



**OECD Reviews of Risk Management Policies**

# **Seine Basin, Ile-de-France: Resilience to Major Floods**





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Management Policies:  
Seine Basin, Ile-de-France,  
2014**

**Resilience to Major Floods**

*MAIN RESULTS AND RECOMMENDATIONS*



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## Flood risk prevention in the Seine Basin, Ile-de-France

### 1. Impacts of a major Seine flood in the Ile-de-France region

#### *A historic reference: the great 100-year flood of 1910*

While the possibility of a major flood of the Seine River may initially seem remote, it comes back regularly and arouses public attention as was the case during the spring of 2013 when floods took place upstream of the Seine River basin. Even though the flooding did not cause any major damage, it reopened the question of risk management and the region's vulnerability to flooding. The prospect of a historic event is a key concern for French risk management stakeholders. The 1910 flood was particularly destructive in the context of an era marked by industrial and technological progress. Such events illustrate the difficulties societies have in compromising between economic development and the management of increased vulnerability of society and multiple economic sectors.

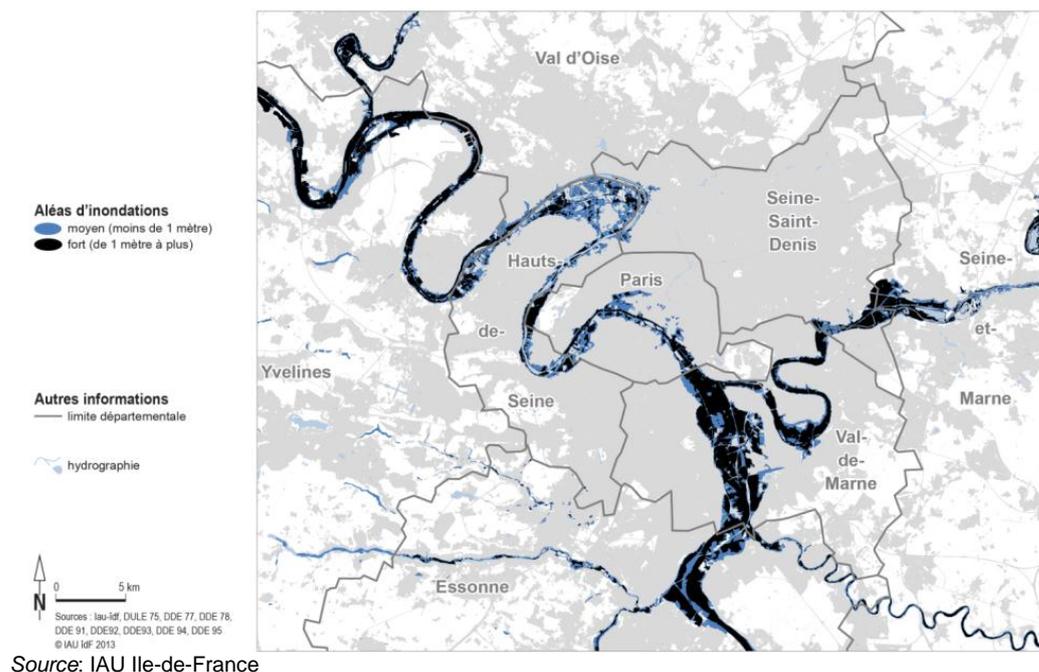
1924 and 1955 also saw major flood events in the Paris region and in the entire Seine basin. Nevertheless, the lack of a significant flood for more than 60 years tends to lessen the memory of risk. Seine floods are characterised by their slow progression and, following on a period of submersion which may be very long. For instance, the waters took almost two months to subside in 1910. Even if the effect of climate change on the frequency and extent of the Seine floods is still uncertain, greater floods than the one of 1910 are still possible, such as the one that occurred in 1658. In other countries, many recent floods significantly exceeded the 100-year levels. This was the case with the floods in Queensland, Bangkok, and Pakistan; as well as during the coastal flooding following hurricane Sandy in New-York, and the 2013 floods in Germany. The EU Floods Directive uses the 1000-year frequency as a reference for extreme events.

#### *Despite investments in protection, increasing urban development and the interdependence of critical infrastructures have accentuated vulnerability*

Since 1910, the risk of a Seine River flood in the Ile-de-France region has been reduced in various stages by protective structures, including dams built upstream and river development starting in the 1920s, then in the 1950s up until the early 1990s. Major investments have been limited in the last decades, and it appears that protection levels are not up to the standards of many other comparable OECD countries, particularly in Europe. On the other hand, the exposure to the risk and the resulting vulnerability are accentuated by increasing urban density in the economic centre of France, as well as by the construction of a large number of areas activity centres and critical infrastructures (transport, energy, communications, water) along the Seine River. The interdependence

of these networks; the interpenetration of production lines and their “just-in-time” operation; the key role played by the mobility of people and exchange in a dynamic economy; urban development and the concentration of populations and capital are just a few of the many factors of which increase modern societies' vulnerability to shocks. Today, these elements justify the necessity of the assessment approach in this field and the re-examination of have public policies.

**Figure 1. Map of the floodplain for a 100-year return period flood**



**Table 1. Return period for recent major floods**

Pays ou ville	Année	Fleuve ou rivière en crue	Période de retour
Prague	2002	Vltava	500 ans <sup>1</sup>
United Kingdom	2007	Severn	200 ans <sup>2</sup>
Pakistan	2010	Indus	>> 100 ans <sup>3</sup>
Brisbane	2011	Brisbane	120 ans <sup>4</sup>
Bangkok	2011	Chao Phraya	> 100 ans <sup>5</sup>
New-York	2012	Inondations liées à Sandy	400-800 ans <sup>6</sup>

