A participative process to decrease coastal vulnerabilities and optimize land use transformation

Bourlier B[1], Heinzlef C[2,3], Lambert M-L[4], Long [1], Serre D[5]

[1]Laboratoire Lienss UMR 7266, Université de La Rochelle, 2 rue Olympe de Gouges, 17000 La Rochelle – Courriel : nlong[at]univ-lr.fr

[2]UMR 7300 ESPACE – University of Avignon, 74, rue Louis Pasteur. Case 19, 84029 Avignon Cedex 1, France

[3]University of Mons, Faculty of Architecture and Urban Planning, Rue d'Havré 88, 7000 Mons, Belgium

[4]LIEU-IUAR, Aix-Marseille Université, 3 av Robert Schuman, 13100 Aix-en-Provence

[5]EIO – Ecosystèmes Insulaires Océaniens (UMR 241), Universiy of French Polynesia, Punaauia – B.P. 6570, 98702 Faa'a, Tahiti, French Polynesia

1. Introduction

This article presents some of the INEGALITTO research program, which aims to, first, characterize the impact of the coastal territories' environmental inequalities in relation to risks coming from the sea, and to produce a spatial systemic approach. The study areas are located on the French west coast between the city of La Rochelle in Charente-Maritime and Saint-Brieuc in the Cotes d'Armor.

Thus these territories were largely affected by the storm Xynthia in 2010 causing several deaths and many property damages. Recall that a marine submersion corresponds to a "Temporary flooding of the coastal zone by the sea during bad weather and oceanic conditions (low atmospheric pressure and strong wind of influx acting, for the seas and tide, during a full sea), they can last a few hours to a few days" (MEDDE, 2014). In the case of Xynthia, the climatic event of magnitude had been planned but not the extent of the submersion. The case of Xynthia is particularly interesting because it combines storms and high tide as well as strong coefficients. It is the accumulation of these parameters that caused the disaster. But the management of this crisis has also shown first, a failure of public authorities, a problem of communication and information sharing by scientists, and lack of awareness of risks by population (CHAUVEAU et al, 2011). Thus, if coastal risks had been a little forgotten or at least considered secondary in the late twentieth century recent events like Xynthia but also Katrina, Johanna or Sandy have put these risks at the center of public concerns worldwide. Moreover, these events have reminded us that the densification of coastal territories is a central element in understanding the vulnerability. Urban extension alone is a vector of risk (SERRE, 2011).

Our approach makes it possible to establish links between the environmental inequalities, peculiar characteristics of littoral territories, and submersion hazard (KOLB, 2015). In fact, risk management policies can modify littoral territories. It can affect different aspects, such as social aspects, land, accessibility ... However, this can also go up to the representations of the actors of the territory. It is important to understand, for example, how different groups of actors and inhabitants are less vulnerable to potential hazards or already experienced from the sea.

Faced with these risks, coastal managers aim at reducing the impact related to coastal hazards, for which they put in place various strategies according to the characteristics of the affected territory. The first set of investigations demonstrates that different groups of actors experiencing this storm adopted different conclusions dealing with retrofitting and planning these vulnerable areas. Some of them would design

projects to better protect inhabitants and assets, others prefer to restore ecological issues and pathways, finally many organized groups would prefer to rethink the land planning strategies in deciding to continue to propose urban and economic development of their areas, sometime without clearly taking into account past (but recent) risky situations. Taking into account that initial results and contradictory issues on the same place, we decide to design a process and tool to help actors, group of interests and inhabitants to compare and simulate different land planning strategies.

The objective of this research is therefore to create a decision support tool based on a geographic solution in a participatory approach with, as a benchmark, the improvement of the resilience of the territory by the integration of environmental inequalities in the operating of coastal areas. Resilience is multiple meanings term, covering elements before, during and after a crisis (REGHEZZA, 2015). Therefore improving the resilience of a territory could mean working on future development projects, so called non-structural measures. On the other hand, intertwining with environmental inequalities implies, for example, understanding how the distribution of the population's access to amenities, decision-making power, and information implies a wide variation in people's vulnerability. These questions will then directly question the decisions of risk and planning policies. Finally, the proposed tool will aim to answer the question: does this project increase or reduce the resilience of the coastal territory taking into account the numerous aspects of the territory's vulnerability?

In this way, at first, we will recall in a state-of-the-art section the main concepts implemented in this project, the concepts of the resilience of the city facing the risk of flooding, and on the other hand, the concept of environmental inequalities as an increased factor of the vulnerability of the territory. In a second step, we will present the study areas and their main issues before developing the first results of the implementation of the tool as well as the prospects for improvement.

