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## **An orientation for coastal disaster risks management and prevention policy in a global warming context: case study in Ouvea (New Caledonia)**

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## 1. Introduction

The implications of global warming on coastal areas, in terms of erosion, submersion and environmental changes in general, bring about a source of uncertainty and worry for the Pacific region. In New Caledonia, Ouvea (Archipelagos of the Loyalty Islands) is considered to be one of the most at risk areas from the rising sea level. The island inhabitants are witnesses to the environmental changes and coastal erosion, which seem to only worsen over time. Thus, the people of Ouvea seek a solution to be able to adapt to their current environmental crisis.

Adaptation by coastal populations living on small islands is very common. In the Pacific Region, such adaptation strategies branch out in two main forms:

- The displacement of the population. There are two main ways in which this strategy is possible:
  - Under the form of “climate refugees” [1, 2, 3, 4], which is widely publicized and heavily politicized [5, 6]. Such a case is evident in Tuvalu (*Ibid*). However, different studies have shown that erosion on this archipelago only occurs in particular areas [7, 8, 9]. Thus, the physical entirety of the island is not affected (*Ibid*). The analytical model generally used to capture the relationship between sea-level rise and coastal erosion is the one proposed by Bruun [10]. This implies a direct relationship between sea level rise and shoreline retreat. This theoretical model is now widely discussed and amended [11, 12]. While sea-level rise is an important parameter to consider, especially in the current context, other factors also have an essential role in understanding coastal erosion. Natural factors (swells, tides, sedimentology winds, bathymetry, etc.) are numerous and their relationships are complex. Marine weather forcings, including the passage of cyclones for the Pacific islands, play a significant role in coastal sediment dynamics [13]. Similarly, anthropogenic impacts, through development (walls, riprap, groynes) or inappropriate uses (material extraction, urbanization), play a crucial role in understanding the erosion observed on many islands [14, 15]. Moreover, the idea of abandoning one’s territory as a Climate Refugee remains a last solution for many Tuvaluans. For them, this solution would only be conceivable when all other possible solutions fail [5]. In numerous places around the world, and particularly in the Pacific, attachment to the land is an essential element for inhabitants, as it is fundamental to their cultural characteristics and identities. However, this attachment presents a limit when strategies based on the idea of abandoning the land are considered [16]. This is the same situation that is seen in New Caledonia, where attachment to the land is an essential component of the Kanak culture [17, 18, 19, 20, 21]. Studies around the subject of risk adaptation and migration, as far as the rising sea-level is concerned, all too often evade the will and capacity of the population to cope [22, 23, 23]. Nunn *et al.* [25] showed that in the neighbouring archipelago of Kiribati, coastal stone structures had been constructed more than 1000 years ago by preceding populations, in order to adapt to the environmental changes linked to the evolving sea-level. The authors speak of “cultural determination to resist” changes in the environmental conditions. Different scholars stress the need to integrate a cultural dimension into the development of a truly effective adaptation strategy, and to adjust to the local context [26, 27, 28, 29, 30].
  - The displacement of the population can also be considered on a smaller scale, by “moving inland” [31, 32, 33, 34]. It refers to the intra-island migration of the most exposed populations, towards the interior of the island. It is a solution that has already been employed by different countries in the Pacific, such as Vanuatu [35] and Fiji [24]. This is due to erosion processes and/or natural forces [24], as well as seismic activity [35]. This strategy was also rooted in the traditions of many peoples of the Pacific region as a response to previous flooding. However, it had posed less of a problem than it does today due to the relative nature of sedentary life at the time [19, 25, 36, 37].

- Strengthening the resilience of communities in the most exposed areas. The objective is to reinforce the population adaptive capacity, by using different methods of action. These methods are often divided into two main approaches:
  - The first approach, *top-down*, refers in some ways to the classic model, which is heavily based on scientific expertise [38, 39]. This type of approach corresponds to a risk analysis of natural hazards and modelling, in order to anticipate future scenarios [38]. However, the gathered information is not easily understood nor used by local participants. In terms of coastal risks (coastline erosion and marine submersion), the response patterns resulting from this type of approach, often reflect considerable investment in heavy structures for security purposes. These strategies are increasingly criticised today due to their economic cost, systematic use, which sometimes causes subsequently decisive problems in construction, or their maladaptation to the dynamical context. They imply secondary effects on the environment [40, 41, 42, 43]. These secondary effects can equally occur on a conscious and social level. This can create more vulnerability by forgetting past natural disasters, or by the “optimistic effect”, which masks the reality of such risks [44, 45, 46]. In some cases, this type of structural strategy is complemented with the desire to inform the population. In regards to the French model, this sensibilisation of the population can take many forms: with the standard form (posters, flyers, information booklets), or even better, by going to meet the population in a single public meeting. Due to the lack of resources (human, financial or technical), expertise and political will, this type of approach has a very limited impact on the population [47, 48, 49]. In addition, it is often criticized for its lack of consideration towards local cultures [50, 51]. Elsewhere in the Pacific, these information strategies are often developed through sources of non-sustainable funding, making any form of long-term support impossible. The aim of strengthening the resilience of the local community may then seem artificial, because the implemented measures remain limited in both space and time. These measures can also seem disconnected from the daily life of the population and their actual concerns. The methods of representation that they associate with risks, local knowledge, or more generally, the relationship they maintain with their environment, are not always taken into account insofar as these measures are concerned [52]. These constraints thus limit the scope and effectiveness of this type of approach [53];
  - The second approach, *bottom-up*, represents approaches based on the involvement of communities, where a different solution should be brought forward with the help of the population, more precisely from the population, i.e. from the grassroots to the governing bodies. Nevertheless, these approaches sometimes present the same limitations as the previous ones: whereby interaction or implication of the population is sometimes presented as a pledge of appropriation. In reality, this does not suffice and the process is can be deformed due to the lack of mutual understanding between the participants. In this type of approach, the initiative can come from the governing bodies that benefit from dedicated funding. The will to involve the populations is real, but it can happen that social concerns do not correspond to this institutional will. A gap can thus appear between the resources dedicated to the implementation of action and the expectations of the populations. Various authors have shown that in different Pacific countries, islanders are not always as sensitive as that to the issue of global warming. This is the case that scholars have found to be true in Tuvalu Gemmene [5] and Worliczek [54] Wallis. Their findings coincide with those of Nunn [37, 55, 56], which stated that issues surrounding global warming are not of primary concern for small island populations of the Pacific. Rather, they consider such a subject as an external matter, which should be resolved by those they find responsible, namely the Western and Asian powers<sup>1</sup>. The question of local methods of representation and the relation to the environment by its people, is a crucial variable to be grasped in order to build adapted tools. The majority of participants are well aware of the importance of

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<sup>1</sup> There is also this type of discourse on Ouvea and neighbouring islands such as Lifou, where responsibility for local impacts as well as responses to them are attributed by a part of the population to "large countries".

developing this type of integrated approach and redefining the methods of governance, especially in the Pacific. These are the tools to achieve this, which are still difficult to build because of these differences in representation between governing bodies and populations. This is why other means of implicating the populations are promoted progressively, relying more on so-called "cultural" approaches [25, 29, 57, 58]. The challenge then is to find bridges that will make it possible to build the dialogue between "scientific knowledge" and "indigenous knowledge" [26, 39, 59].