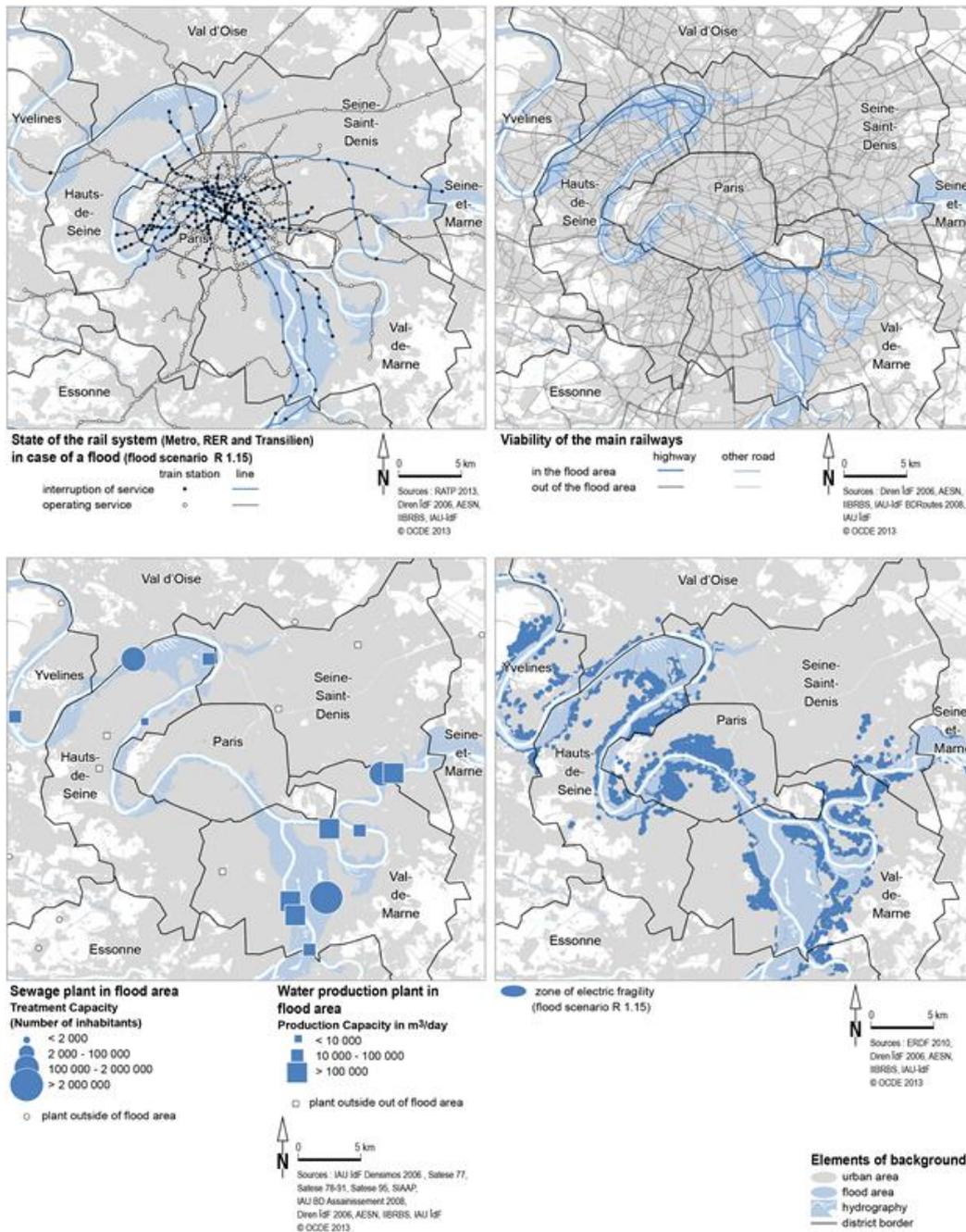
Source: 1. City of Prague, 2013. 2. Severn Trent Water, 2010. 3. Japan International Cooperation Agency, 2012. 4. Queensland Flood Commission Inquiry, 2012. 5. Aon Benfield, 2011. 6. Lin et al., 2012.

***A major Seine flood would today have important potential impacts on well-being, and on the activities of the government and businesses***

The Ile-de-France region represents about one third of the economic activity in France, the second largest economy in the euro area. The seat of the government and major industries are located there, as well as the main decision-making and research centres. It represents a large logistics hub for the whole French economy. In the most

extreme case, a Seine flood in the Ile-de-France region could have direct and indirect impacts on almost 5 million people and a large number of businesses, with significant economic, human and social effects. It could disrupt the functioning of the government and many institutions, as well as most of the infrastructures and critical networks that ensure the daily functioning of the Paris metropolitan area.

**Figure 2. Impact of a major flood on critical networks**



The distribution of electricity could be largely affected with almost one quarter of power sub-stations flooded or cut off as a precaution and more than 1.5 million customers who could experience power cuts. Public transport could be affected with almost 140 km of the 250 km underground network closed as a precaution. The road network could be blocked at many points: the bridges crossing the Seine closed to traffic, due to their weakened structure, would make it impossible to travel from the right to the left bank. The drinking water supply could be interrupted around Paris where more than 5 million clients could suffer extended water cuts and 1.3 million a deterioration in quality.

The debate on such impacts must examine the sector's interdependencies, for instance, between the critical networks (energy, communications, water, transport) and the large industrial and service sectors. A major flood could affect key sectors such as tourism or food distribution, or the car industry. The issues are therefore major at national level. Accordingly, the subject of preparing for a possible Seine flood, and reducing the risk, is an important, complex and sensitive issue of public policy.

***The macro-economic impact of a major shock could be significant in terms of GDP, employment and public finances***

Assessments of the economic impacts of various flood scenarios centered around the 100-year flood of 1910 show that a large-scale shock could have a significant macro-economic impact in terms of GDP, with repercussions both on employment and on public finances. These could come under severe pressure with corresponding deterioration over a long period. According to flood scenarios, the damage from such a catastrophe has been estimated to be between 3 to 30 billion euros for direct damage, together with a significant reduction in GDP which, over five years, could reach 1.5 to 58.5 billion euros, i.e. a consolidated total of 0.1 to 3%. The resulting contraction in business activity could have a significant effect on the demand for labour; up to 400,000 jobs could be lost in the worst case scenario. Even if a rebound in business activity could rapidly reduce some of these effects after a year, the harmful consequences of a major Seine flood could be felt over the medium to long term and weigh on public finances. In the case where the impact exceeds the reserves available through the national catastrophe compensation regime CAT-NAT and the Central Reinsurance Fund (*Caisse Centrale de Réassurance - CCR*), the State could be called on to fully assume its role of ultimate guarantor.

Even if these effects are significant, it should be emphasised that this analysis is an exploratory one, and that it does not implicate a systemic risk with irreversible effects: a variety of budgetary response mechanisms could be rapidly put in place –if they are foreseen and planned in advance. Nevertheless, there is considerable uncertainty and the effects could also be accentuated by the impact of a flood on the rest of the Seine River basin.

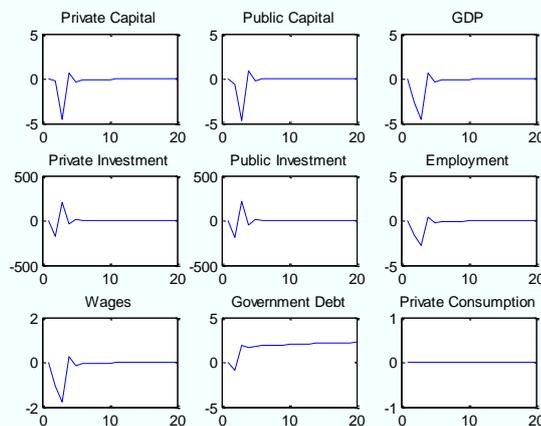
### Modelling the macro-economic impact

In view of the potentially substantial direct or indirect damages and losses, questions should be asked about the overall economic impact of a shock of this extent. Such an assessment needs to examine two problems: the cascading effects of the interruption to the critical networks on companies' activities and the macro-economic impact at national level, given the weight of the Ile-de-France region in the French economy (30 % of national GDP in 2011). For this purpose, a hybrid approach was developed, combining modelling of direct damages, assessment of the impacts connected with the interruption of critical networks and macro-economic modelling.