2. State of the art

2.1 Origins and principles of the resilience concept

The concept of resilience has been increasingly used in scientists' discourses and even policies for a number of years in the context of the rapid and uncertain expansion of cities (SERRE, 2018). The concept of resilience is increasingly used in various scientific and societal fields: ecology, psychology, geography (populations and territories faced with risks), risk analysis, politics, and the banking and insurance sectors, etc. It is now acknowledged that the term hides a rainbow of meaning depending on the disciplines and context in which it is used (PROVITOLO, 2012).

First, let's recall the main principles of the concept of resilience and its application to land use planning. Resilience reflects "the capacity of a territory and a population to restore or even improve after a damage" (LEONE, MESCHINET, DE RICHEMOND, VINET, 2010). Indeed, one must not confuse the ability of a society to "withstand" an event, with the ability of a society to return to its original state and "normal" functioning. The resilience of territory and society can be measured in a very concrete way through indicators such as the economic losses of the territory, the time of reopening of services, the number of companies affected by the crisis...
The concept of Resilience inherently involves the onset of a crisis and damage. However, the measure of resilience should not wait for the onset of the crisis. Serre and Heinzlef (2018) consider that resilience is intrinsic to the environment, that it is inherent in the internal functioning of the system.
During the event, resilience can correspond to:

- The capacity to resist and cope with a shock;
- The capacity to absorb a shock, which involves a degree of flexibility

Before the shock, resilience refers to:

- The capacity to anticipate, especially unpredictable and inconceivable scenarios, in order to ensure the operational capacities of systems and organizations, even in "damaged mode";
- The capacity to manage or preserve the essential functions, structures and organizations in order to adapt them to a future situation (anticipative adaptation);
- The capacity to learn.

After the shock, resilience reveals:

- The capacity to recover and rebuild, here or elsewhere. These capacities mobilize a system's internal and/or external resources, whether it is an individual, a neighborhood, a town, a country, etc.;
- A system's capacity to maintain its integrity and return (or bounce back) to either the former state of balance or a new state;
- An individual or community's capacity to adapt, to take advantage of a negative situation and to renew and transform the system

We can see that the post-crisis resilience phase covers several temporary realities, more or less short-term, medium-term and long-term. For example, in the context of crisis management, managers must carry out feedback. Feedback (REX) is a decisive tool for improving knowledge. Indeed, a fine analysis makes it possible to highlight the weaknesses and weaknesses of the organization. In order to improve the management of future events, this phase also corresponds to the setting up of feedback to analyze how the crisis has been managed. The objective of a REX is to characterize the phenomenon itself, analyze how it has been anticipated and what operational response has been implemented by the actors of the territory to protect populations. It is a tool defined as very operational by the actors with the objective of returning to normal. But when you take a step back, the experience feedback offers new perspectives and completes the information on the territory's resilience capacity.

It is important to understand that the concept of resilience gives us an all-encompassing approach, particularly in the context of the resilience of the city. It is, therefore, the capacity of the city to maintain its functions during the crisis and to rebuild afterward. It is by considering the city as a complex system that one apprehends all the complexity of this concept. Cities combine history, natural amenities, economic activity, heritage and architecture, planning strategies... Moreover, permanent changes in cities (infrastructure, mobility, economy) create new risks and require a permanent update of the model. In this context, the participation of the actors of the territory seems relevant.
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 (SERRE, 2018). This model, constructed around a systemic logic, differs in how it is organized. The DS3 model focuses on the capacity of technical systems to face up to floods (SERRE, 2018). The DS3 model is feeding the PGIS we are developing to answer the question of land planning strategies contribution to coastal resilience.

2.2. The interest to complete this approach with environmental inequalities data

The indicators of environmental inequality are intended to reflect the well-being of a population. It is a concept initially political, appeared in 2002, in the context of the World Summit of Johannesburg, the concept of ecological inequalities is presented as being in the continuity of the reflections led around sustainable development (CHAUMEL & LA BRANCH, 2008). Thus, environmental and ecological inequalities can be defined as "observed and perceived differences that may disadvantage individuals or groups of individuals in their relation to the environment, which concern both the impacts they suffer and the externalities they generate (KOLB, 2015).

