisis, to be resilient.

Finally, the level of vulnerability is specific to each territory, closely linked to its history, its use and its population (Barnett et al., 2008; Kasperson et al., 2005). Because it is socially localized, its analysis is territorialized. Regarding coastal areas, Meur-Férec et al. (2008) propose a "systemic vulnerability" approach which consists of considering the hazards as an integral part of the vulnerability, whereas they are generally studied separately. Integrating hazards into vulnerability makes it possible to avoid "a Manichaean and naive reading of the hazard-vulnerability pair (opposing nature on the one hand and culture on the other)" (D'Ercole and Pigeon, 2000).

The concept of resilience intersects in many ways with that of vulnerability. It is polysemous and is used in many disciplines, including materials science and psychology (Bourcart, 2015). In ecology, it was first used to characterize the ability of ecosystems to maintain themselves despite disturbances (Holling, 1973). The recognition of the inextricable links between these ecosystems and social systems led to the evocation of the resilience of social-ecological systems (SES) (Folke et al., 2010). Geographers who work on risk consider it as the opposite of vulnerability, i.e. the capacity of societies to integrate the risk of natural hazards into their way of life (Wisner et al., 2014; Cutter & Emrich, 2006, Gaillard, 2010).

Folke et al. (2010) emphasize that social change is central to resilience and highlight two essential elements of resilience: adaptability and transformability. According to these authors, adaptability "capture the capacity of a SES to learn, to combine experience and knowledge, to adjust its responses to changing external factors and internal processes (Berke et al., 2003)", while transformability has been defined by Walker et al. (2004) as "the ability to create a fundamentally new system when ecological, economic or social structures make the existing system untenable".

The Guyanese examples described show a great capacity for adaptation of Amerindian and Creole settlements to coastal change, an adaptation made possible by mobility. This adaptability allows for a stability of lifestyles that are not transformed.

Unlike populations who face new events and must change their way of life, particularly through mobility (Zickgraf, 2018 and 2019), we note that for

Amerindians and Creoles, displacement was somehow part of life. If coastal change was a strong constraint for them, by modifying access to resources or forcing inhabitants to move their houses, it was not socially constructed as a danger or a disaster.

On the other hand, in Kourou, where adaptability is non-existent because the concrete pavilions cannot be moved, the situation is worrisome for the inhabitants of the affected neighborhoods. The same coastal change, by provoking the destruction of a road and threatening several buildings, is experienced as a serious event that generates social tensions. Some of them say that they would like to see the construction of protective structures, but given the financial and technical difficulties, it seems that the solution now being considered by the public authorities is relocation. This solution appears to some as an abandonment by the authorities and raises new difficulties: lack of available land, problem of financing, supervision of the operation.

The adaptability and resilience of Amerindian and Creole seaside hamlets can thus be contrasted with the vulnerability of the "ville spatiale", which shows, if it were still necessary, the socially constructed nature of "natural" disasters (O'Keefe et al., 1976).

Mobility and collective appropriation of the territory, a model in decline?

As discussed above, mobility is an essential element of the response of the Amerindian and Creole populations to coastal change. In recent years, many researchers have published works on mobility as one of the responses of populations to environmental changes that affect their resources and living environments, a timely topic as climate change may increase these mobilities (Zickgraf, 2018, 2019, Van Praag et al., 2021). Here we present a case where populations have lived on a moving coastline for centuries (or even longer in the case of Amerindian populations), and whose primary response to coastal mobility is their own mobility.

But is mobility as it was practiced in the past reproducible today? This mobility was possible because private property did not exist, and the territory was collectively appropriated by the group. An individual could work the land and the products of his or her labor belonged to that individual, but the land did not belong to him or her nor to his/her family (Davy et al., 2016). Therefore, if conditions became unfavorable in one place, another free place could be chosen to settle. The collective appropriation of land has been able to continue until recently in French Guiana because the majority of the land belongs to the State—95.8% in 2017 (AUDEG, 2018)—and because the size of the territory limits human pressure on the land. The appropriation of land without property title has thus been practiced for a long time by Amerindians, Maroons and Creoles and is now practiced by immigrants (Palisse & Davy, 2018). The Amerindians struggle to maintain this system. In 1987, the French state granted limited territorial rights to Amerindians through the "Zones de Droits d'Usage Collectifs" (collective use rights zones) (Davy et al., 2016). For example, in Awala-Yalimapo, land issues are thus managed jointly by customary and municipal authorities (Filoche, 2011). However, while these forms of collective appropriation have not disappeared, the increase in population and its density is generating more pressure on land, particularly around cities, and making it difficult to move. In addition, the private property regime has expanded. The Creoles in the villages of the savanna region are now landowners, and although many Amerindian villages, as well as Awala-Yalimapo, are built on collective use right zones, this does not prevent some Amerindians from acquiring property elsewhere. Mobility is also limited by the fact that populations now increasingly tend to consider access to running water, electricity and garbage collection services as minimum standards of comfort. Now, on the coast, it is mostly migrant populations without residence permits who live in neighborhoods without water and electricity. Therefore, movements must now be made towards areas that are already equipped, or the authorities must coordinate the installation of networks in the areas concerned, which is generally long and complicated. In Yalimapo, where the erosion is getting closer and closer to the houses, if some inhabitants do not seem to be worried, explaining that if necessary they will move as they have always done, the municipal authorities are trying to anticipate the displacement, and deplore both the complexity of the operation and the lack of responsiveness of the State services given the emergency of the situation they claim.