Three flood scenarios centered around the 100-year flood occurrence were used, taking threshold effects into account. For each scenario, all direct damage and business interruptions directly linked to the flooding and to the interrupted networks were calculated first. A combined hydraulic-economic model calculated the damage for private individuals and companies using damage functions on the basis of geo-distributed data on land use and types of firms. It also assessed the business losses suffered by firms in the floodplain. The combination of the vulnerabilities and damage to various critical networks is based on the work carried out with the network operators on crisis management for a decade. The effect on firms' activity due to the interruption to electricity and transport networks was assessed using the proxy of the number of employed affected in relation to those directly affected by the flood. By integrating all these micro-economic effects, a coherent and holistic initial economic assessment of direct and indirect damages and losses was obtained. Results were regrouped in terms of the destruction of public and private capital stock, as well as reduction of business turnover according to the various crisis scenarios.

With regard to the macro-economic impact, a dynamic general equilibrium model was developed to assess the indirect effects on growth, employment and public finances and to incorporate non-linear effects. A national model enabled to represent the impact dynamically in the short, medium and longer term. The incorporation of the specific features of the compensation funding linked to the French natural catastrophe insurance system, CAT-NAT, also made it possible to assess the impact on the public debt and to test various scenarios in the budget response to such a catastrophe.

#### Macro-economic impact of a flood scenario over 5 years



*Note:* these charts show the variation of the different parameters as a percentage of the initial state as a function of time with the quarterly measurement. The flood occurred during the first quarter. The flood scenario represented S3 corresponds to a flood with the same water-height as the 1910 one, with a flow 15% greater.

***Ambitious prevention policies could boost the resilience of Ile-de-France in the long term***

In light of these issues, such a situation is in no way inevitable: an effort to recalibrate, better co-ordination, and refocus public policies would decrease the consequences of the risk whilst increasing resilience. Apart from longstanding investments made over the last century, additional foresight and investment efforts may enable better management and containment of the risk. The aim is to increase the capacity of the Ile-de-France ecosystem to restore its functional capacities rapidly, in both human and economic terms. Given the risks incurred, but also the potential opportunities, a re-examination of the public policies in this sector would appear necessary, whether in terms of crisis management, essential for the authorities, or the prevention policies given in detail below.

Policies for prevention and vulnerability reduction to such a risk may enable the resilience of the Ile-de-France region to be strengthened, commensurate with its resources and economic advantages. The recommendations in this study address the following three concerns:

- governance of flood risk prevention
- resilience measures for the Ile-de-France region
- financing prevention

## 2. Governance of flood risk prevention of the Seine River in the Ile-de-France region

### *Towards a shared strategy: efficient distribution of roles and responsibilities*

The response to the major risk of a Seine flood in the Ile-de-France region should be based on an appropriate governance framework aiming to organise public policies to improve resilience. Experience in other OECD countries shows that risk management requires co-ordination of a large number of organisations and resources at various administrative levels, within the private sector and civil society. For each of the phases in the risk management cycle, a robust legal and institutional framework together with well-defined governance mechanisms is necessary to enable an integrated approach for risk management. Hence, an effective prevention policy must be based on a clear definition of the obligations of each, supported by incentive and sanction mechanisms to effectively reduce exposure and vulnerability. The key elements of good governance concern the coherence of the legal and regulatory framework and of institutions' mandates to contribute to an established and shared strategy, as well as co-ordination and effective co-operation between the various stakeholders for its implementation. This includes questions of vertical coherence – between the various administrative levels – and horizontal coherence – between the various spheres of public policy – in the distribution of roles and responsibilities, avoiding duplications of effort and favouring synergies.

### *The institutional context has not favoured the emergence of an ambitious and coherent strategy for preventing Seine River floods in Ile-de-France*

Despite a progressive legal body (Acts of 1982, 1995 and 2003) and an exemplary set of regulatory, financial and contractual tools (Risk Prevention Plans, CatNat insurance regime, Prevention Funds, Flood Prevention Action Programmes) for the prevention of risks at the national level, the Seine flood risk in the Ile-de-France region is managed within a fragmented framework resulting from successive waves of decentralisation. This has partially hampered the emergence of a global shared vision on flood risk management despite the risks faced by the region. The lack of an overall vision in this strategic territory – contrary to other major French rivers such as the Loire or the Rhône – reveals a governance weakness, even if awareness of the issues at stake is emerging. The tools developed at a national level in the past struggled to find a practical and effective application in this region with extraordinary issues at stake.

### *The institutional fragmentation has been, in the past, a restraint on action*

With the prospect of establishing a holistic strategic framework for managing the risk of Seine floods, a particularly acute question of governance is raised in Ile-de-France. The institutional and territorial fragmentation in flood prevention results in poor governance particularly among the various administrative levels. As a rule in France, mayors and prefects are solely responsible for managing risks, both with regards to prevention and crisis management. In the case of the Ile-de-France region, its specific nature and resulting institutional characteristics, add another layer of complexity to decision-making. The large number of stakeholders involved whether national, regional, departmental, municipal or metropolitan, makes it difficult to ensure synergies between the various administrative levels.

Apart from questions of multi-level co-ordination, territorial disparities prevent the emergence of a shared vision. Competing views may in fact appear between Paris and its suburbs, the West and the East of the territory at risk, the urban area and the peri-urban and rural areas. Each of these areas has different levels of exposure. Their technical, financial and human capacities to implement public policies independently also vary.

### ***Overcoming administrative fragmentation to facilitate interaction between various public policies***

Beyond questions of horizontal and vertical co-ordination between the various administrative levels, there is also a need to address several areas of public policies which contribute to the various dimensions of flood risk prevention. Each of these policies involves specific stakeholders, different territorial sensibilities, as well as different approaches which may be in conflict or confront each other. Up to now, isolated approaches have often prevailed. The various policies include:

- the risk prevention policy conducted by the Ministry of the Ecology, Sustainable Development and Energy (MEDDE) and its decentralised structures in the Ile-de-France region;
- the crisis management policy of the Ministry of the Interior (and its Prefecture de Police – Paris Defence area), with a large number of stakeholders in the Ile-de-France region;
- the territorial development and planning policy in which the region plays a key role as well as governance at the local level through town planning;
- the water management policy and its institutions, including the Seine-Normandy Water Agency (Agence de l'Eau Seine-Normandie), which plans and finances the conservation of water resources in the Seine basin, and the *Etablissement Public Territorial de Bassin Seine Grands Lacs EPTB-SGL*, an operational stakeholder which historically manages four large dams upstream of the Seine basin with the double objective of combating floods and supporting low water levels.