The themes including environmental inequalities are multiple but central thematic is the inequalities vis-a-vis the risks: the notion of inequalities vis-a-vis the nuisances and the risks (related to the places of residence, lifestyles and activity ...) , the inequalities of perception and appreciation of these nuisances (noise, pollution, etc.), unequal access to information on the risks involved, unequal treatment of these risks (insurance, precaution, compensation, repair, etc.) and also inequalities in the production of negative externalities (related to places of residence, lifestyles and activity ...) (KOLB, 2015).

The amplitude of these inequalities broads and includes very physical aspects of exposure to a hazard, up to considerations taking into account the perception of the populations concerned.

When we take the example of coastal risks (erosion, submersion), we observe factors implying lower visibility of certain risks or the exposure of certain populations (LAMBERT, 2017). The denial or minimization of risk can be maintained by companies that generate risk for their development. It can also come from economic actors, owners, whose main concern is to maintain a significant value for the coastal goods and amenity.

When one looks at natural disasters, characterized as "an extreme event being relatively rare in magnitude, frequency or duration for a given socio-environmental system during a given period" (DECAMPS, 2007), vulnerability depends on the context in which these events occur, a demographic, economic and environmental context. Thus, Decamps explains that "the vulnerability of socio-ecological systems to extreme events depends on complex and varied interactions between the conditions of exposure, sensitivity, and resilience specific to these systems". Vulnerability depends here on the links between the environments, the society, the biophysics... Thus, the problems such as climate change, the demographic growth or the poverty of the population are to be taken into account in the measure of the vulnerability.

2.3. The development of a PGIS

In this context, a hypothesis has been formulated: the use of a collaborative or participatory GIS will allow sharing a common vision to discuss, integrate, and lead together stakeholders towards strategies to reduce risks as well as inequality. On the other hand, the GIS will aim at better territorial resilience.
The challenge of the GIS is to reduce the risks when setting up future development projects. One observation is that the actors "clash" on planning choices: the SIGP must, therefore, show the project's contribution to risk reduction (vulnerability, resilience indicators, etc.) to optimize the choice of the project.

First, it's about understanding what place GIS can have in the participatory process. GIS in the participatory process is part of the continuity of the use of cartographic geographic information in these same processes, through cartography. The word participation mainly concerns two cartographic uses: the map as iconographic support for public debate and the participation of local communities, on the one hand, public involvement in the design of the map itself, on the other hand, share (ROCHE and HIRT, 2013). Thus, this second aspect is based on the assumption that the involvement of the local populations but also the actors and managers of the territory will improve the final cartographic rendering. The map can then serve as a "mediator" highlighting the “territorial controversies”.

Regarding the term GIS, the definition of (FISHER et al., 1993) a GIS as: “a database management system designed to capture, store, manipulate, analyze and display spatially referenced data for the purpose of complex management and planning issues” seems most relevant. A participatory GIS is found through several acronyms and several terms covering a reality sometimes equivalent but also

significantly different. The terms used are PGIS or PPGIS for Participatory GIS, but also the notion of GeoWeb which will involve the Webmapping technologies and the creation of online interface. In an anecdotal way, we also talk about MIGIS, Community Mapping CiGIS, a term that cuts across the same reality (MERICKSKAY, 2010).
First of all, the close links between participation in GIS and the development of Webmapping must be noted. The term "Webmapping" is broad because it brings together various skills and techniques. This term refers to "broadly defined, all that relates to online mapping on the Internet."
There are three degrees of Webmapping (PORNON, 2008): a tool or a simple consultation is possible, a dynamic tool where the map is interactive (changing layers, tooltips ...) and finally the WebSIG that allows more advanced functions. In this context, these tools seem to be largely relevant from a perspective of participation of the actors of the territory.

The process of territorial representation is to be considered by gathering the knowledge of all the individuals and collectives of a territory. PPGIS seem to be effective tools for formalizing this local knowledge as: "the success or failure of participatory GIS in learning and ownership largely depends on their ability to integrate all this knowledge" (GHOSE, 2004). In this way, local authorities will question how best to encourage this feedback from the field, the structure, and take it into account later.

One can also imagine a decision-making tool will contribute to decision-makers, actors "enlightened", not amateurs in the context of what we can call projects "citizen science".

So the objectives of our participatory GIS are diverse. In general, it is, therefore, a question of bringing a better perception of the risks and the inequalities for the actors. To represent and analyze the inequalities related to risks and coastal amenities and social inequalities based on the data initially produced in the program. On the other hand, this tool must allow the actors to collaborate for better decision-making in the field of planning and the territorial project. On a technical level the tool must meet the requirements:

- Data management and geographical information analysis.
- To identify certain issues affecting the territory and to explain certain behaviors to the territory's stakeholders. However, we can start from the observation that managers at the communal level have a good or very good knowledge of their territory. The relevance of their vision will depend for a lot on the skills and profiles of people working on these topics.