This brief overview of current actions in the Pacific region, allows to better position the focus of the study. It presents the approach implemented in Ouvea during 2015-2017. It concerns the implemented communal observation of erosion, where the ultimate objective is to contribute to the establishment of such necessary bridges between knowledge.

This observation initially aims to acquire data on the evolution of the beaches, thanks to topographic surveys carried out by the local populations with simplified protocols [60, 61, 62]. But beyond the accumulation of this geomorphological data, the observation is more considered as an interface which enables an exchange of dialogue between "expert" knowledge and "inhabitant" knowledge. This is to promote exchanges between local participants, customary authorities, local institutions and external partners, such as researchers. The idea is to reach a mutual understanding to allow for the construction of a strategy of adaptation which is coherent, progressive and well-adapted to the cultural context. The goal is to be a part of a sustainable approach, aiming to support local populations and participants in their reflection. It is the interest of the observatory to register these different actions over time. This amounts to proposing a tool to help build the outlines of a territory-specific risk prevention policy. This would involve relying on the specific characteristics of the territory studied. The territory is being understood here as a social construction, an inhabited and appropriated space [63].

In this, the observatory meets a number of requirements set by international frameworks, as the Madrid Protocol<sup>2</sup> (2008) related to the implementation of the Integrated Coastal Zone Management (ICZM) around the Mediterranean. Indeed, this protocol underlines the need to improve the state of knowledge available on the coastal sectors and establish a scientific observation on the subject. This would be possible through the creation of observatories which are committed to the establishment of effective public action (particularly in terms of information and public awareness) as well as the development of efficient, transparent, collective and multi-stakeholder governance of the coastal zone [64, 65]. Particular importance is also placed on the recognition and enhancement of the heritage and cultural dimensions (i.e. local knowledge) of the coastal zone, particularly in the islands (art 12). In a context of shared responsibilities and legitimacy, this refers to the integration of customary and institutional authorities, local populations and associations, into a common reflection on the management of the coastal zone and the pressures exerted on it.

Achieving these different objectives requires a re-examination of the relationship between scientific expertise and the way that it is used by institutions, and more generally, the public. The purpose of this approach is to promote better management of the coastal area. This implies taking equally into account the methods of representation that the populations have with this environment, and the physical processes at work. Identifying the reversal, acceleration or attenuation of the coastal erosion can only be possible by comparing the data series with each other. This therefore requires the long-term establishment of this observation. The involvement of the population in the implementation of these measures is an important lever to mobilize in order to sustain the surveillance and ensure the awareness of local actors over time. In the same way, this unification of actors is essential in fostering mutual understanding. Local actors are the guardians of specific knowledge relating to certain practices, perceptions and methods of appropriation rooted in a cultural dimension. Such knowledge is ever-evolving in itself as history shows, where it has crossed various ruptures and tensions over time [19, 20]. It is crucial that apprehend these factors in order to duly adjust management strategies over time.

This article reviews the establishment of this communal erosion observation. First, we will come back to the general context of the study and the specificities of the field of application. Then, a presentation of the material and the method chosen for the constitution of a corpus of reference knowledge,

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<sup>2</sup> <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:034:0019:0028:FR:PDF>

concerning the coastal erosion and the terms and conditions of its management is proposed. Following, a presentation of the main results acquired is submitted before discussing the participation of local actors within the plan. Finally, we will discuss the advantages and limits of such an approach.

### **1.1. A pre-existing environmental governance in Ouvea**

Since 2008, Ouvea's lagoon has been listed as a World Heritage Site by UNESCO. This enrolment was put in place by the construction of a partnership between local participants. These participants are the institutional stakeholders and the customary authorities of the island gathered within the Groupement de Droit Particulier Local (GDPL), otherwise known as "*Bomene Tapu*"<sup>3</sup>. This group works with the environmental association of the island. The management plan results from a participative construction with the local population. They have identified a set of issues such as coastal erosion, rising sea-levels and marine flooding. The purpose of this co-management is to promote sustainable local development which respects local customs and the environment. The idea is to make people responsible for both the quality of their environment and the preservation of their cultural specificities, knowledge, methods of representation and management, i.e. everything that constitutes their identity. Another aim is to find guidelines to adapt to new situations and challenges, such as global warming, rising sea-levels or coastal erosion. The proposition of involving the population in monitoring the coastal erosion, derives from this preexisting environmental governance, which strongly favours complete establishment and autonomy on the island.

### **1.2. Ouvea is a low island affected by coastal erosion**

The field of work is in Ouvea, which is located north of the Tropic of Capricorn between 20° 20' to 20° 80' S and 166° 10' to 166° 80' E (Figure 1). It is a relatively low island, rising to just 43 m where 60% of its area is less than 10 m above sea level.

*Figure 1*

Geologically, this coastal area consists of recent sandy deposits linked to the Holocene transgressive maximum. It marks a succession of former shorelines linked to the gradual drop in sea levels and vertical movements affecting the region's tectonics, which are characterised by the convergence of the Australian and Pacific Plates resulting in subduction in the New Hebrides Trench. The study area is located on part of the Vanuatu Arc where the convergence speed is estimated to be about 12cm/year [66, 67, 68]. Subduction of the Australian Plate under that arc is accompanied by vertical movements of the lithosphere. In the Loyalty Islands, they are estimated to be between 0.12 mm and 0.25 mm/year over the past 125,000 years [66, 67, 68]. This subduction is deforming the Australian Plate above the New Hebrides Trench, described as a pre-subduction lithospheric bulge (Figure 2).

*Figure 2*

The island has a population of 3374 [69], with nearly 44% living in risk zones<sup>4</sup>. The Lekine tribal<sup>5</sup> area is one of work areas (Figure 3). This tribe is part of the Mouli District (southern Ouvea) and is home to about 266 inhabitants. Generally in Ouvea, human activities determine the use of land. This has led to such challenges being concentrated along the coastal strip across from the lagoon, thereby leading the island to be highly exposed to marine and weather forcing, and global warming (*Ibid*). More specifically in the study area, the human-related issues found there are tourism-related business facilities, i.e. a camping ground-restaurant, "le camping de Lekine", the "Fassi" snack bar/restaurant, and a luxury hotel, "Le Paradis d'Ouvea". There is also the road that links the small island of Mouli<sup>6</sup> to the rest of the main island.

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<sup>3</sup> "*Bomene Tapu*" means "The sacred island".

<sup>4</sup> Risk zones refer to the coastal sectors that are no more than 10 m above sea level and whose coastlines are no more than 500 m long [36, 70, 71].

<sup>5</sup> Kanak villages are designated with the term "tribe" in New Caledonia.

<sup>6</sup> Mouli is the name of the tribe, district and little island.

Figure 3

Geomorphologically, the specificity of the area is Lekine Bay which connects Ouvea's lagoon (*Gööny*) to the Pacific Ocean (*Cöu*). This connection begins firstly at the Lekine bridge and secondly at the presence of two reef passes: the Lifou Pass, which is oriented to the south-east, and the New Caledonia Pass, which is oriented to the south-west. The *Hnyimäk* Channel also allows marine waters to enter the Lekine mangrove. The presence of these passes implies the circulation of tidal flows, which plays an essential role in the sediment dynamics of the site [72].

