

**PUBLIC GOVERNANCE AND TERRITORIAL DEVELOPMENT DIRECTORATE
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High Level Risk Forum

**SEINE FLOOD RISK PREVENTION IN THE ILE-DE-FRANCE REGION
MAIN RESULTS AND RECOMMENDATIONS**

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This document presents the main results and recommendations in the OECD peer review study on flood risk management on the Seine basin in the Ile-de-France region.

Delegates are invited to COMMENT on the report and its findings and APPROVE in principle its results and recommendations.

Charles Baubion, tel: +33 1 45 24 13 78, email: charles.baubion@oecd.org

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**SEINE FLOOD RISK PREVENTION IN THE ILE-DE-FRANCE REGION
MAIN RESULTS AND RECOMMENDATIONS**

NOTE BY THE SECRETARIAT

1. This document is a synthesis of the results of the OECD peer review study on prevention of flood risk of the Seine River in the Ile-de-France region. Through an innovative approach, it includes a dynamic assessment of the economic impact of a major flood of the Seine in Ile-de-France as well as an analysis of prevention policies associated to this risk. The recommendations proposed by this study address three main topics:

- Governance for risk prevention
- Measures aiming at increasing the resilience of Ile-de-France
- The financing of prevention

2. This report builds on broad engagement with French stakeholders in flood risk management of the Seine in the Ile-de-France region. A detailed questionnaire was sent to 200 stakeholders, requesting information on flood risk management policies. The OECD analysed the information collected, which served as a basis to identify the key public policy issues related to flood risk prevention in the Seine basin in the Ile-de-France region. An expert team conducted interviews with stakeholders from 27 to 31 May 2013. The expert team was composed of Prof Richard Ashley from the United Kingdom, Mr Ingwer De Boer from the Netherlands and Prof Michael Faber from Denmark, as well as the OECD Secretariat. Preliminary results were discussed during a policy dialogue held on 17 September 2013 at the OECD, gathering a large number of the participating stakeholders.

3. The economic impact study was conducted in partnership with the OECD Economics Department. It encompasses previous modelling work as well as information collected from the different French stakeholders and critical network operators. Preliminary results and the methodology were discussed with French experts on the 17 October 2013.

4. Delegates are invited to:

- COMMENT on the report and its findings in light of the experiences of the countries and partners in the following areas:
 - Governance for risk prevention
 - The proper mix of structural and non-structural measures to increase resilience
 - Financing prevention
- APPROVE in principle the results and the recommendations of the report