Moreover, when one is interested in managers and planners, one must see that in planning projects urban planning has a rather particular vision of the territory, they will practice the "change of perspectives" on space, go also change scales. Often the project will evolve from an approximate form to its precise final form, thus during the participatory process of the design, the discussions tend to be part of a conceptual perspective at the beginning and then to be specified. In this sense, CIOBANU et al (2007) will propose "the prototype of a GIS with a structure adapted to the dynamics of the design process and to ensure spatiotemporal monitoring". GIS would make it possible to identify specific study areas, medium or large study areas, non-spatial study areas, more general.

Finally, the GIS by the organization of its database would have the vocation to produce thematic maps that could account for the participatory process of the actors by superimposing the different contributions over time. This tool could then be addressed to a non-expert public. The implementation of this tool will, however, face some difficulties starting with the transcription of the expert approach for a non-expert audience. The path of some may follow a tacit process difficult to follow for other actors. The tool must help in this process but the limits are numerous.

3. Material and methods

3.1. The choice of these territories

The fields of study are therefore initially the agglomeration of La Rochelle (17) and the intermunicipality of Saint-Brieuc (22). It seemed relevant to have a comparative approach between two sites with similar socio-spatial and infrastructural characteristics to validate the approach of environmental inequalities in relation to risks and the assessment of the resilience of the territory. Subsequently, it was to reduce size of study areas and focus on the coastal towns of Aytré (La Rochelle Agglomeration community) and Charron (Aunis Atlantique community) in Charente Maritime and the commune of Saint-Brieuc in the Côtes d'Armor. The scale chosen for setting up participatory GIS is, therefore, that of the municipality. This makes it possible to work on a limited scale on specific development projects with identified local actors.

This remains consistent with the urban planning skills of the municipalities and their choice of facilities. However, in the context of risk management, the municipal territory is not necessarily the most relevant. Indeed, several elements will come into play. Thof risk pool that will involve a wider territory most often expanded to several municipalities. A municipality may be present in several risk pools. So we are talking about the dichotomy between administrative territory and natural hazard territory. Moreover, risk management skills do not only concern municipalities and EPCIs will have a leading role and superior skills. It is as many actors as it appears necessary to involve in the process. For example, for the town of Aytré, it is the La Rochelle Agglomeration Community that is a key interlocutor.

3.2. Presentation of risks and main issues

On the coast of Charente, the coastal communities were strongly marked by the storm Xynthia of 2010 which is today the hazard of reference on this territory. In the town of Aytré, the submerged area was very wide affecting many homes and causing the death of 3 people. This event, with far greater consequences than the storm Martin of 1999, has deeply marked the spirits. Thus the State has set up zones of solidarity where the deconstructions of buildings were implemented between 2010 and 2012, in Aytré but also Nieul-sur-mer and La Rochelle for the PAPI zone, as well as the Boucholeurs on the commune of Châtelaillon-Plage. The storm Xynthia is today the hazard of reference and more particularly the hazards said + 20cm see + 60cm are obligatorily taken into account in the policies of arrangement figure 1).

The coastal issues of the agglomeration are numerous, the marine submersion hazard concerns first the population and about 8000 inhabitants exposed to a hazard Xynthia +20, more than 1000 companies of the tertiary and the tourism are exposed, collective infrastructures (wastewater treatment plant, Nantes-