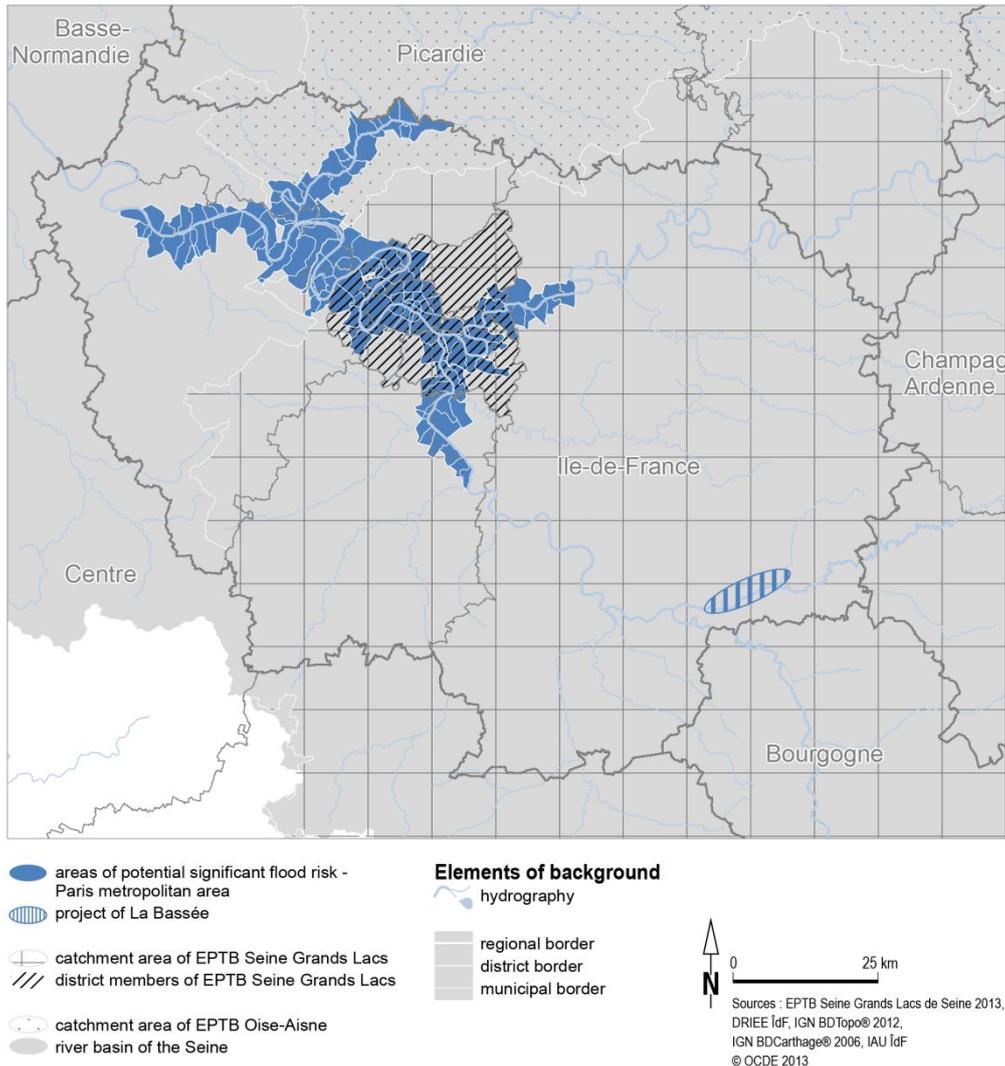
### ***Well-identified governance deficiencies can be overcome...***

The governance of flood risk management and prevention in Ile-de-France appears to be very complex. Because of their dispersion, existing efforts cannot be fully effective. The inadequate distribution of responsibilities and resources among stakeholders at various levels has prevented the emergence of a coherent leadership as well as a common vision with shared objectives for the prevention of flood risk. Strategic planning documents on the Seine basin, on the river development, or on the development of the Ile-de-France region up to now have not allowed for a genuine multi-stakeholder approach or to align the various initiatives on a common strategy for flood risk prevention. Only work undertaken by the General Secretariat of the Defence Area (*Secrétariat Général de la Zone de Defence*) on crisis management has been able to unify metropolitan area stakeholders on the development of an emergency response plan.

The appropriate linkage between the two spatial scales, that of the river basin for work on the hazard side, and that of the metropolitan's exposed area for work on the vulnerability reduction side is a condition for the success of the implementation of effective prevention policies. Furthermore, despite the involvement of a large number of

stakeholders, there is no criterion making it possible to assess the respective contributions of preventive measures undertaken by each. This lack of performance assessment increases the difficulty in efficiently allocating responsibilities and resources for risk prevention. Subsidiarity, local ownership, monitoring and evaluation of the measures undertaken, as well as public engagement and participation in decision-making are the principles of good governance which enable increased responsibility and accountability of the various stakeholders.

**Figure 3. Map of the High Flood Risk Zone of Paris metropolitan area**



***... by seizing opportunities that arise, particularly from the Grand Paris project and the EU Floods Directive***

Today there is an on-going momentum on flood risk management with the implementation of the European Directive on assessing and managing flood risks, for which 2013-2015 is a key period: a national strategy on the management of flood risks is being developed and a priority area for flood risk management in the Ile-de-France region was recently defined. Comprised of 141 municipalities, this High Risk Territory (TRI)

seems to be the appropriate scale to address issues of vulnerability. A flood risk management strategy must be developed by 2015 in this TRI, together with a governance mechanism for its implementation. This is being established through a partnership, under the auspices of the State, between the actors of both prevention and crisis management. Local stakeholders such as EPTB SGL will be associated to this partnership within its area of jurisdiction. Furthermore, a Flood Prevention Action Programme (*Programme d'Action pour la Prévention des Inondations - PAPI*) was also prepared by EPTB SGL and local stakeholders, which anticipate substantial work on the hazard control side and additional actions on the vulnerability of the Ile-de-France urban area.

Opportunities are also arising to incorporate resilience into the Grand Paris development project. This long-term investment project (transport networks, metropolis status, Territorial Development Contract) makes it possible to tackle the issue of flood risk at the scale of the Ile-de-France urban area, and to take major urban projects into account. These opportunities could make it possible to engage the region in an ambitious and long-term resilience approach largely shared with all the stakeholders. Opportunities for the development of the Grand Paris development project in the coming decades can be fully met through a transparent and responsible approach to risk management question.

### Recommendations on governance

1. **Ensure the appropriate linkages between the various levels of flood prevention– from the exposed Ile-de-France metropolis to the river basin.** This will mean engaging a differentiated approach with the stakeholders at local level in the Ile-de-France risk basin, and the upstream territories by means of a partnership from which they will also benefit, and which can also draw on the implementation of the EU Floods Directive. The governance structure envisaged between the State and the local contracting authorities at sub-basin level should be thoroughly explained to the local authorities and benefit from current developments in decentralisation reforms to become well-established locally.
2. **Define an ambitious and mobilising global vision over the long term together with actionable principles.** This global vision should be consistent with the ambitions of the Grand Paris project and will enable public decision-makers and citizens to mobilise beyond the regulatory obligations of the Directive and risk management policy. The principles for action in the national strategy for the management of flood risks may be adapted and formulated at the risk basin level (pooling risks, minimising the moral hazard, proportionality of the charges and benefits, subsidiarity and role of the State, adaptability).
3. **Break-down the global vision into precise objectives and make the stakeholders aware of their responsibilities.** The local strategy's operational objectives and those of the PAPI should be aligned with each other and with this long-term vision. Economies of scale and greater effectiveness may be achieved by redefining the stakeholders' roles and responsibilities, as their numbers and diversity make co-ordination and efficiency more complex. The definition of performance criteria should make it possible to analyse the respective contributions made by the various stakeholders towards flood risk prevention; to monitor the performance of the various initiatives set up; and to establish more rational distributions of responsibilities and resources.
4. **Create effective gateways between the flood risk management strategy and related public policies.** This involves incorporating the risk of floods in a multi-hazard approach with other aspects of resilience for the development of the Grand Paris project (environment, green economy, well-being). This also means ensuring that the various initiatives and sectoral policies (water management, regional planning) actually incorporate the issue of flood risk management with a view to creating synergy and sharing benefits.