## 2. Material and Method

The observatory interest is to create a legitimate framework to produce a body of knowledge. The aim is to establish an initial state from which it will be possible to identify changes. It also makes it possible to use a set of methodological approaches to construct a multidisciplinary analysis. Below we present these tools and methods used for the development of a corpus of reference knowledge.

### 2.1. Erosion study

Several complementary approaches are being mobilised to characterise, quantify and monitor the evolution of coastal erosion at distinct spatial and temporal scales.

- By processing old aerial photographs and satellite images, it is possible to ascertain the geomorphological evolution of the site on a secular scale (1954-2012). This also makes it possible to quantify the evolution of a natural indicator classically used for the study of coastal erosion, which concerns the position of the coastline<sup>7</sup>. We will not go into the details of the results of this analysis [73, 74, 75]. However, it will be present a very brief discussion on the main findings that emerged from the study.
- For more details and precision it is essential to go through a field approach. This kind of work involves establishing long series of data. Simultaneously, a naturalistic analysis is also conducted to identify erosion indicators<sup>8</sup>. The field monitoring was built around the production of beach profiles, a type of data that is traditionally used in coastal geomorphology. The selected data-acquisition protocol was initially proposed by the research team in response to specifications that had been defined beforehand. These specifications required that the surveys be carried out directly by local partners, so that they may be easily reproduced by any person, or group of persons, wishing to invest themselves in the approach. By this method, topographic data production was one of the levers for participation and knowledge transfer. On the technical level :
  - The beach profiles are made from a network of geodesic terminals whose positions have been accurately recorded using GNSS. A network of 20 geodesic terminals have been deployed in the study area. These are spaced approximately 200m from each other (Figure 4a). Each terminal is the profile head from which topographic measurements are taken<sup>9</sup>. Surveys are done every 4 months as well as after the most important natural disasters<sup>10</sup>. The comparison of the profiles between them, makes it possible to characterize the evolution of the studied sectors. The choice of placement for the geodesic terminals is built to meet both scientific (morphological monitoring of beaches) and socio-cultural consideration. In consultation with local partners, the "*geography of the sacred*" has been integrated of the study site. The taboo spaces were thus identified and respected<sup>11</sup>;

<sup>7</sup> The definition used is the seaward boundary of perennial vegetation [76, 77, 78, 79, 80].

<sup>8</sup> Morphodynamic processes translate into specific topographic, biological and sedimentary morphological characteristics. They make it possible to distinguish a beach in equilibrium from a beach in accretion or *a fortiori* in erosion. It is the observation of these indicators that will allow to characterize the state of a beach.

<sup>9</sup> A reference azimuth is defined at the start, so as to cross the shoreline perpendicularly. Repeating the measurements from the same azimuth allows the surveys to be compared with each other.

<sup>10</sup> (...) such as the cyclones Pam (March 2015) and Solo (April 2015) on the northern part of Ouvea.

<sup>11</sup> This means that no terminals have been installed in these taboo places.

- Topographic data is acquired according to a simplified protocol (Figure 3b). It is inspired by methods of constructing beach profiles from instruments of low technical quality, but they are nevertheless precise [60, 61, 62]. The instrument used, called a "topometer" [81, 82, 83], makes it possible to establish beach profiles with a satisfactory degree of accuracy (Figure 4b). Indeed, the margin of error associated with each measurement is 0.5 cm vertically [43, 84]. The difficulty is that this error is cumulative along the profile. In this, the longer the profile is, the greater the risk of error is. This is one of the limits associated with this method, which is also observed in the literature on this kind of approach (*Ibid*). Caution should therefore be exercised in quantifying the observed trends.

*Figure 4*

The construction of this observatory has also made it possible to establish a database on marine and meteorological forcings (cyclones, tsunamis and marine flooding) that have occurred over time [85, 86, 87]. To do this, archival materials (photographs, written press, military reports and missionary correspondence) were used. This documentation facilitates the reflection and understanding of environment/society interactions over time. Information relating to the position of the coastline, as well as the artificialisation of the environment or the consequences of flooding are thus identified and exploited. This data helps to boost exchanges with the populations and to reactivate a hazy memory with visual supports or vintage testimonies. The same is true for old aerial photographs (example: oblique photography of 1943, NARA) which can be considered as archive materials. They were mobilised within the framework of exchanges with the populations during various workshops, a subject that will be later on return to.

## 2.2. Social representation study

Another equally important dimension of the observatory, lies in understanding the methods of representation that the populations maintain with their environment. To understand this, different methodological levers have been mobilized:

- **Semi-directive interviews:** a series of semi-directive interviews were conducted with institutional leaders and the local population as part of a 6-month training course, 3 of which were spent in the field. Boudjema [87] was thus able to conduct a sample of 80 interviews, covering both individual and collective representations, uses and practices associated with the coastal domain and natural hazards. A set of information also concerned the toponymy, their meaning and the factors motivating the nomination of a place (*Ibid*). Investigations in this context have been carried out in the northern part of the island. They were conducted according to a double dimension. The first was specific to the customary world, which directed the investigator towards the guardians of knowledge. They were generally elderly men who were esteemed as legitimate in the eyes of the population. The second dimension gave a voice to other actors in the community, including women. This was not a problem so long as the discussion was a relatively neutral oratory. As soon as the subject touched on toponymy or customary relations, the interlocutors referred people whom they deemed more legitimate to speak on the matter Boudjema [87]. The method used to draw up the sample therefore consisted initially of following the customary path proposed by interlocutors, respecting customs and legitimacy, and then supplementing it by giving a voice to other categories of actors, such as young people and women;
- **Participatory observation and informal exchanges:** this part of the methodological approach is more diffuse, linked to daily experience in the field, and allows a better interpretation of the relationships maintained by the populations with their environment. This brings qualitative elements to the reasoning that would be difficult to figure out from an external posture [88, 89]. Many elements of understanding could also be collected and discussed collectively amid the participatory workshops carried out during the study and during the accompaniment of local actors in mastering the tools.



Interconnection of these methodological approaches brings an original point of view on the subject in its spatial, temporal, environmental and cultural components.

