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The French *Cat' Nat'* system : post-flood recovery and resilience issues

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Abstract

Successive French governments have progressively decentralised flood control policy to increase the role of local authorities in planning and crisis management. In 1982, a law mandated local risk maps for 5 types of exceptional natural hazards and set up *Cat' Nat'*, a national system of damage compensation based on an insurance super-fund. While this system clearly improved the situation of victims of extreme events through subsidies in housing and infrastructure reconstruction, it did not necessarily foster a parallel reduction of vulnerability: insurance is more tuned to the past than to the future, and the tacit rule supports identical reconstruction so as not to increase the pre-disaster vulnerability (but not reducing it either). Yet indirectly, the recognition of a state of natural disaster triggers vulnerability reduction later, through various measures at various scales, from housing level (*build back better*) to the PAPI (action programs for flood prevention); we describe them and present a case study before presenting hypotheses to explain the resistance of private landowners as well as potential improvements to better bridge recovery and resilience.

Key words: France, post-disaster recovery, floods, *Cat' Nat'* system, insurance, resilience

Introduction

In France, flood control (the most important natural hazard both in terms of the number of events and the scale of economic impact) has been framed by specific central-local relationships, like most territorial policies. The Constitution of the Vth Republic adopted in 1958 increased the centralised nature of the regime, but met with resistance from local government, giving rise to what Michel Crozier and his disciples, Pierre Grémion (1976), Jean-Pierre Worms (1966) called 'cross regulation': central government developed a policy to modernize the economy, but at local level, society would resist the proposed change, unless the government would bring financial support. Without this support it would have to postpone the reforms or give dispensations. Bargaining took place between the 'prefect' (*préfet*, head of central administration at *département* — county — level), and the county's political leaders and aldermen. International comparisons fostered by the rise of European water policy then triggered decentralisation as a way to make territorial authorities more responsible.

¹ Centre International de recherches sur l'environnement et le Développement. Article publié dans la revue *Environmental Hazards*, <https://doi.org/10.1080/17477891.2019.1696738>

The decentralisation policy initiated in 1982 included an important reform of the control of 5 natural hazards: floods, landslides, avalanches, earthquakes and volcano eruptions (the latter in overseas counties). It created a national funding mechanism generated from additional insurance premiums paid by all households and vehicle owners, to be mobilised to cover damages resulting from natural disasters (exceptional events). As a counterpart, local authorities in risk areas were required to draft 'risk exposure maps' to ban construction or subject it to vulnerability reduction measures in the disaster prone parts of their territory. Repeated severe droughts more recently led to add a sixth eligible disaster: housing damages due to clay soil subsidence.

According to Lamond & Proverbs (2009), the notion of resilience encompasses pre-disaster planning and warning systems, emergency handling procedures and post-disaster reconstruction. In this article we focus on the link between recovery and resilience; we first present the context of flood control and land-use policies in the country; then we discuss the way post-disaster recovery procedures operate, and how they improve the situation for victims of natural disasters; and follow this by questioning whether the recovery system also triggers resilience measures, in particular we ask "at household level, is recovery leading to 'building back better'?" Finally, we illustrate the presentation with a field case study, before concluding with potential improvements to the policy.

In other words, we address four questions: how far was decentralisation of flood control driven and why was it incomplete? Is post-disaster recovery now improved and how much does it cost? Does the insurance-based recovery funding improve resilience? And how can landowners be better involved in vulnerability reduction?

Decentralisation of Water Policy and Flood Control in France

As early as the 1960's, a regionalisation policy initiated a new form of governance, made more transparent and open to civil society through public participation mechanisms (Duran & Thoenig, 1996). In the water policy sector, this regionalisation included the creation of 6 *Agences de l'eau* and 6 *Comités de bassin* (institutions at the river basin district level) covering the country, and operating under a mutualised version of the polluter-pays principle: i.e. that water users degrading the quality or the quantity of water in the environment pay a collectively agreed upon levy to the institution, which uses the money to subsidize environmentally friendly projects proposed by pro-active water users. Over the following decades, these river-basin institutions helped the learning process about valuing water and turning water policy into one focussed on usership rather than on ownership, *i.e.* separating the right to use water from landownership rights, an important change in the country which invented the Civil Code. Interestingly, French river-basin institutions were not entrusted with flood control measures: they remained a prerogative of central government (Barraqué, 2014) despite the overlap between the recovery of the aquatic environment and flood control, as some land-based measures support both.

Decentralisation was promoted further with laws voted in 1982-83, under the left wing government. New planning laws gave competence for granting building permits to local authorities, on the condition that they first set up a land-use plan, for review by the

government's services at county level. The idea was to decentralise urban planning at local level, but to limit the possible subjections of elected councils to vested interests and land-use based speculation, as well as to check the incorporation of national regulations. But rarely would a prefect take a local authority to court for illegal planning decisions.

