Pacific Island Long Term Resilience Monitoring

PhD Proposal

1. Rationale

In a global changing – and warming – context, natural disasters have increased of about 2%/year in the world over the past 15 years [CAT 16]. Among these disasters, the risk of flooding appears to be the most "damaging" [VIN10]. Indeed, since 1960, the number of floods has increased considerably, reaching more than 600 events for the year 2007 [ZEV 10]. For example, in 2013, we observed that “flood damages were 90 % above their 2003-2012 annual averages” [PES 16]. Although the number of deaths has decreased in the face of this risk, floods are still the costliest natural catastrophes, reaching "100 billion euros per year by the end of the century" [BAR 13].
At the same time, the increasing complexity of sociotechnical systems makes flood risk management difficult. Over the last ten years, half of the world's population has become urban [SER 11]. Human concentration (50% of individuals living in urban areas [UNH10]), and urban population contribute to increase flood risk in such areas. Urbanization has increased from 10% in the 1990s to 50% in just two decades [MEE 16]. This very rapid process has weakened the territory because cities are not prepared or not equipped to manage the needs of such a concentration of population, especially when risky situation appears. This, due to a lack of available land, comes to settle in the risk zones. These spaces left free are gradually nibbled by urbanization without respecting the natural functioning of catchments, rivers… leading to impervious soils, preventing the necessary infiltration of rainwater. Also, the increase of man-made disasters - an increase in frequency and intensity [QUE 13] - makes these territories even more fragile and complex to manage. It is therefore established that, in urban areas, man-made risks tend to have “more severe consequences” [NOV 94] especially because of concentration of issues “in more vulnerable areas” [NOV 94]. Besides, these areas are increasing because of urban sprawl. While urban systems are supposed to concentrate security and development, the recent climate-related disasters around the world (Hurricane Katrina in New Orleans (USA), 2005; Storm Xynthia (France), 2010; Paris flooding (France), 2016; Storm Ophelia in Ireland, 2017; Hurricanes Harvey and Maria (USA), 2017; etc.) revealed urban vulnerability to such events [QUE 13]. For more than ten years, experts have begun to question themselves about how managing risks. In policy, economics, urban planning, architecture and scientific research focus is now increasingly on strategies to make urban systems simultaneously less vulnerable and more resilient to climate-related disasters, while addressing the long-term challenges of sustainability and quality of life [QUE 14]. The injunction of international authorities [UN 15], [UNI 15] to found a new risk management able to "make a transition to a general culture of risk prevention and mitigation" [EUR 13] led researchers and managers to look at other approaches to manage natural hazards. A new approach has thus been gradually integrated, based on the concept of urban resilience [SER 11].

We make the hypothesis that such approaches based on the concept of resilience and taking into account the system complexity may be interesting in terms of scientific results, innovation and decision for Pacific Islands. Helping decision makers and populations to define a set of priorities for a long-term resilience to floods would be a major result.

2. Operational needs

In September 2014, a French Interministerial Report dealing with flash flood risks has concluded that French overseas territories are very concerned by flash floods but this risk is poorly addressed by the national Government and local authorities. Indeed, overseas are strongly exposed to hurricanes, earthquakes and tsunamis, but resulting flash floods are not sufficiently taken into account compared to the French Hexagon [IGA 14]. However, several combined factors of overseas territories like geography, climate, land planning constraints and social structures, are increasing the vulnerability to flash floods and risk issues in general.
The report is also pointing a share of responsibilities of poorly risk management processes between national and local authorities. As an example, French overseas people in charge are not represented in a national commission preparing prevention plans to face flashfloods. Furthermore, the national risk observatory is not covering overseas territories.
At the same time, local authorities do not seem willing to fully engage in risk management, except for hurricane issues, due to a good culture of the population to such hazard. A critical issue is the lack of control of land and urban development by local authorities.
The report is also making some recommendations to improve risk management strategies overseas:

- showing a national engagement overseas to face less advanced risk management strategies;
- transforming overseas as innovation territories for risk management in engaging the scientific communities;
- developing alert systems;
- turning urban planning into a nonstructural measure to reduce risks;
- exchanging good practices;
- addressing ultra-marine context in risk reduction strategies.
- To address the last point, the report is gathering some crucial topics where efforts are expected:
- coastal submersion caused by hurricanes;
- conjunction of coastal submersions and fluvial flooding;
- runoff in tropical zones;
- incidences of climate change;
- dynamic of small catchments including debris flow management

3. A methodological framework

The PhD project aims at achieving two main objectives:

- adapting existing approaches to assess Tahiti and Moorea resilience level to floods;
- laying the foundations for long-term research with the design of a risk and resilience observatory in Pacific Islands.