### 3. Result(s)

#### 3.1. Linked with erosion

The sedimentary dynamics of the channel communicating the Ouvea lagoon to Lekine Bay (at bridge level) is under the major influence of the hydrodynamics prevailing in the channelization and on the western frontage of the sedimentary formations studied. The influence of marine circulation through the Caledonia and Lifou channels plays a significant role in the understanding of sedimentary facts at the scale of Lekine Bay, but it is minimal when considering the erosive phenomena around the Lekine Bridge [72]. The diachronic analysis of aerial photographs over the period 1943-2012, provide more precise answers in explaining the erosion marking the landscape. This erosion is very localized. It occurs primarily on the eastern facade of the two arrows and is to be put in relation with local developments unsuited to the morpho-dynamic context (Figure 5). This is a classic design error in coastal civil engineering, causing several levels of unwanted groyne effects on the site. It is linked to both the launch ramp of the Lekine campsite (Figure 5a) and the support abutments of the Lekine Bridge (Figure 5b). Another form of identified pressure concerns the removal of materials, such as beachrock used for the reinforcement of the riprap forming the abutments. The analysis also shows a more general trend towards accretion of the two sandy arrows on their lagoon frontage. The analysis of aerial photographs makes it possible to interpret this accretion of the western façade of the arrows, as the environmental response to the meteorological forcing dating from 1951 (February 1951, 961 hPa, 167 km/h, 2 deaths). This is a post-cyclonic resilience process. However, this general dynamic, which is clearly marked in the pictures, masks a latent erosive trend. It is identifiable in the field by the naturalistic approach and with the topographic surveys acquired by the "topometer" method. The main erosion indicators identify are: beachrock exposure, erosion slopes, beach width and vegetation condition. These indicators are not exclusive and most of the time they are associated in the same field. These various elements, which demonstrate the characteristics of ongoing erosion, constitute crucial information to be taken into consideration when defining a management strategy, particularly with regard to current issues. Similarly, the presence of these indicators justifies the interest of establishing regular monitoring of these sites by *in-situ* geomorphological measurements. A mere two-year perspective on the implemented follow-up is not sufficient in order to establish an in-depth analysis of the erosive dynamics on the study sites. Nevertheless, some points can be identified from the analysis of the profiles, which confirm that the general hydrodynamic conditions of the lagoon and Lekine Bay are relatively weak. Additionally, it confirms that the cyclones that occurred during this period did not have a major impact on the position of the coastline within Lekine Bay. During the two years of study, Ouvea Island experienced several cyclones and tropical storms<sup>12</sup>. However, the nature of the hydro sedimentary dynamics of the site associated with the nature of the works built on the sector, implies a low capacity of resilience of the sedimentary formations. This is particularly the case on the eastern façade of the two arrows, which are deprived of any contribution of materials. Although the sector is protected<sup>13</sup> from prevailing winds from southeastern sectors, its vulnerability is reinforced by development errors inherited from the late 1970s.

Figure 5

#### 3.2. Relative result to people's perceptions and representations of coastal space and natural phenomena (erosion, sea level rise, cyclone, tsunami, marine submersion...)

With participatory observation, the use of written archives, bibliography, informal discussions as well as the analysis of the various interviews conducted, allow us to draw up a general typology of the speech registers mobilised by the populations with regard to the two main points of attention: the

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<sup>12</sup> Pam in March 2015, Solo in April 2015, Cook in April 2017, Donna in May 2017.

<sup>13</sup> This fact can also be found in the toponymy "*Launihu*" and local practices, the toponym in question referring to a haven where fishermen keep their boats safe in the event of heavy weather, a secular practice widely shared by the sailors of the territory according to the reading of historical archives (*La France Australe* of 28 March 1891).

relationship of the populations with the coastal space and the methods of representation linked to the existence of natural phenomena. Three main registers of discourse can be distinguished: religious, customary and naturalistic. These were three broad categories that Calandra [90, 91] was also able to identify in the dialogue of the Vanuatu populations following the passage of cyclone Pam. Parallels were made by Revet [51] during her investigation in Venezuela, which concerned the 1999 mudslide catastrophe that devastated hundreds of victims. This author, Revet [51] speaks of a religious, animist and naturalist register that exists concomitantly and is mobilized alternately by the populations. The investigations also show that a certain individual, depending on their degree of spatial, emotional or temporal proximity to the event, may be led to use these different registers of discourse. Therefore this shows that they do not constitute closed or hermetic categories, but rather general reading grids that can be mobilised according to circumstances. Let's take a closer look at these different registers for the fields of study.

### 3.2.1. Customary register

Firstly, it's recalled that in the Ouvean<sup>14</sup> cosmogony [92, 93], there is a road leading to the land of the dead. In Ouvea, the land of the dead is located at "Beautemps-Beaupré" atoll (*Heo*<sup>15</sup>), to the northwest of the main island. There are three entrances for the souls of the deceased to enter, which are all located at sea and guarded by deities [94, 95]. Songs trace the route taken by the spirits, especially on the east coast of the island and the on islets of the "Pleiades du Nord" in Ouvea [94]. Also, the coastal area is often attached to the spirit realm. Certain places (toponyms) located on the coasts are particularly known to be points of passage or important stages of this spirit road. Oral traditions are associated with these toponyms. This dimension generally gives the whole coastline a particular "aura", leading to the existence of certain prohibitions. Boudjema [87] reports that women and children must avoid going near the coast at night because of the presence of the "invisible". In the same way, if the coastal space is attached to the spirit realm and land of the dead, it is also a privileged space of the living. This is because it is a source of life, insofar as it gives access to lagoon resources. This is a very general cultural reading that can be found both in the islanders' speeches extracted from the press in the 1970s and in the speeches collected today (*Les Nouvelles Calédoniennes n°927 of 08<sup>th</sup> July 1974; interviews 2010-2017*). If we then focus on the site of Lekine in particular, we notice that it shelters various taboo places, to which legends and oral traditions featuring mythical characters are attached. These taboo areas are both on the sandy arrows directly studied with regard to erosion (what it has been taken into consideration in the installation of profile heads) and all around, by the cliffs or the *Hnyimək* channel. These sites often have specific restrictions; sometimes they are totally banned, sometimes they are only banned for certain clans or individuals. Access to these places may also be have behavioural prohibitions, such as jumping, shouting, running or simply talking or asking questions [87, 95, 96]. Failure to respect these prohibitions can lead to unfortunate consequences for offenders (diseases, accidents).

Similarly, natural phenomena can be read as the expression of a particular power, attached to a particular clan or individual, and to specific knowledge related to stones or "medicines"<sup>16</sup>. It can also be seen as the manifestation of a will of communication between the spirit world and the living world, between the "invisible" and the "visible" world [87]. Natural phenomena such as cyclones, earthquakes, rain, wind or thunder are sometimes read by people as the visible forms of the mythical ancestors of certain clans. The occurrence of a natural phenomenon and its consequences on the environment or populations will then be interpreted and included in the social field. In this way, the word of the invisible takes shape in the visible world, and it is in this sense where we see a permanent relationship between these two worlds.

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<sup>14</sup> This can also be found in Lifou [18, 92, 93].

<sup>15</sup> In oral traditions, the land of the dead is sometimes referred to by names other than *Heo*, which encompasses the entire Beautemps-Beaupré atoll. In his work on the myths and songs of Ouvea, Guiart [94] compiles a number of texts in which the land of the dead is sometimes referred to as *Bunaca*, *Oijone*, *Hijonem*, or *Motu Tapu* or *Hma Masina* (piece of the moon), which refer to a very rich toponymy present within the atoll of Beautemps-Beaupré.

<sup>16</sup> Some examples from bibliography: In the XIX<sup>th</sup> century, Father Lambert [97] described very precisely how a storm maker prepared a drug of this type in northern New Caledonia. More recently, Guiart [18] proposed a description of a practice to control swells from small bones and plants.