In the same spirit in 1982, a law was passed to launch a new recovery and vulnerability reduction policy for the above-mentioned 5 types of hazards². To fund the recovery, rather than use the budget of the *Agences de l'eau*, the law mobilised insurance companies to provide compensation to victims from a special insurance fund called Cat' Nat' (abbreviation for *Catastrophe Naturelle*) (Fig. 1), set up thanks to an addition on all insurance premiums at national level; for vulnerability control, the law mandated all appropriate local authorities to draft risk maps, the '*Plans de prevention du risque*' (risk prevention plans, PPR, and for floods, PPR-*inondation* or PPRi); however, the plans were not done well or quickly; in addition long term precaution and environmental issues could not compete with short term added value of urban development. In 1987, through additional legislation, the prefects recovered the responsibility to draw the PPR, but difficulties remained in their completion and they were not rapidly incorporated into local town plans.

Central government services eventually found themselves with flood events responsibilities, as illustrated by the Xynthia disaster (47 casualties in total): in February 2010 on the Atlantic coast in La Faute-sur-Mer, close to La Rochelle, a severe depression provoked a sea surge which broke the dykes and submerged housing estates on floodable land (Vinet, 2011). Families of the victims brought a lawsuit against the municipality of La Faute-sur-Mer and central government. The municipality was condemned, criminally for the mayor; but central government was also condemned for its inaction against a town plan which favoured development in the hazard prone areas, and for insufficient maintenance of the dykes.

Today, the implementation of the Floods Directive³ (FD – 2007/60/EC) is the responsibility of the prefects and local authorities, as in the past, i.e. at the level of administrative territories. However, in the years before the FD's adoption in 2007, catchment-based institutions called *Etablissements Publics Territoriaux de Bassin* (Public Territorial Catchment Institutions – EPTB) were created at a smaller scale than the 6 river basin districts, and some of them developed a tool called *Programmes d'Action pour la Prevention des Inondations* (Flood Prevention Action Programs – PAPI), to financially support projects aimed at reducing vulnerability and 'returning space' to the rivers; which has become an essential part of flood risk management policy, as illustrated below.

More recently in 2014, and possibly following the Xynthia lawsuit, the government decided to transfer the competency for aquatic environment management and flood protection at local level, by organising a grouping of tiny local authorities into larger and more sustainable units called *Etablissements Publics de Cooperation Intercommunale* (Intercommunal Cooperation

² Act n°82-600 of July 13th 1982 for the compensation of victims of natural disasters. Floods represent more than 90% of events.

³ Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks.

Public Institutions – EPCI). Again local authorities complained that these new tasks would be an unfunded mandate. The government allowed them to tax local residents and landowners up to 40 €/cap/yr to cover this new expense. But on January 1st, 2019, only one third of EPCI had adopted this new tax (AdCF, 2019), with limited rates, since they are already pressed by the Cour des Comptes (national accounting office) to reduce budget spending in general...

The progressive decentralisation of the control of risks as presented here should be challenged with key questions related to recovery and resilience: does this evolution improve post-disaster recovery, and in addition does it foster vulnerability reduction? Before discussing this, a presentation of the recovery system and its effectiveness is needed.

Recovery with Cat’ Nat’: how does it work?

As mentioned above, Cat’ Nat’ works thanks to an additional fee on all insurance premiums in the country, whether policy holders are at risk or not. The resulting fund covers only the damages of extreme events, which were not covered before the 1982 law: insurance companies would then argue a case of *force majeure* (i.e. beyond what is statistically foreseeable, sometimes called ‘an act of God’ in the English speaking world).

In their typology of flood coverage systems at international level, Lamond and Penning-Rowsell have picked Cat’ Nat’ as the typical example of ‘bundled insurance backed by the State’ (Lamond & Penning-Rowsell, 2014). The Cat’ Nat’ fund is created from 12 % extra on the premiums paid to cover homes, businesses and some agricultural assets, and 6 % on automobile premiums. 53.1 % of the total comes from domestic residences, 37.3 % from business risks, 3.4 % from agriculture risks, and 6.2% from automobiles i.e. €100 million. If an insurance company has difficulties in facing its liabilities, it can get the support of the Caisse Centrale de Réassurance (Central Reinsurance Agency – CCR).

When an extreme event occurs, mayors of municipalities hit by a natural disaster can make a Cat’ Nat’ claim to the prefect (fig. 1); the prefect in turn reports to an inter-ministerial commission, responsible for deciding on the ‘naturalness’ and ‘exceptional intensity’ of the phenomenon, and whether “the usual measures to avoid such damage could not prevent them to happen or could not be taken”⁴. Upon the commission’s advice, the relevant ministers will eventually sign a Cat’ Nat’ order, acknowledging a state of natural disaster. Only then, are insurance companies liable to mobilise the additional premiums they have set aside through the super-fund, and cover the damages.

⁴Quoted from the 1982 Cat’ Nat’ law. Our translation.