At the end, the ultimate goal is to help stakeholders to prioritize actions and for land planning, to match risks challenges in a context of global change.
By the way, this research contributes to improve the poorly risk management pointed by the interministerial report of 2014, using resilience modelling and spatial decision support systems (observatory) applied to risk management for long-term strategies.

3.1. Resilience modelling

As new benchmark for public risk and disaster anticipation and management policy, resilience is still a barely operational concept, whose methodology must be explained. Yet, it should be noted that only a few models and methods for analyzing the resilience of a territory have been developed. Resilience is interpreted in the stylized models of the Adaptive Cycle [WAL 04], Panarchy [GUN 02] and the method proposed by the research group Resilience Alliance [RES 10]. In reality, these models are rarely used by researchers in France and are mistrusted by institutional and operational parties. As well as the language barrier, which means that the Panarchy and Resilience Alliance models have not yet been used in French works, these methods are difficult to implement because they use a complex vocabulary (panarchy, bifurcation) and are organized in phases that are too global and too far removed from local discussions (e.g. analyzing the phases of growth and reorganization of territories in the Adaptive Cycle and Panarchy models). Most research therefore highlights the difficulty of implementing an operational resilience process. However, some attempts have been made in this field, notably the DS3 model [SER 18]. This model, constructed around a systemic logic, differs in how it is organized: it focuses on the capacity of technical systems to face up to floods [SER 18].

Such a model (DS3), completed with long-term research methods and tools, like an observatory, will bring useful results for implementing resilience strategies in Pacific Islands.

3.2. Long-term strategies

Before the nineties, observation systems were deployed at an international level, based on Universe Science Observatories dedicated to universe science parameters monitoring (planets, climate, atmosphere and risks); such systems were driven by researchers [LOI14]. From the nineties, observatories were gradually developed for environmental issues including new sciences like natural sciences as well as humanities. In France, this period matches with the development of CNRS observatories like OHM (Observatories for Environment and Societies) [LOI14].

Confronted to globalization and climate change, researchers are using observatories to monitor spatial and temporal tendencies [DES 11; LEV 07] and improve knowledge on specific territories. With continuous observations, it is admitted that knowledge and comprehension are improved, including processes leading to such evolutions. Territories are becoming central in observatories and interdisciplinary is now the rule, with new partnerships gathering researchers and end users. Other types of observatories are developed or tackle some technical questions where priorities are exchanging information for development perspectives. In this case, researchers are always absent from this process.

As a result, some observatories are sometimes partially redundant on a same territory and there is a research question about developing new observatory structures allowing a mixed approach useful for the territory itself and for a large range of actors. Such observatory principles are based on (spatial) information systems, where one of the aims is to support spatial decisions [GAY 97]. Whatever the issue raised, such observatories may include scientific knowledge and monitoring, as well as a mean to operationalize decision processes with concerned actors.

Such a resilience observatory prototype developed for Moorea and Tahiti may help decision makers to plan in a strategic way the land planning in a long-term perspective. This is one of the conclusions of the first Conférence de la Recherche (RESIPOL) "Risks: understanding, monitoring and managing" organized in December 2018 by the University of French Polynesia where attended most of the area actors (research and operational).

4. Expected results and Calendar

4.1. Some expected results

- A flood resilience assessment framework for Pacific Islands;
- A risk and resilience observatory prototype;
- Inclusion of the modelling process in the observatory;
- An improvement in terms of resilience management in this area;

Based on the scientific results cited above, the PhD research will allow designing a framework, relying on the resilience concept, to answer some of the operational needs cited in section 2. Since 2014, some actors and researchers tried to address some of these

topics, but separately at this stage and without enough support from national and local authorities. This PhD program will structure and test methods and tools for enhancing Pacific Islands resilience conditions.

4.2. Global Calendar

The PhD program should start in September 2019
M1-10 State of the art, data collection, modelling choices, Polynesian issues…
M4-18 Long-term research infrastructure development (Resilience observatory)
M12-30 Testing and adapting flood resilience models in Tahiti and Moorea – Integration of models in the observatory prototype
M30-36 PhD manuscript writing

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