In parallel to this symbolic, cosmogonic dimension of the coast, it is also a political space, which is shared between different customary legitimacies. Land ownership is linked both to mythical stories of the arrival of the first men, and to the political history of conflicts, alliances and allegiances between groups over time. Land properties are divided according to rights of use and are attached to a toponym that reminds everyone of the limits and conditions attached to these uses. Not all fishing techniques can be used everywhere, at anytime and by everyone. There is a spatial, temporal, social, generational and even "gendered"<sup>17</sup> distribution of the use of fishing techniques. More generally, this distribution applies to the uses revolving around the coastal area.

The coastline is therefore a political space referring to questions concerning land tenure legitimacy, the regulation of access to food resources, as well as the distribution of uses according to a spatial-temporal and social articulation. It is also an important symbolic and cosmogonic space marked by a structuring duality representing the source of life and domain of the dead, spirits, and more generally of mystical entities.

### 3.2.2. Religious register

In this kind of representation, the concept of Nature takes an important place, because it is often a recurring subject in discourses. It can be directly connected to the idea of the Christian God in the speeches of people met. "(...) *Me, I know that come from God. It's the Nature that command, it's the Nature that for its job. If the good God, he send a knock of..., so who goes to do something?, it's not a man that send a cyclone, wind to send erosion over there. We can only ask that to up above: cyclones, bad weather, marine erosion, big waves which arrive.*" [87].

In the Christian religion, Nature is the work of God, it is a part of creation to which Man also belongs. Nature is both an element of God's work and a vector of communication between God and humankind. In this sense, all the natural phenomena that affects the island are potentially linked to a divine will. In the same way, the absence of major forcing and damage in recent years in Ouvea can be linked to the protection granted by God in response to peoples' prayers. This reading of the causes of natural phenomena affecting coastal areas, leads to ambivalent responses. These include passivity and fatalism: "(...) it is God alone who can save the world." [87]. Alternatively, it can also be a call to take action. If the cause is divine and punishes men for their deviant behaviour (*Les Nouvelles Calédoniennes of 25<sup>th</sup> september 1986 ; interviews 2010-2017*), then this behaviour must be changed, and this change necessarily requires action. This gives rise to a paradox: does the representation of the phenomenon as divine expression lead to action or inaction? For us, this apparent paradox is not really paradoxical because it does not focus on the same dimension of action. Apparent fatalism refers to several explanations:

- temporary dejection of people in the face of destruction ;
- the lack of knowledge and understanding of the physical mechanisms involved in natural processes, i.e. hazards, technical or behavioural solutions that can be provided locally to reduce vulnerability and strengthen the resilience of populations ;
- the absence of effective means at the individual level to act against these natural processes in a curative manner ;

This last aspect of the question becomes all the more important for societies that have become sedentary and paradoxically, more vulnerable. This vulnerability can be linked to the abandonment of certain knowledge and certain cultural practices. They contributed to the adaptability of populations and characterized a relationship with nature in which caution dominated. From another point of view, the call to take action, which can also be read in the method of religious representation, does not seek to act directly on the natural phenomenon or even understand its mechanisms or solutions that can be offered. Rather, it seeks to modify social behaviour<sup>18</sup>. In this, such an event occurs because man has sinned, which means that the action is no longer on the technical level, but on the behavioural and moral level. This appears in the form of prayers and various support platforms for the people, which is

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<sup>17</sup> For example, gun hunting is mainly practiced by men, on the Cöu side, a maritime and coastal domain reserved for men [87, 96, 98, 99].

<sup>18</sup> Durkheim [100] said that "*Religion is an eminently social thing. Religious representations are collective representations that express collective realities*" [101].

a prism of religion and the action taken to strengthen the resilience of the people. Since the XIX<sup>th</sup> century in Ouvea, and more generally in New Caledonia, the churches have played a particularly important role following disasters. They have acted on different levels: both in the requests for material<sup>19</sup> and financial assistance which were made to the administrative bodies (governor and religious authorities), and also on the spiritual and social levels, by organizing vigils and masses aimed at bringing people together to face adversity. The goal was to both give meaning to the event and to strengthen the community's solidarity, in order to encourage and uplift the populations. It was also common to see families entrust their children to religious authorities, as they had no means in which to feed<sup>20</sup> them. Izoulet [102] also recalls that after the cyclone of 1859, the recently built "house of prayer" for the Catholic Fathers in the north of the island was destroyed. So, the chiefdoms and populations rallied together to build a "true church"<sup>21</sup>. Here again, the sharing of work favoured the strengthening of ties within the community, a dimension all the more important at the time as the context was part of a strong confessional and customary competition, with the chiefdoms at the centre of the island adopting the Protestant faith.

In addition to the customary, political and cultural dimension of the coastline, there is also a symbolic dimension concerning the coastline. It is a component of divine work, which is ultimately perceived as such by the populations. There is therefore an overlap in the methods of representation. The religious activities in Ouvea are inseparable from this space, not only because of history, but also because the missionaries arrived by sea and, for various reasons<sup>22</sup>, they are implanted on the coasts. There is also the fact that these coastal spaces had been used for practices such as religious processions during sacraments, various monuments, as well as cenotaphs intended to inscribe memories there. This constitutes an additional symbolic dimension to this space. Similarly, natural phenomena, whether or not it affects the coastal space, can be the subject of analysis in the religious register. The divine factor can be interpreted in as much vengeful as it is protective, but it is always linked to the virtuous or unvirtuous behaviours of Men.

### 3.2.3. Naturalist register

By naturalist, we mean scientific, that is, as what can be observed. This is the use of explanatory discourse on the natural, physical and/or social mechanisms that cause the hazard and/or disaster. In this way of thinking, the search for explanation is no longer anchored in a symbolic dimension, but on tangible facts. As before, we can also consider that this is a type of discourse that refers to another form of cultural construction, in this case Western [51]. It is then based on an analytical reading of the subject that shows a de facto dissociation between man and nature [103]. Research on the causes of natural phenomena is established in the principles governing the functioning of the environment, as well as in anthropogenic activities on the shore, such as the exploitation of sediments for construction: *"There was a time when the extraction of the soil was really, you had the shovels from the commune coming and digging at I don't know how deep, six meters, four meters. (...) [Why were they digging?] To take sand for construction. "* [87].

Although it is not the most popular explanation register, it is not the exclusive prerogative of experts, even if it can observe that it is more mastered by the most educated people working with or within

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<sup>19</sup> Food (flour and rice) and building material (sheet metal and carpentry) (*Letters from Father Levasseur dated 18 February, 16, 18 and 28 March, 1920 ; Letter from Sister Marie Jean-Baptiste dated 14 December 1920 ; etc*).

<sup>20</sup> This practice was still very present at the beginning of the 20<sup>th</sup> century, when, following the major cyclone, populations were confronted with long months of food shortages (*Letter from Adrien Hoble dated 19 February 1920 from Eacho (Lifou); Letters from Father Ernoult dated 03 and 13 July 1933 from Saint Joseph (Ouvea)*).

<sup>21</sup> We speak of a "real church", because at the time the first religious building built was closer to a wooden hut than to a real religious masonry building as know it today. Moreover, in the following century, the same solidarity was expressed to repair the damage that the church had suffered following a terrible cyclone, as reported by Father Ernoult in his letter dated 3 July 1933 from Saint Joseph (Ouvea).