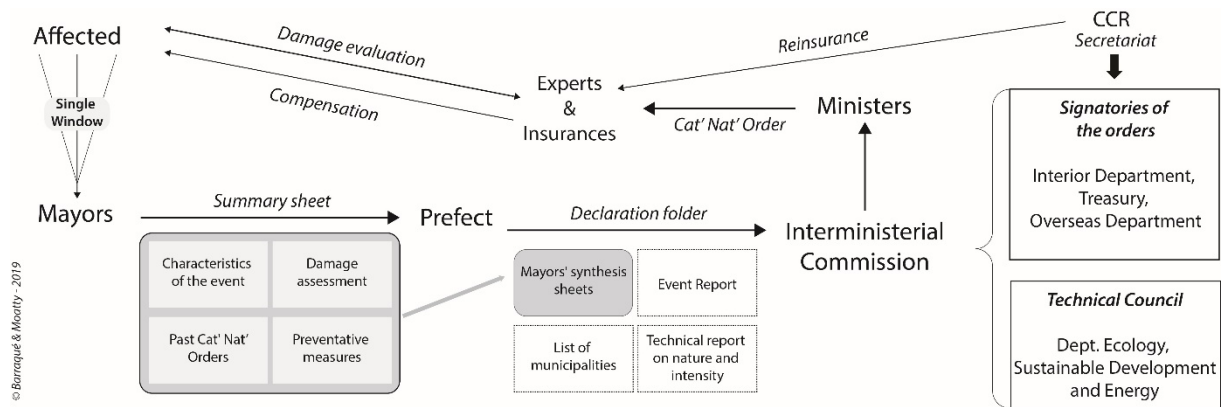


Figure 1 : The Cat' Nat' damage compensation system (source: authors' elaboration)

Post-disaster coverage includes the replacement of damaged infrastructure and buildings, as well as the complete restoration of services and economic revitalization. This support through the insurance system can be supplemented with direct subsidies from the State: The government supports local authorities in dealing with the distress of victims on top of the insurance system, including compensation for uninsured local public assets. For instance, the *Fonds de Solidarité en faveur des Collectivités Territoriales* (Solidarity Fund in Support of Local Authorities - FSCT)⁵ can be mobilised if the amount of damage to the local authority is between €150 000 and 6 million; beyond this level the *Fonds de Calamités Publiques* (Public Calamity Fund) can be called in. These funding measures, which are separate from Cat' Nat', play a decisive role, since they better encourage the adoption of preventive adaptation measures within reconstruction (Moatty *et al.*, 2017).

The Cat' Nat' system prevents many insured families and businesses from being ruined, and in theory allows them to obtain quickly (within 3 months) the funds they need to repair their belongings, at least for those who are insured. In addition, after the event, insurance companies are in principle not allowed to raise the premiums of concerned insurees, given that it is exceptional. This can be compared with the situation in England where insurers may change the contract conditions for those flooded (Lamond, 2009). Although based on a small set of examples, the following table illustrates the improved damage coverage allowed by Cat' Nat' compared with 2016 data collected by Munich Re:

Table 1 : Cost and coverage rate of some 2016 disasters (Munich Re ; French CCR)

Area	Event	Cost estimate	Coverage rate
World	Total natural disasters	€ 167 bn	30 %
Japan	Earthquake April 14-16	€ 29.6 bn	19 %
Europe	May-June storms	€ 5.7 bn	47 %
France	May floods*	€ 1.4 bn	64 %

* this was the second costliest event since the inception of Cat' Nat', with 150 000 victims and 5 casualties

In 2017, the last year with available consolidated statistics, the total amount of additional premiums raised by insurance companies reached 1.641 bn €, vs 1.601 bn € in 2016. This

⁵ The FSCT is a financial package announced in the Decree in the Official Journal of August 27, 2008. So far, we have limited information on its performance.

budget is being used chiefly to cover two exceptional events: the first, cyclone Irma which hit the Caribbean islands of St Martin and St Barthélemy, and cost around 2 billion € of insured losses according to CCR; the second, the 2018 drought following the one of 2016 will certainly cost even more to the system.

Table 2 : Cat' Nat' key 2017 data (from CCR , 2018)

	2017	From 1982 (2000 for vehic.)	Yearly average
Number of insurance contracts (– including vehicles)	90 million		
Cat' Nat' income from additional premiums	1.64 Md€		
Cost of Cat' Nat' events on non-vehicle insured damages	IRMA 1.97 Md€ Drought 800 M€	33 Md€ (56% floods, 33% droughts)	936 M€
Cost of insured -vehicle damages		707 M€	40 M€

Altogether in its 35 years' existence, the Cat' Nat' system has managed to finance the physical reconstruction of damaged assets at national level whilst increasing additional premiums paid to insurance companies by only 10 %. Confidence in the system relies on public reinsurance system which supports insurance companies facing hardship, and collects the data allowing a good follow-up (CCR, 2018). On top of it, the whole system is guaranteed by central government budget which would typically be mobilised in case of a more devastating event like an earthquake hitting the Nice area.