### 3. Increasing the resilience of Ile-de-France by flood risk prevention

#### *Structural and non-structural prevention measures*

The only way of reducing the Seine flood risk in the Ile-de-France region is by means of practical measures aimed at increasing the territory's resilience. Even though a re-examined governance will enable a vision to be determined, the objectives and major principles of a flood management strategy and its implementation should take shape at the local level (in the upstream basin, in exposed territories, in public and private planning and development projects, within companies) on two major areas of actions: hazard control and vulnerability reduction. Structural measures aimed at limiting risk exposure by building infrastructure were given priority in the past. Their financial, social and environmental limits are now leading towards risk control approaches that are more aligned with environmental protection. Reduced vulnerability is also achieved through non-structural measures. It is fundamental that the risk knowledge and awareness be developed to create the culture of risk as a condition for action at any level. The territories' increased resilience may be based on a more balanced urban development which incorporates the flood risk appropriately. This includes the question of the critical networks and infrastructures whose vulnerability to floods results in the multiplication of catastrophic effects. On a wider scale, the resilience of firms and individuals should also be developed, for instance through approaches aimed at the business continuity.

#### *Synergies between preventive measures could be optimised through a coherent resilience approach*

A wide range of measures play a role in preventing the risk of a Seine flood in the Ile-de-France region, even if their application is very heterogeneous. Whether these are regulatory or voluntary, set up by the State, the local authorities, citizens or firms, opportunities for improvement and numerous synergies could be better optimised in the following areas: risk awareness and culture, territorial resilience, public services and firms, and the options for reducing hazard through protective measures. This includes, in particular, incorporating resilience in policies on the Grand Paris project development; the link between the river culture and the risk culture; the river bank restoration processes and reinforcement of protective infrastructures; and the closer relation between risk prevention policy and crisis management, or the recovery of the hydro systems' flood buffer functions with a view to protecting the environment. The local flood management strategy being developed in Ile-de-France is an opportunity to organise all the prevention measures and to establish priorities in a coherent approach towards an ambitious resilience plan for the Metropole.

#### *Risk awareness is progressing thanks to harmonising approaches*

Risk awareness is growing and a harmonisation of approaches is on-going so that all the actors in risk prevention will eventually have the information enabling them to act coherently. Up to now, the multiplicity of approaches, tools and standards for assessing risks played their part in causing some confusion, preventing the stakeholders from agreeing on similar results with each of them tending to develop their own evaluation methods. The current process of sharing and harmonising awareness among the actors in risk prevention and crisis management – including network operators – as well as developing an accurate mapping of the risks with the implementation of the European Floods Directive makes it possible to envisage having the tools required to devise and

make a detailed assessment of all the preventive measures. This could be continued with other stakeholders such as the insurance sector, in a consistent comprehensive risk assessment approach, particularly from an economic standpoint. The questions of probability, improved damage functions, and evaluating floods by the groundwater level are all subjects for which knowledge improvements and closer relations would be relevant. Initiatives carried out at national level can contribute in improving this situation particularly by the creation of the National Observatory of Natural Risks (*Observatoire National des Risques Naturels*) together with the insurance sector.

***Reinforcing the risk culture among citizens and decision-makers is essential as the memory of historical floods disappears***

Citizens' and decision-makers' risk perception is very low while vulnerability remains high and even increases in some places. According to all the stakeholders, the level of information and the degree of awareness of a major flood risk for citizens are insufficient in view of the extent of the danger. There has not been any significant flood for almost 60 years and the impacts of low frequency events of 10 to 30 years ago have nearly disappeared thanks to the upstream dam reservoirs. As a consequence, the flood risk tends to fade from collective memory. On the other hand, the collective insurance cover provided by the Cat-Nat insurance regime, while presenting many advantages, can create a moral hazard by giving citizens, firms, and decision-makers the impression that, come what may, they will be compensated for their damage: this does not lead to increased risk awareness or to initiative to try to set up preventive measures. A voluntary approach to raising awareness in Ile-de-France is necessary to develop a risk culture.

***The effectiveness of risk communication is limited while awareness is slowly increasing in the private sector***

The development of a flood risk culture seems to be a subject that many actors support in view of the many initiatives identified in this area. French risk regulations make procedures to inform or consult the stakeholders mandatory. However, they do not institute quantified objectives for risk awareness. Their effectiveness and their implementation are quite low and variable depending on the various local authorities' level of commitment. At the same time, innovative approaches, which are not regulatory for raising citizens' awareness carried out by actors which are not responsible for these subjects have met with a good response from the population (exhibitions, work in schools, 3D films). The strengthening of the river culture and its appropriation is also a good way of raising risk awareness. It is difficult to have an overall view and to know the impact of all these measures when there is no precise assessment. Overall, it would appear that the public decision-makers' failure to communicate on the subject is a major factor limiting the development of a culture of risk. This reveals a low awareness of the risk since flooding continues to be considered unlikely.

In recent years, awareness has increased in companies but is still variable. Large companies in a certain number of sectors (energy, transport, water, telecommunications, banking) became aware of this risk through their participation in work on crisis management, through the regulation on business continuity for vital sectors or through local initiatives run by the business districts of the Chamber of Commerce. Once businesses become aware of the issue they demand access to accurate information on the risk, both with regard to the precise water levels and the interruption of critical networks. On the other hand, smaller companies or other sectors have only a very limited awareness

of the risk. There are very few actions intended for them in this field, as well as toward essential stakeholders for resilience development such as those in engineering, urban planning or architecture. Ultimately, the differences in the degree of awareness and commitment between the various sectors and the various stakeholders hamper the development of a genuinely shared culture of safety.

### ***Control of urban development in the floodplain comes up against limited regulatory tools***

With regard to a territory's resilience, risk prevention policies based on controlling urban development have only limited resources in view of the underlying economic issues at stake. The stakeholders' sharing of responsibilities on the planning of land use prevents a coherent management of the risk. The local development approach does not encourage municipalities to limit building in the floodplain but rather to develop these often very attractive areas. In this context where the fabric of the urban areas does not put the flood issue to the forefront of its planning process and does not set any objectives, public decision-makers and planners are ultimately content to live with the regulatory aspects, particularly through the Flood Risk Prevention Plans (PPRI). These documents negotiated by the State and the local activities only determine a few non-constructible zones, they are not standardised across the different departments of the risk basin, they do not impose specific regulations to network operators and they are not restrictive with regard to existing constructions, which are predominant in the Ile-de-France area. In this way, during the past 20 years, 1500 hectares as well as some major infrastructures were built in the floodplain.

### ***Urban planning and innovation policies could use the Grand Paris project as an opportunity to boost resilience***

The Grand Paris project includes urban densification and the development of a major transport network by 2030. In this context of a densely populated urban area, this unifying project offers opportunities: a flood-resilient city may emerge from innovative urban projects built all along the Seine. Examples in other OECD countries show that resilience can be the source of innovation and, in this way, participate in green growth. Certain initiatives proved that it is possible to build an urban environment with infrastructures resilient to floods or to improve existing constructions when a strong political will and sustainable governance structure carry this ambition. Resilience to floods is at the heart of the project for the urban renewal of the Ardoines district, severely exposed to this risk. Located in the area of the Orly-Rungis-Seine-Amont Development Agency (*Établissement Public d'Aménagement Orly-Rungis-Seine-Amont*), this project is directly managed by the State and may serve as an ambitious demonstration of resilience innovations. Similarly, the initiatives around green and blue corridors in the Ile-de-France region may incorporate flood prevention even more.