<sup>22</sup> These reasons are strategic (accessibility and communication), economic (copra production), health (moving out of wetlands and outbreaks of mosquito-borne vector-borne diseases) and political (conflicts of various kinds, customary, religious, national sovereignty). It is an important example as it is very structural for Ouvea. The decree of Governor Guillain of 1865 imposed the Churches to install their religious building within the property of the public domain (which corresponds to the zone of the 50 steps of the king) in response to the numerous conflicts which already opposed the Catholics to the Protestant on the whole of the island, and which thus attaches the coastal space to a socio-spatial organization articulating itself around the place of worship.

institutions. It is also a register mobilised by different members of the community, both young and old, which corresponds to the type of information available. It is linked both to the media<sup>23</sup> and to the actions which were carried out for several years on the island in terms of environmental information. Moreover, it globally refers to the westernization of lifestyles and the influence of a globalized conceptual framework [105]. This type of discourse can be found both with local associations and institutions on the island.

We also note that this register can sometimes be accompanied by a more symbolic discourse, attributing to nature an intentionality, i.e. a specific existence, a capacity for reflection, judgment and action. This is expressed in words such as: *"One must be in communion with nature, you have to respect yourself. If you respect nature, then nature respects you. If you ever don't respect her, by the end of this century we're in the water! (...)"* or *"Borŋ, for me it's nature. She does what she wants, we're just passing through, I don't mind too much."* [87]. This type of discourse aligns with the register identified by Revet [51] in the form of *"naturalist animism"*.

Nevertheless, on Ouvéa, this form of *"naturalistic animism"* seems to us to be used more as a "stylistic figure" or as a semantic shortcut. Depending on the case, this particular form of discourse can either be linked to the underlying idea of the action of the Christian God, or in an excerpt proposed earlier we note the correspondence of this form: *"(...) I know that it comes from God. It is nature that commands, it is nature that does its work... (...)"*, here the idea of God and nature merge; either as a metaphorical purpose aimed at synthesizing a scientific idea that is sometimes poorly controlled: *"The sea has risen a lot. I thought maybe it was because of... I don't know. I think it's because of..., because people will always pick up shells. Around November there are big waves, with the north wind, it always brings a lot of shells to the shore. People will always pick up shells to put in their homes, to put in houses like this. We used to think it was because of that. According to scientists, this is normal. Before we used to go down to the bottom, the beach is further down, down. The sea has risen a lot, I can't explain it to you."*; or to relate it to respect for certain values that are strongly rooted in socio-cultural and moral terms, from this point of view the notion of respect is central and echoes the customary register presented earlier: *"All disasters will happen if young people do not respect and that they drink."* [87].

This is what Horowitz [105] had already pointed out on the perception of nature by the Kanak: *"(...) in the contemporary world, where globalization allows us to exchange and transform our visions of the world at the speed of light, no one can say 100% "traditional". It is therefore logical and even inevitable that, to state his ideas about his relationship to his natural environment, the Kanak uses the elements he finds in his intellectual environment, including concepts, originating from a typically Western vision of the world, but adapted and incorporated into a new Kanak discourse"*. This is why the *"naturalistic animist"* dimension does not seem to us to be a register of representation in itself. A dimension that must also be repositioned in the linguistic context of the island where 3 different languages coexist, the nuances in the understanding of concepts are therefore many; especially since in Kanak languages (here Iaai and Fagauvea), the concept of nature does not exist in the sense that we understand it in the West. During field surveys, it was sometimes necessary to explain its meaning to interlocutors, and in this case, it was often the vernacular term for the "country" as a whole<sup>24</sup> that emerged from the respondents' comments as an element of translation, *Hnyei* in Iaai: *"Hnyei is the... there's everything in it. There are all the taboos. But taboos are part of people. With the people who live with it. Hnyei in there is all the spirits, the Old Ones, there are the leaders. There is everything that is concerned in the Hnyei. There are lives in it. Let it be the visible spirits and the invisible spirits. But the two of them have relationships together. He lives together. Both are invisible and visible. They are in the Hnyei."* [87]. This is precisely what Leblic [106] observed in the *Paicî* area, what Boudjema [87] identified in the north of Ouvéa, and what Horowitz [105] mentions generally for New Caledonia.

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<sup>23</sup> The main New Caledonian daily is *"Les Nouvelles Calédoniennes"*. A keyword search of the journal's archives reveals that over the past 12 years the production of articles in which the term "climate change" appears has increased from 5 articles per year in 2005 to 224 articles per year in 2017. This indicates not only the rise in local media coverage on the subject in recent years, but also the permanence of this discourse in the media. This necessarily influences population representations [104].

<sup>24</sup> The whole takes into account, men, social structures, divinities of all kinds, it is the entire sensitive and symbolic world that constitutes the country. A definition that evokes that of creation among Christians and that could be compared to the words of Pope François in his encyclical letter *Laudato si'* (2015): *"(...) the book of nature is unique and indivisible" and includes, among other things, the environment, life, sexuality, family and social relations. (...)"*.

On the basis of all these elements, we have a better understanding of the ways in which people represent the coastal area and the natural phenomena that affect it. These are interpreted by the populations according to a plural grid of interpretation which remains dominated by culturally meaningful representations, mainly in the customary and religious domain. The naturalistic (scientific) discourse refers to a different grid, marked as a Western cultural construction, which, without being ruled out, does not find such massive and deep support among the populations. There is also a more symbolic naturalist discourse: "*naturalist animist*", but its interpretation must be cautious because of the plurality of meanings that can be attached to it.

Another dimension also emerges from some of the speeches and bibliography consulted: the disaster is not always, or not only, perceived negatively. In some oral traditions, it is the cyclone that provides the seeds for vegetation development and makes life possible [106]. In some of the testimonies collected, the populations see in the cyclone a way to revive plant activity, to revitalize plants and thus the production of fruits in particular. Similarly, waves if they do not destroy everything in their path will be welcome to "clean up" the beaches. Paroxysmal events and their consequences on the island will be interpreted in the social field as a form of dialogue between the "invisible" and the "visible" world, and this can also be perceived positively: "*It means that it is the spirits who tell us, it is messages. But we have to find out what it is, what it means to tell us. Did we do something good, did we do something bad? Because there are also some good things, that he tells us too. But through signs like this.*" [87].

Finally, it should be noted that the expression of solidarity and the strengthening of social ties is all the stronger when it is expressed in adversity, following a major trauma. In a sense, it is the disaster that creates solidarity or at least gives it the opportunity to express itself, as the examples cited earlier on religion have shown. And it is also the disaster that reveals the need for men to change their behaviour, as a call to do good. These elements from the different interpretation registers identified on the island can help to understand this aspect of the positive representations of the disaster.