Now, a potential accumulation of extreme events, related to climate change, questions the sustainability of the recovery system. The fee on insurance premiums has already been growing steadily since its inception: initially, the additional rate on non-vehicle premiums was set at 5.5%, but it was raised to 9% in 1985, to restore an interannual balance between income and expenses; and it rose again to 12% in 2000, because more severe and repeated droughts resulted in soil subsidence provoking damage to overlying properties. Today with the possibility that climate change increases the number and severity of extreme events, the system could potentially become bankrupt. In 2016, the total disbursement of insurance companies to victims of floods and droughts already exceeded the total budget gathered from insurees by 4.5 %. For 2017, the deficit is even worse. It is still difficult to assess because the rate of insurance coverage is much lower in the French West Indies than on the mainland: the rate of housing insurance penetration is only 52 % in the *départements d'outre-mer* (overseas counties – DOM) vs 99 % in mainland France; but the cost of Irma alone represents more than 6 % of total disasters' damage cost since the creation of Cat' Nat' in 1982. In 2018 an exceptional drought on most of France (and Northern Europe), together with a dramatic flash flood in Aude county in October will also probably leave the fund in deficit. It remains to be seen if implementation of the FD will lead to reviewing the PPRi and increasing land-use limitations, or if Cat' Nat' will need a new increase of the fee on insurance premiums.

From recovery to resilience: how and when

“Economic resilience depends on the capacity of a government to fund recovery and reconstruction through a large span of public and private mechanisms, like budget reallocations, tax increase, reserves mobilisation, national and international bonds, international (European) aids, insurance and re-insurance indemnities and financial obligations like ‘catastrophe obligations’” (Mechler, 2006; UNISDR, 2013).

The reconstruction period offers a “window of opportunity” to reduce vulnerability (Christoplos, 2006; Moatty, 2017) This can take two different shapes, which can *a priori* appear contradictory, and yet in fact follow each other and set resilience as a dynamic process. Indeed, during the crisis, resilience means resisting, at household or territorial level; while in the longer post-disaster run, it means a capacity to bounce back to normal or to non-degraded functioning, eventually with adaptation (Moatty et al., 2018).

But in France, the Cat’ Nat’ relative success has a negative counterpart: insurance companies unintentionally reduce resilience since they reimburse victims on the basis of actual damages incurred, which does not foster different and more resilient reconstruction: additional costs of vulnerability reduction are not well covered, as an official inquiry on post-disaster victims’ compensation puts it: “The risk prevention policy and the compensation of natural disasters are juxtaposed but they largely ignore each other” (Moatty & Vinet, 2016). On top of this, many damages are not considered by insurance companies: those on the public domain, outdoor housing damages, non-monetisable values (casualties, health impacts, emotional loss), etc. (Anonym, 2018a). Vulnerability reduction has to be funded differently.

In the French system, resilience then relies more on prevention than on crisis management and post disaster measures, and prevention is chiefly introduced through the risk maps: the PPR. The PPR act as a counterpart of national reconstruction financing by making a local obligation to zone risk areas. Typically PPRi are maps showing areas exposed to a reference flood hazard (it is often the 100-year flood that is used, or the highest known water levels when they are higher), and include bans on building (in areas where the risk is considered strong), or restrictions on building (*e.g.* no valuables on ground floor) in other areas. This remains a touchy issue due to the political weight of private property, and PPR meet land-owners resistance.

And, since Cat’ Nat’ funding is national but PPR are local, obviously local authorities are tempted to underestimate the risks and to support economic and urban development at the expense of prevention, all the more so when they expect that losses will be covered by Cat’ Nat’. Zoning regulations are feared by local representatives as impacting negatively on land values and the attractiveness of the commune, particularly where other natural or industrial risks are identified. According to business daily *Les Echos*, “*this very protective regime also has a perverse effect: it delays setting up efficient prevention policies, and even in some cases, it relieves actors from their responsibilities. Too many mayors allow house building in flood prone areas; too few coastal communes adopt plans on sea surge risks; and too few in general impose a geological survey before granting a building permit.*” (Maujean, 2018 – our translation). Various experts question a perverse effect: “automatic reimbursement” of

disasters tends to reduce the victims' responsibility (Bourrelier, 1997; Ledoux, 2000; Lefrou, 2000).

This is also why the drafting of the plans was transferred from municipalities to prefects' services at county level in 1987, but implementation difficulties remain frequent, due to the 'crossed regulation' politics mentioned at the beginning of this paper.

Additional measures to reduce vulnerability

Floods however do trigger vulnerability reduction efforts, even though not necessarily in the recovery phase. Despite local resistance, the above-mentioned PPRi progressively cover all concerned communes. At the end of 2017, the number of approved PPR and other risk plans resulting from previous legislation exceeded respectively 20000 (all risks) and 14000 (floods and mudslides), covering 10400 communes for flood risks. This means that in most communes at risk of flooding, there are some limitations on building in areas at risk. In addition, a 2004 law mandated municipalities to set up, within 2 years after the PPRi is approved, what is called a *Plan Communal de Sauvegarde* (Communal Safeguard Plan – PCS). This PCS establishes alert and crisis management procedures⁶ such as evacuation and emergency resettlement. The law also mandates local authorities to issue a *document d'information communal sur les risques majeurs* (Communal Information Document on Major Risks – DICRIM), to help the local population be prepared if a disaster is announced. At the end of 2017, respectively 8000 and 6000 communes had set up their PCS and their DICRIM, which means that local knowledge about the level of risk has probably improved, even though in a variable manner: realising a PCS implies that the local authority either has staff qualified in environment and urban planning, or outsources to consultants, who make the vulnerability diagnosis and draft the immediate action sheets needed. In the latter case there is a chance that PCS remain unknown or non-appropriated by elected representatives, reflecting lack of interest or excessive standardization due to economies of time and money.