Adaptability was also linked to pluriactivity. The populations had several resources: if they had to move away from the sea, the share of the sea's resources in their diet decreased, but was compensated by other

resources: fishing in rivers and marshes, hunting, livestock raising… Today, for those who continue to practice it, pluriactivity often includes one or more activities that generates monetary income (informal "job", paid employment, small business…). The income generated can, as has been shown in other cases (Brüning, 2021), help to adapt to environmental change by allowing the construction of a new house in another less exposed location, or, for fishermen, pay for fuel to tow their dugout canoe to a location where launching is possible (Jean-Jacques, 2018).

However, even if mobility and pluriactivity are no longer what they used to be, they have changed and still exist among certain populations, who continue to follow these patterns and do not seem to be overly concerned with coastal change, even though it affects them very closely. The situation is obviously not the same for the owners of the houses in Kourou, who are wage earners, who have invested a significant part of their income in the purchase of their house, and who see their property threatened by destruction.

Margin populations and lightness of development

At the end of the 19th and the beginning of the twentieth century, the Amerindians and the Creoles of the small dwellings were considered as populations living on the margins of the colony. The model of development pursued by the colonial administration was that of the large exporting plantation, employing salaried workers (Lamaison, 2010). Amerindians and Creoles thus occupied spaces neglected by the colonial economy, in which living conditions seemed repulsive: this is the case of the cheniers, marshes and savannas of the coast. They had therefore adapted to these changing environments and learned to live with them. It is striking that they did not seek to transform them. Apart from a few bridges installed over small rivers by the Creoles and often washed away during the rainy season, there were almost no infrastructures. The houses were built of light materials and could be easily dismantled and moved. Inhabitants dug wells and planted useful trees around their homes, and these were about the only traces they left behind them. Their development of these spaces can be described as light,[6] in contrast to the heavy development that was a model for the elites of colonial French Guiana: as in the neighboring colony of Suriname and its polders.[7] Several attempts to build polders took place and failed: on the Approuague river with the Swiss engineer Guisan in the eighteenth century, and in the dwellings near Cayenne in the nineteenth century (Lamaison, 2020; Le Roux, 1992).[8] In the twentieth century, the construction of Kourou was carried out in the same logic of radical transformation of the environment: the relief was flattened, the marshes were filled in, as if it seemed unimaginable to live with them.

The lightness of Amerindian and Creole development must also be related to the marginal status of these populations and their lack of rights and capital. Environmental reasons were not the only ones that could cause displacement. In the 1950s, the Amerindian populations were subjected to attempts at assimilation (Vignon, 1985), which resulted in the will to prevent them from moving by grouping them together in large villages (Guyon, 2013) as well as by establishing boarding schools for Amerindian children in an effort to cut them off from their family culture (Armanville, 2012). We have seen, also, how the Creole populations were expropriated during the construction of the Guiana Space Center. Thus, these populations sometimes had to face constraints from the central authorities. In such a context, discretion and mobility were also a way of escaping central powers. It can be noted that these are also the means used by gold miners in southern French Guiana,

[6] Lightness, Marshall Sahlins reminds us, is a desirable quality for nomadic populations. A light object can be easily carried (Sahlins, 1988).

[7] Many examples of this admiration for Suriname can be given. See for example the book by Daniel Lescallier (1798), pp. 20–21.

[8] One may wonder about the causes of these failures while the Surinamese polders have been maintained. One can incriminate a lack of know-how on the part of the French, who did not have the same tradition in this field as the Dutch and perhaps did not choose the best locations. Certainly, given the chronic shortage of workers in French Guiana, it was impossible to maintain a model after the abolition of slavery that formerly relied on the use of slave labor to dig canals and build dikes. It is worth noting that in Suriname, the polder system was reinvested and used by Indian contract laborers to grow rice (Ramdayal et al., 2021).

marauders of the nineteenth century or garimperos of today (Le Tourneau, 2020, Jebrak et al. 2021).