### **3.3. Results relating to the involvement of the populations**

The participatory approach desired by the management committee as a whole and the group of researchers, was implemented within the framework of the management plan philosophy defined by the Ouvea committee. It was articulated in different ways, including:

- Training workshops (individual or restricted groups): These workshops first discussed the general principles and concepts of coastal sediment dynamics mobilized in the process. They gathered about ten people, members of two environmental associations of the island, hiking guides and technical staff of the town hall<sup>25</sup>. Then, the presentation of the method, the protocol and data acquisition instruments, as well as the learning necessary for their effective implementation, were carried out. Other training modules were provided on integration, data processing and general interpretation. The theoretical and practical aspects relating to coastal sediment dynamics and topographic surveys were then accompanied in the field throughout the two years of studies. This allowed partners to understand the context and local translation of the general principles previously discussed. These activities and the subsequent support made it possible to disseminate researchers' knowledge top-down to the populations. It also allowed for the exchange of knowledge, perceptions and representations related to the coast with partners through the surveys carried out;
- Discussion/restitution/sensitization workshops (collective actions, extended groups): These are more open workshops, taking advantage of festive, religious (Protestant convention), tourist, or scientific gatherings (2nd World Heritage Management Committee Forum, 2015). These workshops aimed to raise awareness, provoke wider discussions between the inhabitants of the whole island, make the work in progress known to a wider public and disseminate the first results acquired on the geomorphological level; all while answering the questions and sometimes concerns of the populations. Here again, the exchanges made it possible to better understand the uses and practices articulated around the shore and their associated

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<sup>25</sup> It should be pointed out that all these people have a plurality of different "hats", some of whom are elected politicians, others from other administrations, associations, religious, artistic actors and, of course, customary responsibilities.

representations. Over the two-year study period, several hundred people benefited from these actions. It can be noted with interest that various requests to join the incentives initially proposed (information meetings in tribes) were finally organized and conducted directly by the partners. Thus several site visits could be conducted by the partners with schoolchildren and several college classes. These school establishments have expressed interest in building follow-up programs in schools located near the coast, as a part of an educational activity co-supervised with the partners. Similarly, we were solicited by religious authorities who are of prime importance on sites. In the future they could possibly constitute as additional partners.

In terms of participation, we can therefore identify convincing results. Gradually, the initiative took root in the local landscape, and the partners are now identified by local actors as experts on the subject. This has already made it possible for partners to organize site visits for field trips as requested by schools. The desired openness towards all of the interlocutors also took shape around the request made by the parish organization committees for our participation in the religious convention of the island in 2015. Public meetings were held in various tribes including those who were not directly affected by the project. The initiative resonated beyond the strict framework of its application. In this, other management committees faced with similar erosive problems showed interest in engaging in such monitoring. Similarly, the nature guards of the Southern Province have integrated the tool into their naturalistic monitoring actions on the islets of the southern lagoon.

All the actions carried out were aimed at leading the populations and the partners to:

- acquire scientific working methods
- contribute to the construction of the analysis of the modifications in progress
- put perspective in their own knowledge
- appropriate conclusions and results in order to integrate them into their own means of reflection and management. This will allow the choices of individual and collective developments to come forward.

Thus all activities (including each of the interventions) have always been carried out in coordination/collaboration with the partners.

Let take an example of this collaboration, which also makes it possible to take into account local knowledge in understanding the sediment dynamics of the study area. The analysis of the old aerial photographs in collaboration with the partners made it possible to identify certain specificities that corresponded to landscape elements, which they attached to childhood stories. Associated with the study of toponymy, this provided important insight into the secular evolution of the sedimentary spire occupying the northern part of the terrain. Thus, this collective analysis on the aerial photographs of 1943 and 1954, allowed us to isolate a dark spot located a few ten meters in front of the position of the coastline at the time. According to the partners, this dark spot corresponded to an interlacing of roots, trunks and branches of dead trees, to which the toponym "babylon" is attached. It is an imported name taken from the Bible, which proves it was relatively recent<sup>26</sup> (post-missionaries). According to the testimonies, this toponym would correspond to the place of residence of an old man who had lived there during the first half of the XX<sup>th</sup> century. Two important points are noted with interest. On the one hand, in the photograph of 1954 (and even that of 1943), the site in question is at sea and, as such, cannot correspond to a place of habitation on those dates (the period of occupation mentioned is therefore earlier). On the other hand, today, this same place has been reconnected and reincorporated to the north sedimentary spire, due to the strong accretion that the site has experienced over the period 1954-2012. This information therefore suggests that the site may have undergone significant morphological modifications during earlier periods. This coincides perfectly with the continuation of the diachronic analysis of aerial photographs, as well as other information collected both from the archives and the populations. They report the impact of extremely violent cyclones in 1920, 1932 and 1933<sup>27</sup>. The latter is at the origin of the partial destruction of the southern sedimentary spire of the

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<sup>26</sup> The Christian religion was established in Ouvea during the second half of the XIX<sup>th</sup> century.

<sup>27</sup> Letter dated 3 May 1933 from Father Chol dated Mouli (Ouvea): *"You have received the details of the damage caused by the terrible cyclone. I went today to see the new pass with the hole south of the big one, [Author's note: Father Chol refers to the pass separating the island of Mouli from the rest of the island of Ouvea and that know today as the construction site of the bridge, it is about the "great pass", the new gap to the south of it corresponds to the current site of the snack fassi and the extension of the hotel "le Paradis d'Ouvea"], and next door I found a sheet metal sheet from my presbytery half silted up [Author's note: the site of this pass is +/- 5km away from the presbytery, downstream from the coastal drift] "*.

monitoring site, where the hotel "le Paradis d'Ouvea" is located today. The interest of this testimony is therefore twofold, both in terms of the study on the processes characterizing the area, and when the time comes, in the transmission of results to the population. At this point, the theoretical explanation on the functioning of the environment takes a historical, cultural, or even familial approach. It is no longer the scientist who speaks, but the partners who share an experience where their family history was put into perspective within the framework of a scientific explanation of the functioning of the site. From then on, the relationship established with the audience is no longer the same. It allows not only for more open exchanges, but also for the anchoring of knowledge within the framework of a personal relationship with the studied subject.

#### 4. Conclusion

The objective pursued by this observatory is multidimensional. It is certainly a question of ensuring a geomorphological monitoring of the coastline through analyses based on different methodological protocols, but it is also a tool that must document other aspects such as local knowledge, memories of events and landscapes. It must also seek to identify the uses and practices of local populations on the coastal space, while seeking to understand the methods of representation associated with them. The idea is to identify, analyse and highlight these different aspects characterising the coastal zone, in order to assist the populations in developing their management and adaptation strategies. The aim is to compile multiple pieces of information in order to analyse, synthesise, highlight and reproduce them, so that local actors can reappropriate them and use them to inform their individual and collective choices. The objective is therefore to perpetuate the existence of this observatory in order to place it in the long term, in a logic of accompaniment. The temporal dimension is essential in this approach, not only in the geomorphological monitoring of beaches sees its relevance in the production of long time series of data, but also in the fact of making it possible to establish links with local actors, links whose establishment requires time. However, building a relationship of trust is essential in fostering interaction and exchanges with all stakeholders and ultimately the appropriation of the knowledge produced.