Altogether, however, the post-disaster period is a time of increased consciousness of vulnerabilities, and thus of better acceptance of prevention's additional costs (Quarantelli, 1999). Improved knowledge of hazards and vulnerabilities lead central government and the insurance system together to update and reinforce regulations. To give an example, a review on *Build Back Better* incentives (MRN & al., 2017; MRN, 2018) was made after the costly flood of May-June 2016 south of Paris. It concluded that the pre-existing PPRi should be reinforced: they had been designed after the worst event ever recorded, the flood of 1910, and yet in 2016 some cities recorded higher levels still (+40 cm in Nemours, +30 cm in Montargis). Detailed observation at building level showed that 95 % of the damage occurred inside houses, and could have been reduced by installing temporary flood barriers, protections on basement light wells, anti-flood backflow valves on sewer connections, and by moving various in-house appliances like electricity, above the highest known water level. Many of these measures, which undoubtedly reduce the vulnerability of residential housing, were in fact mandated before the 2016 disaster: it is typically the case with sewer backflow valves

⁶ Act n° 2004-811 of August 13th 2004 dite « loi de modernisation de la sécurité civile » : civil security modernisation law, art. 13.

which are mandated in the sewerage regulations, or with moving up electric appliances, mandated in most PPRi. However, as usual in France, regulations do not apply retrospectively so these rules apply primarily to new buildings and eventually to post-disaster reconstruction. Insurance companies are not obliged to fund additional costs, but they tend to do it more, for instance by paying for replacing wood floors with tiling at ground level.

Another type of measure indirectly supporting vulnerability control is the reduction of insurance coverage in the case of repeated disasters. As we wrote above, insurance companies were not allowed to raise premiums after a disaster. But this rule was indirectly relaxed when insurance and reinsurance companies realised they were compensating the same landowners in the same communes, for the same works several years in a row! With the reform adopted in 2000, where communes do not have a PPR, the (residential and business) deduction on insurance reimbursement⁷ (*franchise*) is raised when events are repeated: since 2001, if in the last 5 years there were three events, the deductible ('excess' in the UK) is doubled, with 4 events it is trebled, and with 5 events it is quadrupled. In the period between 2000 and 2017, only 5 % of contractual deductibles were thus modulated, and less than 1.5 % were more than doubled. What then appears as a credible threat should incentivise the most vulnerable local authorities to adopt a PPRi faster, and in turn residents to invest in vulnerability reduction.

The most innovative measure was mentioned at the beginning of this article: the PAPI. PAPIs were initiated by communes and catchment institutions which realised that drafting the PPR did not in itself reduce the vulnerability of existing construction, and something more had to be done. For all types of flooding (river overflowing, groundwater rising, stormwater flooding and sea surge), local authorities are eligible to tap a special fund derived from Cat' Nat' called Barnier fund or *fonds de prévention des risques naturels majeurs* (Prevention Fund on Major Natural Risks – FPRNM) (Fig. 2), to reduce vulnerability before a disaster takes place. This began when environment minister Michel Barnier sought a solution to move the population of a village before a neighbouring cliff would collapse on it. Since houses could not be sold, a solution had to be found to buy their property amicably and allow them to relocate. Several other cases were then identified, and finally in 2003 it was decided to call for tenders of local projects to reduce vulnerabilities; and a yearly percentage of the Cat' Nat' fund was diverted to subsidise these projects. The call for tender was a success since more than 100 PAPI were developed, covering respectively 40 % and 60 % of the population exposed to risks from flooding and from sea surges.

⁷ In some insurance contracts there is a fixed deductible on reimbursement, in exchange with a premium reduction.

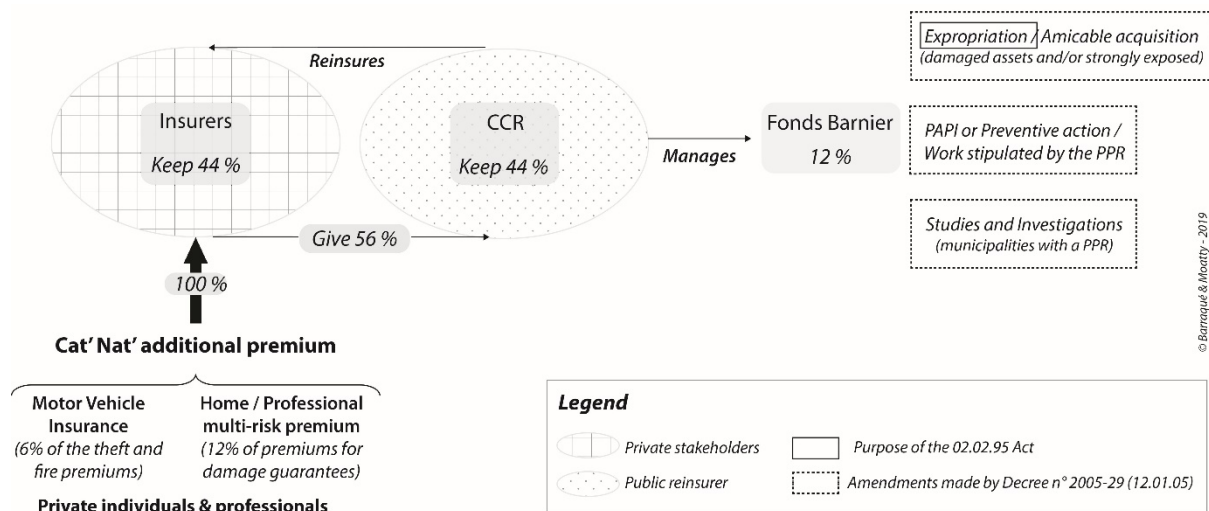


Figure 2 : Barnier fund origin and eligible operations (authors' elaboration)