Colonial frontier and omission of the local populations

What is also striking about the results of this study is that they provide a reminder of the existence of populations that have been forgotten. Amerindian villages and small Creole dwellings rarely, or intermittently, appear on ancient maps. These lifestyles and economies have been forgotten because they were not considered important for the elites of the time. This omission is not surprising. Throughout the existence of the colony, the various administrators constantly announce that the colony will soon reach prosperity (Lamaison, 2010). For the latter, this meant cultivating export crops that would allow it to become part of a globalized monetary economy. The presence of populations practicing subsistence agriculture associated with hunting, fishing and gathering practices allowing them to be self-sufficient was not perceived in a positive light: they remained outside the colonial project. The territories on the margins of colonization, such as the savannas of the West, were perceived as "frontiers" in the sense of Turner (1894), i.e., the places of a process by which "civilization" was to progressively replace "wildness". The notion of frontier has been used in the Brazilian Amazon since the 1970s (Schmink & Wood, 1992). It has recently been reworked by the social sciences, taking into account its destructive aspect for the environment and for local populations (Barbier, 2012; Geiger, 2009), and Jebrak and al. (2021) have recently described the evolution of the gold mining frontier in French Guiana.

When the space center was established in Kourou, the operation was presented as a high-tech conquest over a hostile environment. The site was considered almost empty, and the expropriation of the small creole dwellings was carried out without hesitation. Forgetting the people of the coast also meant forgetting their memory and knowledge of coastal changes. This would come at a high cost as it is known that preserving the memory of these past events is a determining factor in reducing vulnerability (Mathis et al., 2016). The lack of consideration of this knowledge may seem paradoxical in that colonization was in many respects a "colonization of knowledge", particularly botanical knowledge (Boumediene, 2016), and numerous works show how the knowledge of local populations was studied and used in the constitution of a colonial science, notably in the French system (Sibeud, 2002; Regourd, 2008). However, in the Frontier's logic, the objective remained a profound transformation of the colonized spaces, with the aim of making them productive. From then on, the ways of living of the local populations were considered as survivals of the past, destined to disappear.

This leads us to a final remark on the fact that the colonial project, as it continues with the Kourou space center, is deeply inscribed in a linear temporal framework marked by the ideas of progress and modernity (Latour, 1997). Local people, on the contrary, are placed in a much more cyclical temporal framework, marked by the notion of seasonality (Bates, 2007; Chisholm Hatfield et al., 2018), Their knowledge is inscribed in the places they travel, which are linked to elements of the past and inscribed in relationships (Basso, 1996). Thus, events related to coastal change are not perceived as new, but often as a return. "The sea has returned to its place" we heard repeatedly. By placing themselves in a futuristic perspective, focused on an industrial development of French Guiana, the promoters of the space center and of the new city resolutely cut themselves off from the territory's past and forbade themselves to hear other histories than the one they thought they were writing.

Conclusion

Ultimately, two very different ways of inhabiting the territory have coexisted throughout the history of French Guiana and have particularly marked its coastline: on the one hand, the model of major projects which have their origin in the mainland France, consisting of radically transforming the environment to make it productive, and on the other hand, the model developed by the local populations, Amerindians and Creoles, based on adaptation to the environment, and in particular to variations in water levels.

French Guiana was considered a failure throughout the colonial period because the coastal plain was poorly developed. However, today, we can see that the coastline is better preserved than that of Suriname or Guyana, where efforts have been made in recent years to restore the mangroves through costly projects (Anthony & Gratiot, 2012). The only

place where a polder has been built on the seafront in French Guiana is in Mana, where rice fields were established in the 1970s. In the early 2000s they suffered intense erosion accentuated by the effects of dykes and rice field drains, which have altered silting conditions necessary for the natural protection of the coast. Although erosion was probably not the main cause of the abandonment of rice cultivation in French Guiana, which was not economically competitive in view of the high vallue of the euro, the consequences of the establishment of the polder can be seen in the aerial photographs: the coast has undergone more erosion at the level of the polder than in the surrounding areas (Brunier et al., 2019).

The fact that the coastal plain was not transformed does not however mean that it was uninhabited. But people had developed a lifestyle that, ultimately, had little impact on coastal dynamics. Today, we ask ourselves how we can live on the planet without destroying environments and how we can adapt to rapid environmental change. While it may not seem possible to replicate the highly autonomous lifestyle of these small communities, nor their mobility when the private property model has largely spread as well as the use of hard materials like concrete (Fig. 2.4), their history is, nevertheless, of great interest and can allow us to think differently about the development of French Guiana's coastal territory.

Finally, the issue of adaptation is likely to be a strong one in the future. The effects of climate change on this low-elevation coast are expected to lead dramatic changes in the morphology of coast. Sea level rise, the increase in extreme events (storms in particular…), could profoundly change housing conditions in the coastal plain and force people to adapt to aquatic lifestyles or to retreat to higher lands.

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Declarations

Conflict of interest The authors declare no conflict of interest.

Informed consent The interviewees in the semi-structured interviews were informed of the purposes of the study and gave their oral consent for the interviews to be recorded and used, respecting their anonymity and for academic research purposes only.

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