### ***Investment in improving the resilience of the critical networks and infrastructures will be key to ensure resilience for the whole metropolitan area***

A particular theme to be taken into account concerns the urban networks and the critical operators which structure the region and enable it to function (electricity, water, telecommunications, and transport). Investment in infrastructures planned for the next 30 years could be used to improve the networks' resilience. There is however a great heterogeneity between the various operators in terms of risk assessment and preparedness

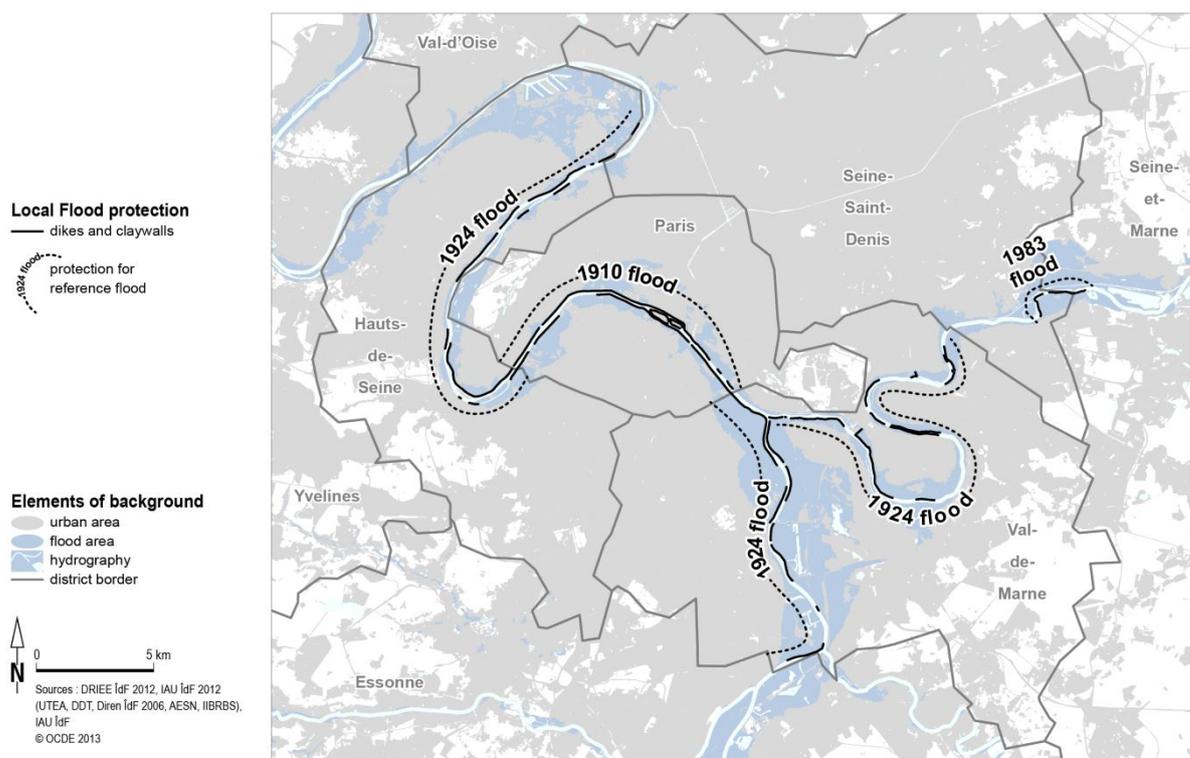
levels to the risk of a major flood. Despite the existing regulatory or contractual context, it appears that the requirements for rapid business recovery are not sufficiently high in the event of a major flood. Work on crisis management contributed to raising the operators' awareness, to persuade them to assess their vulnerability, and the cascading effects they could create for other business sectors. Nevertheless, there are still great differences in their levels of awareness, preparation and resilience to risk. Some have a precise assessment of the impact of the various flood scenarios, developed Business Continuity Plans (PCA) and sometimes invested significantly to reduce their vulnerability (including relocation). Others, however, make few efforts or even are reluctant to share their information which could be useful for everyone's preparedness. There is no precise standard or overall harmonisation which would determine the resilience and protection levels required and would measure them with predetermined indicators.

***Efforts undertaken to increase the resilience and improve public services and business continuity seem limited***

With regard to companies and public services, the development of business continuity and investment in prevention is in its early stages. To ensure the State's continuity, plans must be developed by all ministries. On the other hand, resilience processes in local authorities and particularly the municipalities are limited: less than 40% of the municipalities concerned have developed a continuity plan and little work on reducing vulnerability has been undertaken. Under these conditions, in the event of a flood, it is uncertain that a large number of public services will continue to function. The private sector, particularly large companies, is increasingly encouraged by the markets to take into account its risk exposure, the possible effect on the business plan and the measures likely to reduce the risk. The commitment made by companies in the private sector to improve their own resilience seems to be related to their size or to their sector. While some of the large companies have already developed or are currently developing their own prevention and flood risk strategies in accordance with the regulatory framework and the regulation authorities (banks, telecommunications), overall, SMEs are still vulnerable and ill-prepared.

***The levels of protection against floods are not harmonised at the scale of the Paris urban area***

The difference between the levels of protection provided by dykes and clay walls, the levels of maintenance and the levels of investment between the centre and the outskirts of the urban area do not ensure uniform protection for the citizens of Ile-de-France, reflecting the historic layers which no longer correspond to today's urban and industrial density. Recent efforts to analyse their vulnerability under the auspices of the State should be emphasised as well as the reinforcement work carried out in some places, in a somewhat fragmented approach due to separate contracting authorities. Contrary to other OECD countries, the lack of any predefined standard level of protection accentuates the negative effects of the lack of any overall management approach for these protections and does not enable the level of investment required to be determined.

**Figure 4: Location of dykes and claywalls in Ile-de-France**

### ***Hazard control depends on the effective management of the upstream multiple-use reservoir-lakes***

The hazard is also managed by four reservoir-lakes built upstream of the basin in the past. With a storage capacity of 800 million m<sup>3</sup>, these big dams can together lower the water level by 70 cm in Paris and reduce direct damage by half. They are run by the *EPTB Seine Grands Lacs* whose missions are gradually being extended to other aspects of integrated water resources management. Since their construction, without any major flood, the functions of these reservoir-lakes became somewhat focussed on other uses (low-flow support, leisure activities). The establishment of a new fee collected for the low-flow support service to the major water users which will contribute to the EPTB budget also strengthens this part of its mandate. The optimisation of the management of existing reservoirs with respect to the different uses represents a key issue which should be regularly discussed, particularly in the context of climate change.