In 2017, the transfer to the Barnier fund had reached 12 % of the Cat' Nat' budget, *i.e.* providing 200 mln € at national level (representing 38 % on average of the PAPI investments). Although insufficient compared to all the vulnerability reduction projects, as is now being revealed with the FD implementation, it is difficult to increase the funding from Cat' Nat' for fear that insurance companies would not be able to cover post-disaster damages, whether in case of a major event, or in case of cumulated events of lesser magnitude repeated over several years.

The most recent measure concerning resilience was a decision of the government in 2014 to decentralise the management of flood control infrastructure at local level. On the one hand it is a good decision to give local authorities the responsibility for both the structural measures and for land-use based solutions. But on the other hand, observers suspect that after the Xynthia disaster in 2010, the government wanted to put an end to its own responsibility for dyke maintenance, so as to reduce its deficit. Four new responsibilities were devolved to local authorities, together labelled *Gestion de l'Eau, des Milieux Aquatiques et Prévention des Inondations* (management of water and aquatic environment and flood prevention – GEMAPI). To allow them to face resulting financing needs, local authorities are allowed to tax local residents and landowners up to 40 €/cap/yr to cover this new expense. After 4 years on January 1st, 2019, only one third of EPCI had adopted this new tax (ADCF, 2019), and with rates much below 40 €, since they are already under pressure from the national accounting office for overspending. On top of it, GEMAPI tax is set in part on local housing taxes which the government intends to phase out progressively, as part of general taxation reduction on modest revenues. So it remains to be seen how this further decentralisation move will improve resilience.

A local example

To illustrate this situation of limited progress, we now cover a case in an area south of Paris, where a small river called Yvette is a tributary to Orge river, which is in turn a tributary to the Seine upstream of Paris. Yvette suffered a serious flooding episode in May-June 2016, which

was eligible to Cat' Nat' funding⁸. But in fact, flooding had previously taken place repeatedly, in particular downstream where the Yvette and the Orge meet before merging into the Seine: 17 % of the 121 communes in the catchment were supported by Cat' Nat' 9 times or more between 1983 and 2016! Saint-Rémy-les-Chevreuse, upstream on the Yvette, was also badly flooded several times, in particular in 2016 when a nearly 100 year flood occurred and flooded 300 homes, 10 public buildings and 6 shops. Little was done to stop this repeated flooding directly, while some wetland restoration recently improved the situation.

One has to remember here that the *agences de l'eau* can support the implementation of the program of measures of the Water Framework Directive (WFD - 2000/60/EC), including measures on wetlands that have indirect, positive impacts on floods; but cannot support direct flood control measures in the flood risk management plans of the FD. In the case study, the area is partly covered by a regional natural park⁹, the institution of which funded important efforts towards sustainable landscape governance. The catchment institutions of the Orge and Yvette rivers' and the park together initiated a *Schéma d'Aménagement et de Gestion des Eaux* (catchment plan - SAGE) as soon as 1997. A *Commission Locale de l'Eau* (local water committee – CLE) was set up in 1999, under participative democracy principles: the committee includes 30 elected representatives from the (116) municipalities and the (two) counties, 24 user representatives (farming union, fishing, consumer and environment associations, a university, the regional park, etc.) and 9 representatives of the Government (regional and county prefects, the *agence de l'eau*, regional services of various ministries), etc. Once the SAGE was drafted and adopted by the CLE in 2006, and approved by the prefect, resulting investments were made by the local river institution which is competent on floods and also on waste water: a joint board acronymed SIAHVY¹⁰. The plan had to be updated following the water law of 2006, and the new SAGE was approved in 2014. After the 2016 flood, the decision was made to develop a PAPI to try reducing vulnerability.

In the SAGE approved in 2006, there were already three major targets dealing with floods: protection of people and goods in lower areas (Flood Risk Management Plan, integration in urban plans, flood expansion areas); protection of people and goods from flooding due to runoff (specific stormwater control measures); and developing a risk culture in the population. These projects were picked up again in the revised plan in 2014, and included in the integrated catchment planning carried out by the SIAHVY. Some projects were being prepared before the serious flooding of May 2016, and could be implemented rapidly. In particular, the re-naturalisation of a small tributary of Yvette, the Mérantaise, was carried out to accommodate and store flood waters in a rural site with no damage to properties. Purchase of 800 ha and restoration of the wetland, a 4.5 million € project, was eligible for funding from the Agence de l'Eau Seine Normandie, as part of the programme of measures of the WFD. This project could improve resilience directly, but also indirectly through improving the legitimacy of the PAPI project.

