A method to build territorial resilience to natural hazards

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Introduction

Resilience is a concept that has become recently essential in natural hazards research, and its use increased in risks research after Hurricane Katrina in 2005. It allowes us to think disaster reduction studies on different spatial scales: local, national, regional and global.

Like vulnerability, resilience has many definitions, making it a polysemic concept, that has a common denominator in the field of risk and disaster, **time continuum**: before, during, and after the event (Reghezza, Provitolo 2015).

Our conception of resilience is to consider it as capacities that are changing depending on that time continuum:

+ Before the event: **anticipation** capacity + During the event: **withstand**, **resist**, **absorb** capacities + After the event: **recover**, **rebuild** capacities

Resilience requires to include all of these temporalities because resilience might be built in two times period, before and after an event, and it reveals its efficiency during a crisis (Richemond, 2003).

What are the available tools we might use these days to build resilient cities?

To answer to that question, we are going to introduce an operational framework based on three major targets in case of flooding, the **CREAA Model**.

1. Building the resilience of populations and territories to be prepare to face flooding ... An actual necessity

New-Orleans (USA) under water after hurricane Katrina in 2005 (source : BBC)

Woman traped by water during flooding (source: SDIS 06)

A street in Japan after the tsunami in 2011 (source: Le Monde)

Resulting damages in a house after the flooding in France in 2015 (source: L. Boschetti)

2. What are the available models to study resilience ?

In order to respond to our main issues, we have done some research on the scientific literature and we selected models that appear to be appropriate to our studies. There are four systemic models that we have combined in two groups:

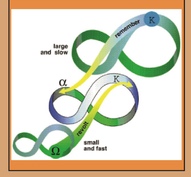
- **Generic models** that are conceptual and distant from the situation on a local scale so far from the operational studies : **Panarchy** and **Adapative Cycle;**
- **Operational models** that have been creating with a formalized method, but those ones are hardly used by operational actors or focalized on one dimension (the physical one) of the district system : **Resilience assessment framework** and **DS3.**

None of those models respond totaly to our requirements, that is why we thought to an alternative model : the CREAA model.

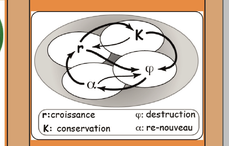
Systemic models available to study Resilience

Generic systemic models distant from situation at local level

Panarchy
(Gunderson et Holling, 2002)



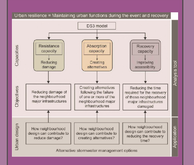
Adaptative cycle
(Walker, 2004)



Operational systemic models hardly used by operational actors

Resilience assessment framework
(Resilience Alliance, 2010)

Spatial Decision Support System (DS3)
(Balsells et al., 2013)



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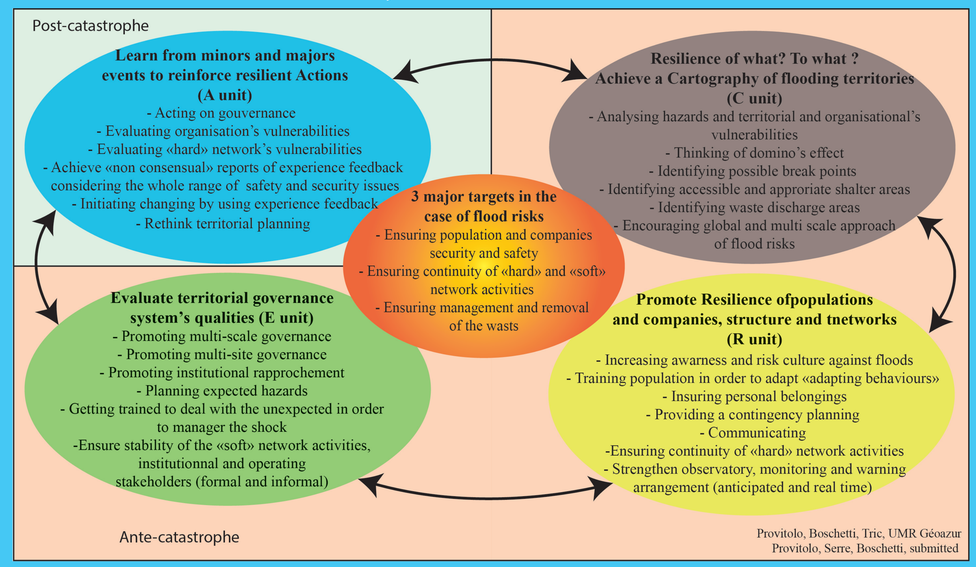
3. CREAA Model : a dynamic use of resilience



CREAA is a systemic model whose the purpose is not to analyze resilience, but helping to "built" resilience, in the before and the after event. Working on that both temporality, helps preparing the territory, the population, the institutions, etc., for the next event. It is only during a crisis that we realize if we are or not well prepare, if the actions that we took are helping or not, and thus if we are or not resilient.

The AA unit is the only one of the fourth, which is working on the post event period. The idea is to review the events that occurred in the past (what worked and what is important to improve) , but not only the major one, it is also interesting to analyze the smaller one, they help to have a better knowledge of our territory and to prepare ourselves to the next episode.

The main aim of the C unit is to study the territory, to cluster and summarize the data and the knowledge that we have about it. Hazard and vulnerability studies help to have a better understanding on how the territory is working.

CREAA model has been created around three key targets, which are the beginning of our reflection. They would be different, depending on our study. Here we choose to focus on population and companies, "hard" and "soft" networks, and waste management.

The E unit is working on the governance, which includes institutions, stakeholders, and involve multiple scales. Its development on different scales and area, and institutional reconciliation are important to make it effective. They also have to learn how to deal with predictable hazard, and even more with unpredictable one, to be able to manage a crisis in every situation.

The R unit focus on the living and dynamic part of the territory, like the population that is living (permanently or exceptionally) on it, the institutions, the company, or even structural components like building, or "hard" network (road, water, electricity, etc.).

Conclusion

All of this different resilience models have similarities; they are systemic, have the wish to studying resilience, and are using the same key concepts like resilience strategies and resilience abilities. They also have the same organization about time and space scales. They are organize in two different types: the first ones that are more conceptual than operational (Panarchy and Adaptive cycle); and the second one that are conceptuel and operational (Resilience Alliance, DS3 and CREAA). The next step is to apply the CREAA model on a territory, the French Riviera, to tsunami risk.

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