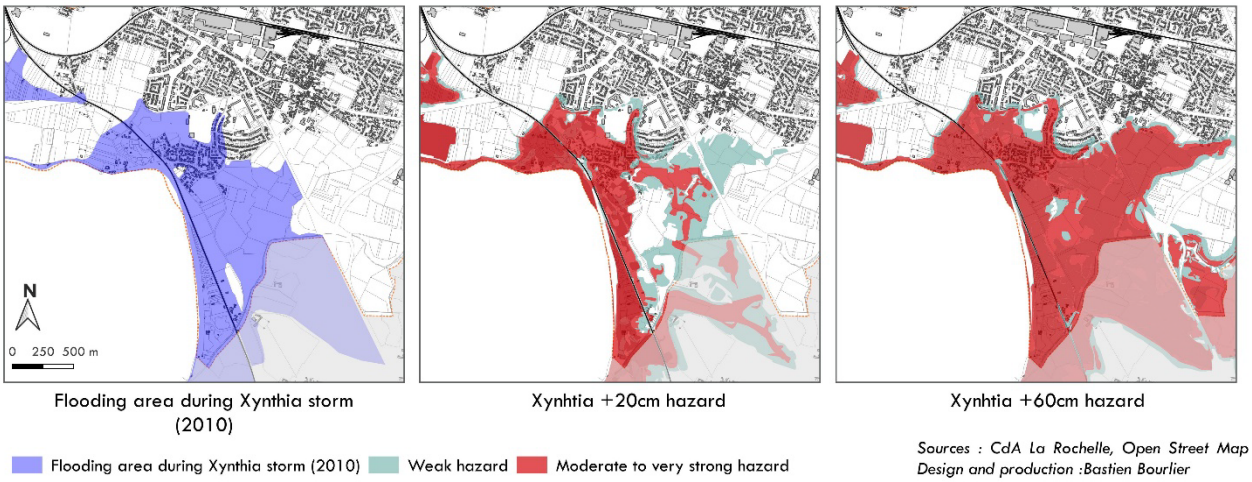

Figure 1 : Flooding hazard on Aytre municipality (17)

Bordeaux railroad ...), as well as numerous establishments receiving public services (ERP). Thus, the agglomeration estimates the population concerned by an exceptional event (figure), 5000 for a Xynthia type event and up to 8000 for a Xynthia +20 type event. The damage on the residential alone is estimated at 30M € for Xynthia in 2010 and up to 50M € for a Xynthia + 60 event. A certain number of tools have been put in place in the agglomeration of La Rochelle and the town of Aytré. Following the storm Xynthia, the Prefect of Charente-Maritime has prescribed the development of Coastal Risk Prevention Plans on the northern basin of the department of Charente-Maritime.

As part of the implementation of this PPRL, the Agglomeration has initiated in partnership with the State services (DDTM) a study to identify coastal risks on its territory. On the other hand, a PAPI was set up on the agglomeration at the origin among other numerous amenities and protective works on the entire coastline.

Finally, the last study area of the town of Saint-Brieuc is much more urban with limited access to the sea and the presence of a commercial port and a real logic of economic development. Coastal risks are not mentioned much by the authorities and risks manager. Predominate questions of pollution of the berries.

3.3. The actors involved and their skills, influence

One of the objectives of this tool is to be a vector of participation, so it is important to bring together the most competent players around these issues. Targets are primarily coastal managers. Thus, this GIS should not involve all the coastal population. It will have to promulgate an exchange between various actors with different interests and opinions in order to target the best strategies to adopt in the face of risks and to reduce the inequalities marked on the territory.

The GIS will have to take into account the fact that each actor of the territory has a different vision. One of the complexities of setting up a collaborative tool between actors working on different scales is the relevance of the tool to each of these scales and the variety of needs of each of the actors. The following table proposes a synthetic approach of the actors to be associated with the project. If the program produces data at the scale of the coastline of an agglomeration, the identification of the actors is then done at the communal scale.

3.4 The tool's design

We, therefore, retain two different objectives for this work:

- The GIS tool itself as a vector for reducing vulnerability by representing certain data variables on the territory.
- In parallel, the second objective is to promote the participation, the interaction between the actors of the territory.

The added value of this tool for managers is primarily the production of data on environmental inequalities. This data from Axis 1 of Inegalitto, however, induces certain constraints as to the operationality of participatory GIS. First of all, the scale of the data produced, that of the 200m square grid. On the over hand, the tool must observe the contribution of the projects to the resilience of the territory and the decrease of its vulnerability. The scale seems, in fact, different. Indeed, we have to enter the thematic field of urban resilience. Thus, the variables used will be more technical concerning buildings, networks...

Actors involved in the project	***Involvement level***
The municipality	The municipality is very important. These are the major players in development on their own territory.
Competent intercommunality	- Increasingly committed into territorial projects in municipalities. Work on intercommunal projects. - Recovered a number of risk-related skills (GEMAPI). - Have an important part in the sharing of the data.
Local association	Necessary association with the project. Significant weight in decision-making especially in the environmental field.
Private owners	- Interest in the development policies of the municipality. Real weight in local decision-making processes especially through associations. - No planned access to participatory GIS (a tool for managers).
Research	- At the initiative of the project. Must accommodate the contribution of an operational response interesting for public authorities, and the valuation of the specifics and originals data resulting from the research. - Technical support (server, cartographic tool ...)