⁸ Severe storms followed by an extreme rainfall episode provoked floods in several parts of France between May 25 and June 6, resulting in damages on insured properties up to 1.4 bn €

⁹ Parc Naturel Régional de la Haute Vallée de Chevreuse. <https://www.parc-naturel-chevreuse.fr/>

¹⁰ SIAHVY : Syndicat Intercommunal pour l'Aménagement Hydraulique de la Vallée de l'Yvette

The Mérantaise operation was a success and is now a show case for the *agence de l'eau*, since in the 2018 flood, there was no damage in that area; and elected representatives are now better convinced of the merits of land-based flood control. The PAPI Orge-Yvette was then drafted: it contains 8 types of actions, covering different phases of risk management (prevention and crisis management) and targeting different scales, from the watershed to the citizen:

- Improving risk knowledge
- Improving citizens' consciousness of the risk
- Monitoring and forecast of flooding episodes
- Alert and crisis management
- Integration of risk maps in town plans
- Reducing vulnerability and improving resilience
- Channelling the high flows
- Maintenance of flood protection structures

In addition, a transversal axis for governance includes a web site to share information between the institutions. In terms of vulnerability reduction and resilience improvement, the chief action is to help the most impacted municipalities in being prepared: drafting vulnerability assessments on public buildings, workplaces and shops, and setting up a strategy to cope with dramatic episodes in real time and hasten recovery. The cumulated cost of the 35 forecast actions of the plan is estimated at 1.57 M€ plus VAT (Mérantaise operation excluded), two thirds being devoted to flood knowledge and consciousness, and 200 000 € to improving resilience. The expected PAPI funding would mobilise the Barnier fund for 45%, the *Agence de l'eau* for only 4%, the County council for 26%, with the rest being self-funded by the builders/managers of infrastructure.

However, local managers of the Yvette catchment are worried about the area being eligible for the Barnier fund, due to the small size of the issue compared to other cases in France. They fear delays in implementation due to bureaucratic control of their projects, leading in the end to a “temporal dilution” of the initial good will of local authorities. Staff in charge of the PAPI are concerned that it does not include more precise anticipation measures to improve resilience in post-disaster recovery.

In addition, vulnerability reduction funding focuses almost entirely on public and business infrastructure, and not on housing: the staff in charge of the PAPI also fear that individual landowners at risk will not invest in vulnerability reduction due to lack of incentives. They propose residents install anti-backflow valves to prevent flooding from sewers, but it is not mandatory, and people are reluctant due to the high cost. In other words, residents are rich enough to be ineligible for benefits, but cannot afford to invest on additional resilience measures, which are not included in the Cat' Nat' indemnity. The worst case is when insurance companies dramatically increase the reimbursement deduction if vulnerability reduction investments are not made. An example was given of an insurance company threatening to raise the *franchise* substantially if buildings were not equipped with removable light walls to block ground floor entrances, and flood barriers. This may ultimately lead

people to quit their insurance. Conversely, these requests are met by the managers of public buildings like schools despite the cost, as being part of the PAPI.

Concluding remarks

Post-disaster recovery can be either addressed by collective or individual coping strategies, planned or spontaneous, with varying objectives depending on the stakeholders.

The French Cat' Nat' system combines individual and collective coping; it clearly represents an improvement in terms of recovery. Its success is due to its funding by all policy holders, be they at risk or not. This globally allows supporting recovery of extreme events without subsequently raising the insurance premiums of the victims, which obviously limits the risk of policy holders exiting. It can be compared with the American National Flood Insurance Program (NFIP) which for Lamond & Penning Rowsell (2014) is a typical example of 'add-on or separate policy, state-backed': insurees are eligible for subsidised extra flood insurance in areas which are largely self-designed as hazard areas. This leaves large areas outside of the scheme, and in addition, the price of extra insurance may be too high, leading to some policy holders exiting and potential fund bankruptcy.

If we compare with Italy, which has one of the worst disaster vulnerabilities in Europe, there is a clear difference: there the risk map is made and updated at national level, but priorities to develop preventative measures are left to local authorities, which are often too small to really control land-use developments at risk. The focus is on emergency management, and not on mid- and long-term territorial resilience. At least in France, Cat' Nat' binds local authorities and the Government through the insurance system and the PPRi together.

However, it seems that Cat' Nat' does not really encourage vulnerability reduction, in particular as concerns private landowners. Considerable amounts of money are invested in recovery but most of them finance an "identical" reconstruction. This is probably nothing new for flood insurance experts at international level. But we want to highlight the difficulty in bridging flood prevention and global river and aquatic environment policy (FD and WFD directives' implementation). This is partly due to the ongoing economic crisis and the excessive national deficit compared to the Maastricht 3 % target. Thus, in line with the spirit of the decentralization laws, the concern of the present Government is to transfer its previous responsibilities on to local authorities. But they also want to regulate the use of public funds to make sure that they are not used, after disasters, to make up for the maladaptation or even the lack of maintenance of public assets before disasters (*e.g.* dykes, the responsibility of which falls to local authorities since 2014); and that this support does not increase the pre-existing vulnerability. In addition, Cat' Nat' reimbursements are reduced if floods occur repeatedly in an area in which stakeholders have not taken any preventive or mitigation measures. Facing this relatively negative / punitive approach to flood control, integrated river policies at catchment scale frequently include more positive measures to improve social and territorial resilience. But they also frequently stop at the gate of private properties.