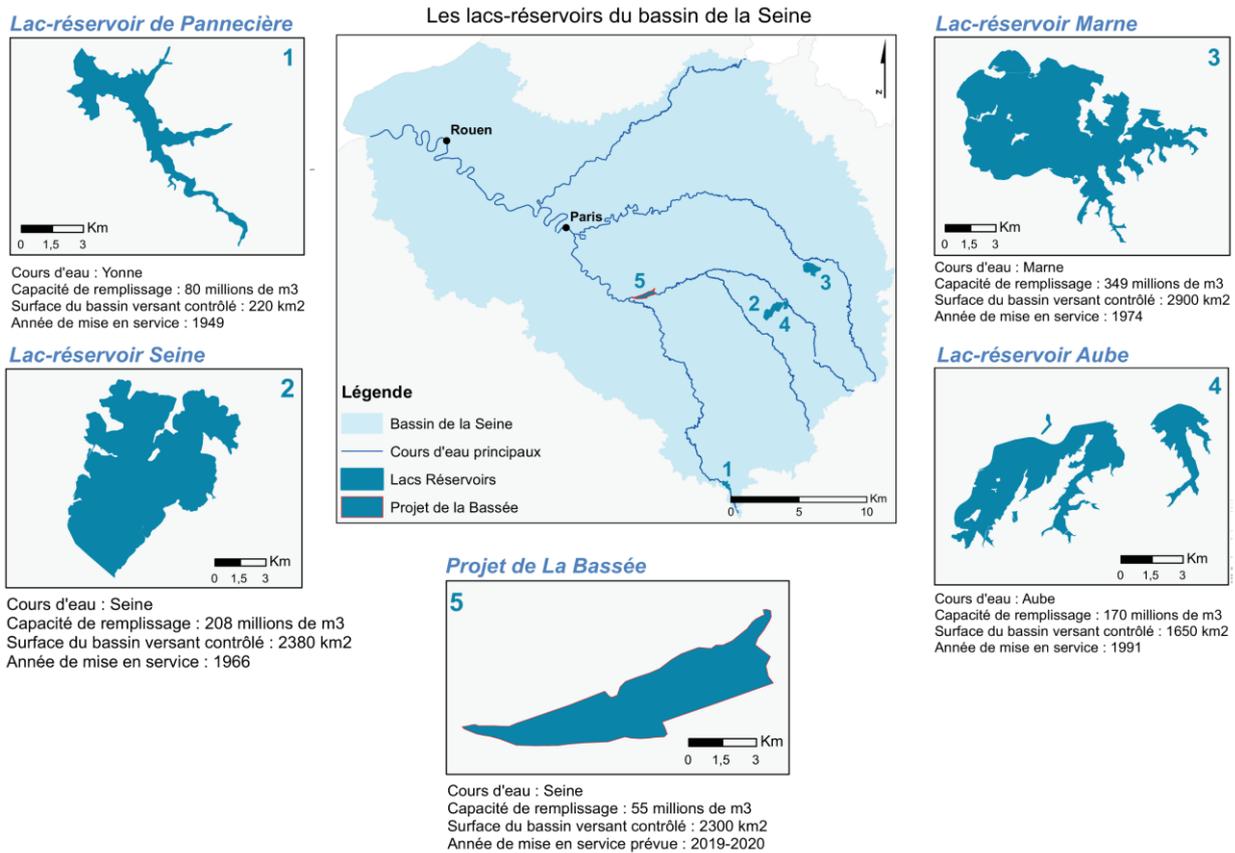
### ***The issues of an innovative but costly new infrastructure in La Bassée***

A new hazard reduction project has now emerged, the La Bassée project, which raises questions on the funding of and priorities in hazard control actions and governance. This project's innovative approach consists in pumping water from the Seine before it is joined by the tumultuous Yonne River, into storage basins installed along the river. The project was developed with a state-of-the-art approach, including the consultation of local populations upstream through a large and transparent public debate, the incorporation of multiple uses in its design (restoration of wetlands, eco-tourism, economic activities), a positive cost-benefit analysis and a multi-criteria analysis. However, this project must still

demonstrate its operational utility and respond to some key questions related to the definition of its operational rules and the related decision-making in times of crisis, in order to better justify its cost-effectiveness. The idea to realise this project in stages seems interesting insofar as each stage will enable experimentation to test the structure to reduce the water level in the event of a major flood.

Apart from this potentially large-scale project, other hazard reduction options have also been identified, such as renovating the Joinville-Le-Pont bypass valve, which would protect a large number of the inhabitants at a low cost, the optimisation of existing infrastructures or the ecological restoration of the basin heads. The same applies for the dykes and clay walls, a comparison of all these projects in terms of costs and benefits has not been made due to the fact that each of these subjects has a different contracting authority, to the detriment of a comprehensive and genuinely efficient approach. Together, the establishment of the local flood management strategy and the Flood Prevention Action Programme (PAPI) project supported by the *EPTB Seine Grands Lacs* are an opportunity to make a reasoned and transparent choice *vis-à-vis* all the stakeholders between the various options.

**Figure 5: The dam-reservoirs on the Seine basin**



Source: CCR, 2013

### Recommendations on the resilience measures

5. **Continue to improve and harmonise risk knowledge and ensure that risk information is made available.** The collaboration between the prevention and crisis management stakeholders could be extended to other actors such as the insurance sector, in a coherent global risk assessment approach, particularly from an economic point of view. All information concerning the risks could be centralised whilst abiding to demands of confidentiality, security and competition. This could go hand in hand with the provision of modelling tools and related data according to needs, taking inspiration from the risk observatory established at the national level.
6. **Reinforce the risk culture of citizens, decision-makers and companies.** New communication approaches stressing the positive benefits of greater resilience, must aim at increasing risk awareness at all levels. Regular information, based on the best available knowledge and to the benefit of a common strategy could accompany the local flood risk management strategy. This communication strategy should use new technologies (3D imaging, virtual animation, social networks) for specific targets (companies, citizens, decision-makers, developers and architects) and its results be regularly assessed through regular surveys on risk perception.
7. **Improve territorial resilience, using the opportunities offered by the Grand Paris project.** The definition of a level of resilience for the Grand Paris project, particularly through the local Territorial Development Contracts could allow model resilient districts to emerge such as *Les Ardoines*. The harmonisation and reinforcement of the Risk Prevention Plans at regional level will enable resilience to be improved towards this predefined level in the long term: these plans should use the latest risk assessments as a basis and their control should be improved. Incentives aiming to reduce the vulnerability of existing constructions could also be envisaged, by using opportunities such as the replacement of electricity metres.
8. **Gradually improve the resilience level of critical networks and take steps towards preserving the continuity of business and public services.** A predefined level of resilience should also be gradually applied to the networks operators to reinforce requirements. New infrastructures, particularly transport, should aim at the greatest resilience to floods. Establishing requirement levels and controlling them may become the responsibility of the sectoral regulator. A mechanism supporting companies in their business continuity approach, and particularly the SMEs, could also be developed, for instance the establishment of a risk-diagnosis service, of a dedicated label or the development of risk awareness guides.
9. **Place the flood protection infrastructures under the responsibility of a single contracting authority** in charge of applying a pre-defined safety standard, based on a common cost/benefit approach, under an appropriate institutional structure. The management and organisation of the maintenance, replacement and work requirements could also be assessed in accordance with common criteria and in comparison with potential new infrastructures. The feasibility of harmonising the protection levels for the whole urban area should be assessed by planning the work over time giving priority to the most beneficial measures.
10. **Encourage experimentation with regard to the La Bassée storage project.** Rolling out the La Bassée project stage by stage should make it possible to adapt the approach through a process of learning by practice and to demonstrate its operational utility, beyond the theoretical cost-benefit studies. The question of the governance of such a structure should also be raised beforehand, particularly regarding decision-making in a time of crisis to guarantee its effectiveness.