Figure 2: Summary table of the associated actors

The first elements can be retained are some of the construction regulations rules of the PPRL. For example, the area concerned, the number of openings, the number of occupants, the building height, the presence of a floor, but also data on urban networks will be identified. Of course, the data on the risks of submersion and in particular the risk of submersion is decisive. Here the data coming from the future PPRL (in process of acceptance) of the municipality of Aytre with the referenced hazard Xynthia and the projections Xynthia + 20 and Xynthia +60 readjusted taking into account the defense works built in the framework of PAPI. It seems relevant to limit the tool to a consideration of the risk of submersion mainly (the erosion risks being less influential).

Taking all of these data into account on the same tool is a real challenge. Thus we highlighted some indicators for the future PGIS tool, indicators of environmental inequalities on one hand, and indicators of resilience on the other hand. The choice was made to tighten the number of indicators of resilience while having a glimpse of the plurality of the concept through indicators of social, technical and urban resilience (HEINZLEF, 2019).

Indicators of environmental inequality	Project resilience indicators
Economic indicator: share of the poorest households	The density of the road network
Social indicator: age of the population	Proximity of bus stops
Environmental indicator: proximity to natural spaces	The density of cycle paths
Indicator of accessibility to amenities: proximity to coastal amenities	Critical infrastructure, built heritage
Legal indicator: urban planning zoning	
Risk indicator: hazard area, water heights	

Figure 3: Summary table of indicators taking into account in the PGIS

It is therefore important to understand that the challenge of this tool is to combine data of different natures on different themes. Thus the question of the scale chosen seems decisive. The data of environmental inequalities are more general and consists of a first characterization of the territory, the data of resilience of buildings and networks are finer and allow to work on the scale of the building, the road network rather than the scale of the district for example.

GIS tool must be primarily intended to offer simple functionalities, accessible to all with the aim of better observing the proposed data, modifying them... Moreover, we decided to go further in decision support. Indeed, a tool intended to "show the contribution of a project to the reduction of vulnerability" could include modelling functions. The proposal could be:

- The selected environmental inequalities data would make it possible to locate areas favorable to development projects, social, environmental, economic and legal arguments (Marie-Laure Lambert's work).

- Once the location is determined we move to a finer scale (the neighborhood, the parcel). And the possibility is left to the manager to propose a project with a number of characteristics (sustainability, size, number of the population concerned, number openings ...) which would allow a rather fine analysis of the project's resilience, a diagnosis of the project in question. This tool could be tested on a small number of projects, concrete projects to be launched in the short term or hypothetical projects in the longer term.

This tool would, therefore, consist of two nested phases. A first phase focused on the environmental inequalities and the relevance of the localization of the development by contribution to its environment. The second one takes into account indicators of the resilience of buildings and networks and allows to characterize the degree of resilience of future development.

This proposal has several advantages and will be the "ideal" outcome of this work. Indeed, such a tool will make it possible to directly associate environmental inequality and urban resilience in a reflection that is quite interesting from a conceptual point of view. Then the idea of modelling would make it possible to invest considerably the actors of the planning (to promote participatory) leaving them a big margin handling the tool.