The participatory approach here first focused on setting up a geomorphological monitoring system for sedimentary formations with members of the management committee (local environmental associations and hiking guides). This corresponded to the general framework of action agreed upon with the management committee before the study was carried out. It has been said earlier that the logic of action within this Ouvea management committee existed before our involvement, and that it aimed to achieve a truly collective and transversal construction of a sustainable local development, respectful of customs and the environment; in short, respectful of the "country". One of the characteristics here is that decision-making, including the conduct of scientific studies, is truly discussed with the entire management committee and the planning of its conduct is also validated by the latter. The decision is taken in a collegial manner, and the conduct of the work, as well as its capitalisation, is carried out in coordination with local actors. In Ouvea, the place of customary people is preponderant and constitutes an essential step in the process of consultation and the implementation of research work. But the legitimacy acquired by the agreement, given by the customary authorities, does not systematically entail having the driving forces to carry out actions. Decision-making and action levels are disconnected. The decision generally rests with the "old" and the action with the "young". The agreement of some, which cannot be ignored, does not automatically imply the commitment of others. This explains, in part, why the actions were carried out primarily in partnership with existing structures and not directly with the populations. On this study site, the populations are not directly affected in the very short term at their place of residence. While erosion is a cause for concern, it does not really interfere with the daily life for many people. Also, at the outset of the study, it was difficult to find a sufficient level of stakeholder support for a long-term commitment for such a work requiring a fairly large investment of time. But this situation is reversible, and precisely the time factor and the trust factor are key variables to gradually see the increase of initiatives and requests for collaboration. As it has been noted, after two years, that other actors have made themselves known to the partners: schools and also religious bodies, which in the field are important actors to take into account and mobilize on the subject. In the same way, the innumerable discussions held with the people who met in passing, who were curious about the work that was conducted, gradually participated in building a climate of trust which helped anchor the approach locally. Other associations subsequently came



forward, such as women's associations, who were interested in carrying out small revegetation works to strengthen the banks...etc.

Of course, a final difficulty arises around the sustainability of the system, which, although it requires few resources, requires a minimum. This financial issue remains, in the current economic context, a barrier to overcome. The work on the environment code of the province of the islands dealing with the coastal domain and associated natural risks, should bring a framework and opportunities to an approach that after two years has demonstrated its interest.

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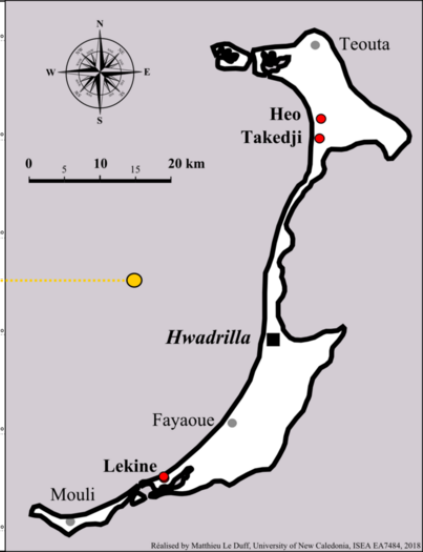
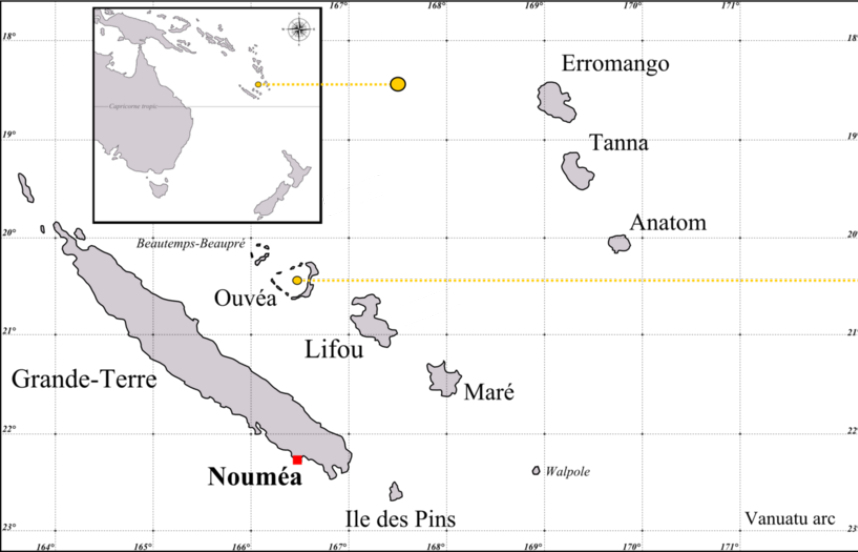
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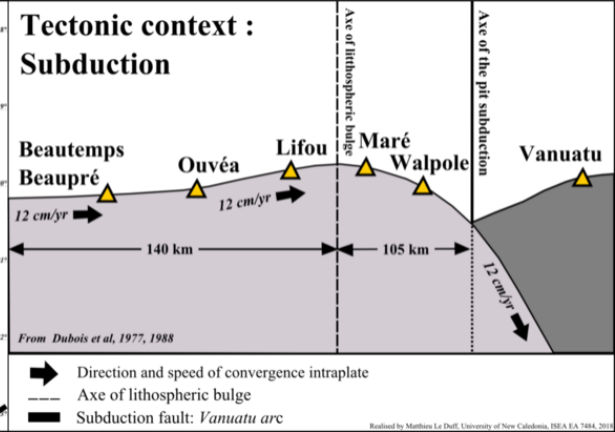
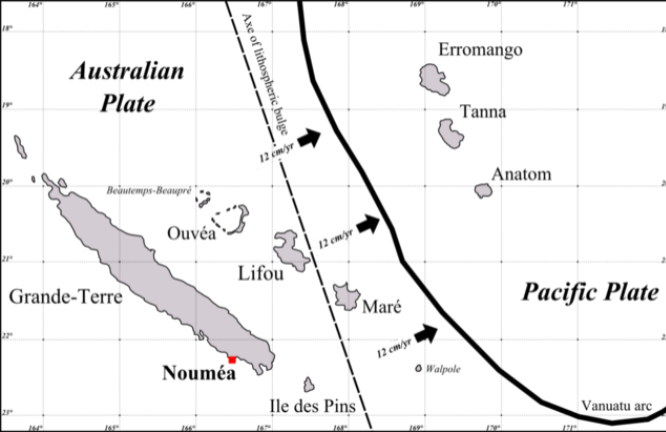
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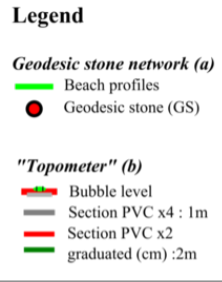
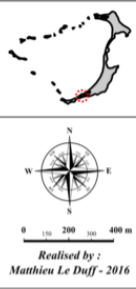
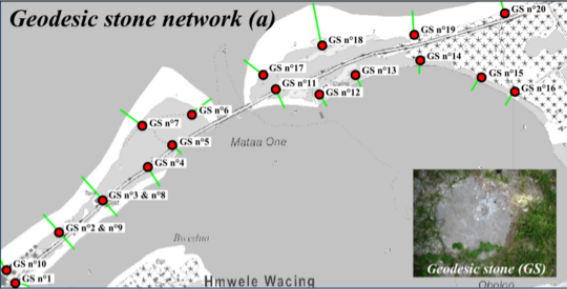
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### "Topometer" (b)