#### 4. Financing flood resilience in Ile-de-France

##### ***How to finance resilience within a constrained budget context?***

Funding the preventive actions required to increase the level of resilience remains a major issue. Within a context marked by under-investment in the past, and current difficult economic conditions, investment in prevention is made under pressure, in view of the tight fiscal environment and the necessity to decide priorities in public spending, by both the State and the local authorities. In the Ile-de-France region, as often elsewhere, decisions to undertake and to fund prevention are dependent on the economic context or the triggering role of recent events. The lack of any significant flood event for almost 60 years tends to reduce awareness and does not motivate stakeholders to structure a financial approach to prevention challenges. The differences in the risk levels and the intensity of prevention efforts between the different exposed areas of *Ile-de-France* make it difficult to fund infrastructures which would be of greater benefit to some rather than others. This can lead to a lack of action to enable a collective resilience surplus to be funded. The allocation of prevention resources is a challenge which requires demonstrating that public funds are used as efficiently as possible.

##### ***Tools for financing flood risk prevention exist, particularly through insurance***

For 30 years now, France has engaged significant flood risk prevention efforts. A series of innovative tools has been set up with related funding mechanisms. Funding flood prevention is generally based on solidarity mechanisms. In addition to national budget resources, France has established an original collective insurance mechanism, the CatNat insurance regime, based on a public-private partnership between insurance companies and the State and on the solidarity principle – among all the insured – against the risks of natural catastrophes. This system also makes it possible to make a large contribution to risk prevention funding, particularly for flood risks, without a direct impact on public finances. At the same time, this is the most frequent and the most damaging natural disaster in France. Nevertheless, this system is faced with growing demands.

Additional resources come from the local authorities, which are generally mobilised through contractual tools with the State such as the Large River Plans (*Plans Grands Fleuves*) and the Flood Prevention Action Programmes (PAPI) or to fund the Basin organisation such as the EPTB Grands Lacs de Seine which manages the upstream reservoir-lakes. Other sources of finance can also be used for prevention, such as those linked to the wider water policy with the water agencies, the network operators and companies which could invest in their own resilience, or the European Union, particularly to implement the Floods Directive.

##### ***The financing of flood prevention in Ile-de-France has benefited from limited existing resources***

With annual average damage from the Seine flood risk equivalent to one quarter to one third of annual average damage caused by floods in France -1 to 1.4 billion euros – it would seem relevant to envisage the prevention efforts should match this level of risk. Expenditures on flood prevention in France may be assessed at between 300 and 450 million euros, or about one third of the estimated damage. Such a level of investment in prevention may be considered satisfactory in view of the public expenditure effectiveness

criteria, if it is ensured that these funds are allocated as a priority towards preventive measures which have the greatest benefits. Although important investments had allowed the upstream reservoir dams to be built in the past, it appears that the instruments for funding prevention have played a very small part in reducing the vulnerability of the Ile-de-France in the last 20 years, compared with other regions or river basins. Other strategic priorities, in particular measures to protect human lives, have mobilised authorities and the available prevention funds. This led to a certain delay in funding the prevention of this major flood risk, as the Seine floods would have limited casualties. Up to now, the national allocation of resources has not been based on criteria giving priority to resources according to the level of risk. This is changing with the implementation of the EU Floods Directive which identified territories at risk of substantial flooding, of which the Paris metropolitan area is one.

***The development of a financing strategy may be based on principles aligned with improved governance***

There is room for progress in defining a financing approach for prevention which is adapted to the issues at hand. In the context of strained public finances, the question of additional resources and the sharing of efforts (State, local government, businesses, citizens, European funds) may be addressed by setting out a number of principles for an overall financing strategy. Improved governance of risk management could help define a level of risk as a shared objective upon which a financial approach could be developed. The general principle is that the beneficiaries of prevention measures should be the first to finance prevention. Identification of the beneficiaries helps to determine the primary sources of funding to be raised for such a strategy. Prevention funding must aim at being most effective through an economic approach based on:

- **Coherence:** the heterogeneity of the different stakeholders' preventive approaches results in duplicated actions and extra costs, as well as uncooperative behaviour – “free-rider” -, and distortions of competition and levels of service.
- **Economic efficiency :** a generalisation of costs-benefits studies and multi-criteria analysis, apart from judging the relevance of a specific project, could enable a comparison to be made of the various options available and their benefits, including non-structural measures
- **Long term:** long-term investment planning makes it possible to introduce flexibility in choices, to take into account the evolution of knowledge and to reduce uncertainties so as to adjust resources in accordance with needs.
- **Equity:** this question arises both regarding the strategic allocation of national resources for this territory exposed to significant risk, as well as within the Ile-de-France region, in view of the differences between the levels of protection.

***Existing resources and additional resources***

A large number of existing financial mechanisms may be further mobilised to prevent this major risk. Adopting a multi-hazard approach (flood, drought, pandemic, terrorism) can provide access to the funding of the water policy or the management of risks in the wider sense. A long-term approach in relation to the Grand Paris regional development project also opens up avenues. Many European systems also provide funds

for risk prevention and this ought to be explored. Several potential sources of additional finance could be mobilised as well. A certain number of actors in the private sector would be prepared to provide resources if they are shown that their contribution to investing in prevention could significantly reduce their level of exposure to the risk. Existing taxes on added-value real estate in the flood zone, local taxes or those on the tourist sector could also be explored as sources of funds. New resources in the form of service fees established for low-flow support by the EPTB-Seine Grands Lacs could also inspire a similar system benefiting flood protection, particularly for network operators.

#### Recommendations for financing prevention

11. **Support the local of Seine flood risks management strategy in the Ile-de-France by a clear financial strategy**, taking into consideration national specificities. This could focus on the following elements: sustainability and long-term vision; principles of responsibility and proportionality among the beneficiaries of the measures taken and the financiers; exploring the best effectiveness and considerations of equity in resource allocation; synergies with the other sectoral strategies (drought, water, development, crisis management).
12. **Mobilise all the beneficiaries of preventive measures in a multi-level approach** which would combine local government authorities and State funding, as well as the various network operators, the private sector and citizens by targeted incentives. Additional funding could come from positive incentive mechanisms in existing taxation raising systems, particularly by bringing together the insurance, real estate and water management sectors.
13. **Strengthen efforts to clarify the priority criteria for prevention funding from State resources**. This can also consider the possibility of European funding which can be mobilised for implementing the European Floods Directive in high flood risk areas such as the Ile-de-France region.
14. **To re-examine the impact of the CatNat insurance regime on flood risk prevention**. The bill aiming at reducing the system's dis-incentivising effect could be revived, which would be an opportunity for a wider reflection on funding prevention.



OECD Reviews of Risk Management Policies

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