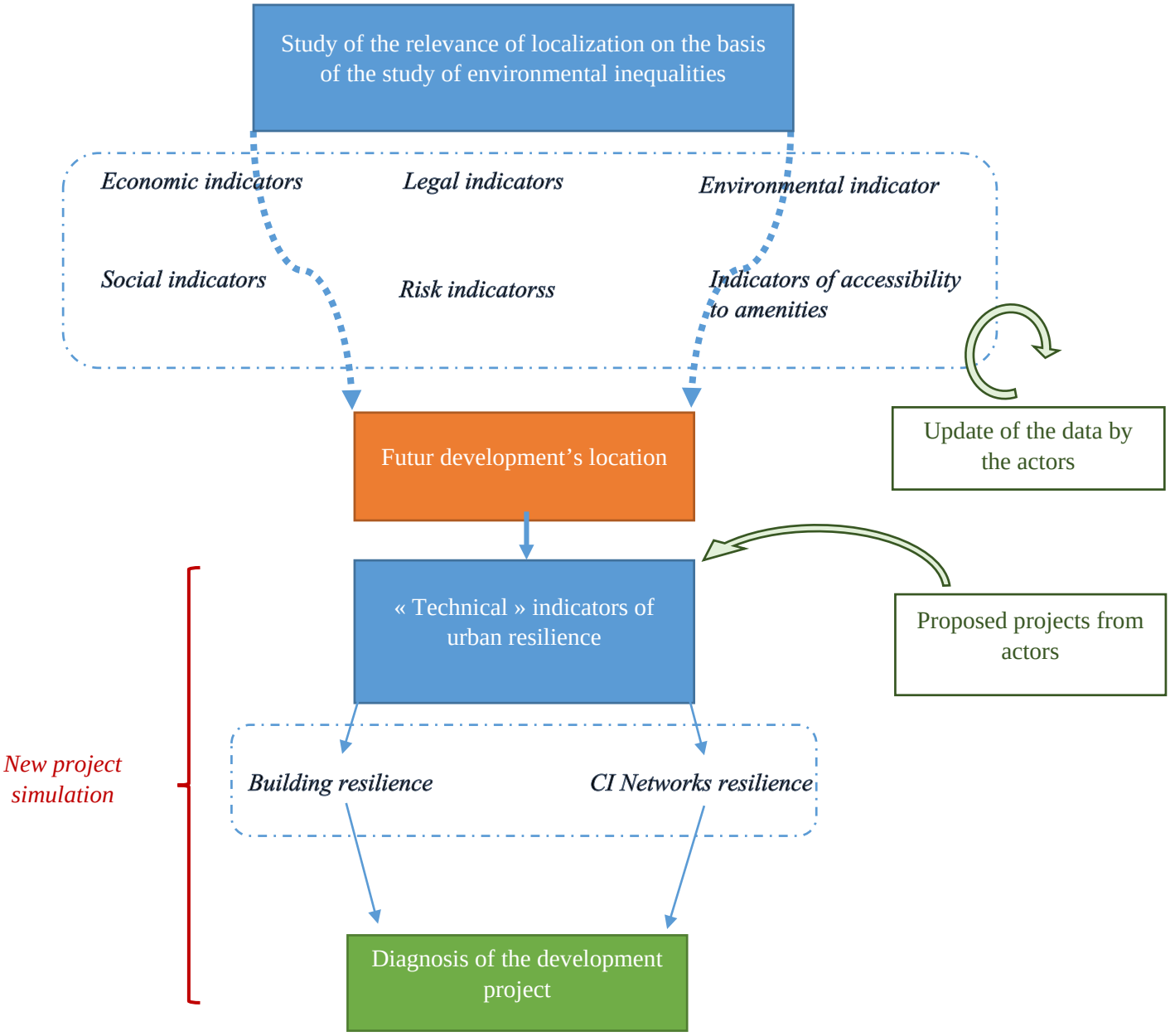

Figure 4 : Conceptual tool architecture

4. Some results

A first cartographic solution was chosen to implement this tool. It is the GEO Generator interface and the Humanum environment. Below is a first version of the tool, developed under this solution. We thus observe the multiple displays of available layers, the geographic attribute data editing functions.

A tool of analysis and decision support for the actors cannot be confined to the superimposition of layers and the sharing of data, even reworked. Thus, the tool must be able to allow a number of spatial analysis options. Spatial analysis proves to be an indispensable tool in the exploitation of data by the actors. It allows selecting the information which interests in priority, to visualize tendencies. This is the central function of a GIS. The spatial analysis is conventionally done on two forms of raster and vector data which obviously must be able to be exploited in the tool. The spatial analysis functions can be calculation functions (density for example), but also calculations of new indicators corresponding to the specific needs of each manager. The GIS must allow the creation of buffers (buffer), as part of risk management, for example. All in all, one of the things to keep in mind is that we are talking to non-GIS specialists.