This can be illustrated with the difficulties in drafting the PPRi. They were first decentralised to municipalities, but soon recentralised in the prefectural services. So decentralisation was

only partial, with local elected representatives mainly continuing to support the urban development potential of flood prone areas at the expense of vulnerability reduction. Resilience anticipation is thus limited by this typical characteristic of French political system: the State is above the citizens but private property is well defended. While landowners often manage to undermine the building bans or limitations in PPRi, the State is tempted to underestimate the impact of floods on private property and the need for adaptations, or leave it to the insurance companies.

Of course, it is much easier to draft a more severe PPRi and a more resilient land-use plan in the aftermath of a disaster: in La Faute-sur-Mer today, in the place of the housing estates where 29 people drowned in the February 2010 Xynthia event, there is now a golf course. Yet anybody can ask why wasn't it zoned that way beforehand?

One answer is to reconsider land-use planning from the perspective of the aquatic environment, and derive planning rules from a catchment plan, which is elaborated more in terms of water usership than of landownership. Participative democracy, which was particularly developed in the water sector in the last 50 years, may then help mitigate the well-known State *vs* private property French antagonism. In places where local stakeholders convene to draft a SAGE (catchment plan) there is a better potential involvement of the population; yet flood control measures directly concerning landowners as such are not frequent, as our case study illustrates. This is also because in France, catchment institutions and the *agences de l'eau* are not encouraged to include flood control measures in their tasks: they would need to get a corresponding funding mechanism beyond what is made available through the Barnier fund, which is reckoned as largely insufficient to trigger improved resilience in most vulnerable areas, while remaining complex to obtain.

Insurance companies are aware of the difficulties encountered after floods by impacted landowners. Yet they have to admit that, paradoxically, the Barnier fund remains partly unspent year after year, and unfortunately any positive fiscal cash flow attracts the envy of the Treasury! After taking 10 % of the 200 million € since 2016, this year instead the total transfer from the Cat' Nat' fund is capped at 137 million €. Facing this unsatisfactory bottleneck, the Government and the CCR are considering an evolution of the regime, at least with two measures: subsidizing temporary relocation of victims, since recovery/reconstruction duration is frequently much longer than expected; and reimbursing some additional costs corresponding to vulnerability reduction in the damages payment calculations by insurance companies.

But again this raises the general question of the trade-off between after and before disasters particularly in Cat' Nat': the more one spends on more resilient recovery, the more is needed for the PAPI and Barnier funding, and the less is left to cover disasters after they occurred. And all this in a context where climate change increases the uncertainty on financial sustainability, not only for flooding but also for drought events which seem to multiply in France.

Some observers consider it would be a good idea to transfer the Barnier fund to the 6 *agences de l'eau*, which could then merge this budget with their own budget aimed at recovering the

good status of the aquatic environment, and help develop more integrated WFD and FD policies. This would be a reversal of the previous policy leaving the *agences* out of the issue of flood control. But the way chosen in 2014 is somewhat different: consolidated local authorities are allowed to raise a new tax on landowners, the above mentioned GEMAPI. It remains to be seen how the new legal responsibility on flood planning and infrastructure devolved to local authorities will help boost this important but yet fragile task: a more resilient recovery thanks to more active policies on land-use planning and on buildings restoration.

In the Netherlands, after the 1953 disaster (1830 casualties), insurance companies refused to cover the flood risks, and then the government developed a strong collective protection system based on dykes at two levels (national and regional). Today most of the flood control policy is implemented at the level of the former polder waterboards, which were dramatically consolidated since this event into what they call Regional Water Authorities (RWAs). But many people think that this focus on flood protection through structural measures has been overly disconnected from land-use management by local authorities, resulting in an aggravation of vulnerability (Doorn-Hoekveld, 2018). So they tend to promote a new ‘multi-layered’ policy, where improvement of the aquatic environment would be combined with alternative flood control policies: returning space to the rivers, mobilising private land to temporarily store and discharge excess water (with due compensation of the losses); and above all, developing better links between RWAs, and provinces and local authorities in charge of land-use management so that they are incited to reduce spatial vulnerability. Local zoning plans and some building permits are now subjected to a ‘water test’ to clearly inform local authorities of their consequences in terms of flooding. This new ‘living with water’ approach even includes an experiment on insuring some assets against floods: the ‘Neerlandse’ insurance was initiated in 2011 but has not attracted many subscribers yet.

If the French would draw on the Dutch multi-layered policy, they could support a more systematic co-ordination between the consolidated local authorities (EPCI) and the catchment institutions (EPTB), so as to plan vulnerability reduction through land-use control, including with compensated storage of excess water on private property; and funding could combine the Barnier fund, the GEMAPI tax levied by the EPCI, plus some specific mutual levy system to be developed at the EPTB level, in the aim at better bridging the implementation of the FD and the WFD.

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