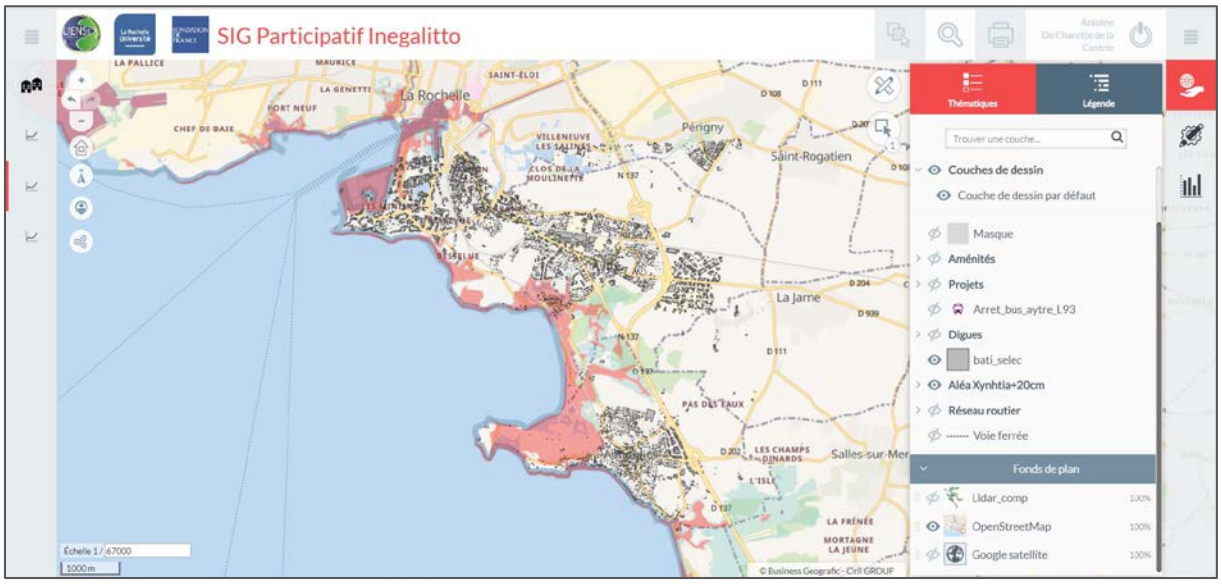

Figure 5 : Example of PGIS with GEO Generator solution

We begin the project with the municipality of Aytré (17). The organization of this work was, first carried out through interviews with the stakeholders concerned, to discuss their vision of spatial planning, future projects on the agenda with the public authorities, and their expectations by contributing to this tool. After Xynthia in view of the emergence of the PPRL and other measures largely constraining the development of the territory with urbanistic limits. But the objectives of the municipality are largely in the development of amenities on the coast. With, however, most often modest infrastructure. Thus, a number of development projects related to the coastline have been noticed. Some rather secondary projects sometimes still very little formalized. Small but urgent projects which are the reconstruction of a primary school previously in submersible areas.

The main project is a natural park spread over several municipalities and carried by the agglomeration of La Rochelle. This park aims to enhance the space left vacant behind the dune and enhance the soft mobility (Figure 6). The idea of this park is to act on a space left undeveloped. It is, therefore, a question of reconnecting the natural spaces between them, of arranging at best the cycle tracks, the walks...

To work also on an improvement of the dune environments as on the beach of Aytré, environments which remain one of the best protections against the submersion. This project seems interesting and accounts for an intelligent apprehension of the coastline by the public authorities.

Figure 6 : Projects on Aytré municipality and submersion hazard

Thus the discussions will focus on the vision of development of the municipality first. Make turn the municipality of Aytré towards its littoral while taking into account the risk of marine submersion. But also other additional risks such as bathing water pollution of the bay.

In addition, questions of inequality of access to amenities will probably emerge. This kind of natural park project could accentuate an already visible dynamic of concentration of amenities in opposition to a concentration of industries and commercial areas on retro-littoral spaces. Questions of solidarity at the municipal level can, therefore, also emerge. These question around environmental inequalities concept may put forward various mink according to the actors. The interest is to lay one's finger on the inequalities present on the municipality more or less known of the services of the communities but especially probably little or not taken into account in the planning of the territory.

5. Conclusion

To conclude this reflection on the implementation of a participative GIS allowed to progress on the problem of the insertion of data of environmental inequalities in the speeches and the reflexions of the urban planners. GIS, therefore, seems an interesting tool to tackle this problem. It is a tool that has the possibility to be visual, to involved stakeholders by spatializing in a clear way their vision of their respective territories. One of the risks in this type of approach is to tend towards too much complexity, both technical and scientific. The concept of environmental inequality, as well as that of the city's resilience, are difficult to understand and planning is a concrete vector for moving towards these concepts. Thus a reflection on pedagogy, on the density of the information, on the modalities of exchanges around the tool is inescapable.

The central idea is to associate the actors of the territory through the associations of owners or protection of the environment. Subsequently, feedback from these meetings will allow us to assess the more or less

shared vision of the actors of the development of their municipality, to assess also the relevance of the proposed cartographic tool. Finally, this method will be repeated for each of the study areas before finalizing a comparative study between territories with varied issues. The purpose of this work is to validate the hypotheses proposed by the INEGALITTO program, to produce a tool to help implement urban planning and risk management strategies, and help understand to what extent these policies can accentuate or reduce inequality on the territory.

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