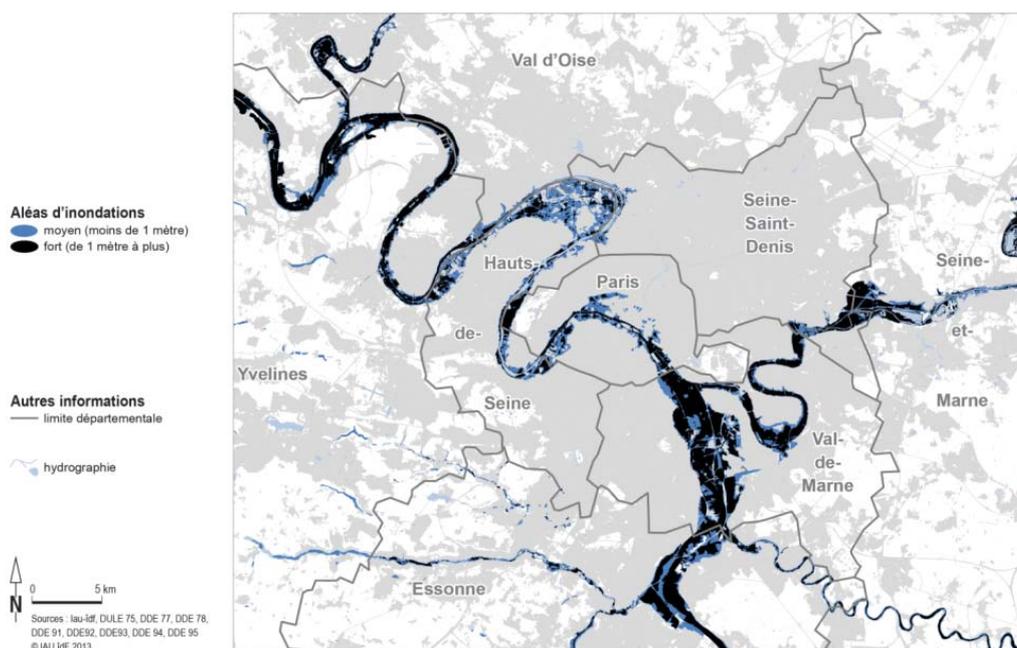
IMPACTS OF A MAJOR SEINE FLOOD IN THE ILE-DE-FRANCE REGION

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

5. While the possibility of a major flood of the Seine river may initially seem to be remote, it comes back periodically to attract attention: hence, in the spring of 2013, floods upstream of the Seine basin aroused awareness in this regard. Even though it did not cause any major damage, nevertheless, this flood reopened the question of risk management and the region's vulnerability to flooding. The prospect of a historic event is a key concern for the 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 managing the increased vulnerabilities of the society and many economic sectors.

6. 1924 and 1955 also saw important flood events in Paris area and the overall Seine basin. However, the lack of a significant flood event for more than 60 years tends to reduce the memory of risk.. 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 recently, many floods significantly exceeded the 100-year levels. This was the case with the floods in Queensland in Australia, in Bangkok in Thailand, in Pakistan, during the coastal floods following hurricane Sandy in New-York, and the 2013 floods in Germany. The European flood directive being implemented takes the 1000-year frequency as a reference for extreme events. Seine floods are characterised by their slow progress and, following on a period of submersion which may be very long. For instance, the waters took almost two months to subside in 1910

Figure 1. Map of the floodplain



Source: IAU Ile-de-France

Table 1. Return period for recent major floods

Country or city	Year	Flooded river	Return period
Prague	2002	Vlatva	500 years ¹
United Kingdom	2007	Severn	200 years ²
Pakistan	2010	Indus	>> 100 years ³
Brisbane	2011	Brisbane	120 years ⁴
Bangkok	2011	Chao Phraya	> 100 years ⁵
New-York	2012	Floods linked to Sandy	400-800 years ⁶
Germany	2013	Danube, Elbe	50-500 years ⁷

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. 7. Delft University of Technology, 2013

Despite protection, the increasing urban development and interdependence of critical infrastructures have accentuated the vulnerability

7. Since then, the risk of a Seine flood in the Ile-de-France region, on the one hand, has been reduced by protective structures, dams built upstream and river development, in various stages, starting in the 1920s, then in the 1950s and more recently. On the other hand, the exposure to the risk and the resulting vulnerability were at the same time accentuated by increasing urban density in the leading French economic basin as well as by the construction of a large number of business areas and critical infrastructures (transport, energy, communications, water) all along the river and in other exposed areas. The interdependence of these networks, the interpenetration of production lines and their just-in-time operation, the key role played by the mobility of persons and exchanges in the dynamism of the economy, urban development and the concentration of populations and capital are just so many factors of modern societies' increased vulnerability to shocks (OECD, 2011). Today, these elements vindicate the extent of the assessment approach in this field to have public policies re-examined.

Table 2. Levels and standards of protection in major cities in the OECD

Ville	Protection level	Protected area	Date of implementation
Paris urban area	100 years	Paris	Existing
	30-50 years	Paris suburbs	
Frankfurt	200 years	New districts & critical infrastructures	Existing
	100 years	Urban area	
London ²	1 000 years	Coastal areas	Existing
	10 000 years		Objective 2100
New York ³	100 years	Coastal areas	Project 2020
Netherlands ⁴	1 250 years	River areas	Existing
	4 000 years	Coastal areas with small population	Existing
	10 000 years	Areas below sea level	Existing
Oslo ⁵	100 years	Residential buildings	Standard national
	200 years	Industry and critical infrastructures	
Tokyo ⁶	200 years	River and coastal areas	Current project
Köln ⁷	100 years	River areas	Existing
	200 years	Particularly critical areas	
Vienna	10 000 years	River areas	Existing
Bratislava ⁹	1 000 years	River areas	Existing

Source: 1. Hessisches Ministerium für Umwelt, ländlichen Raum und Verbraucherschutz, 2007; 2.Environment Agency, 2012. 3. New York City Special Initiative for Rebuilding and Resiliency, 2013. 4. Rijkswaterstaat (Ministère de l'Infrastructure et de l'Environnement), 2012. 5. Norwegian Water Resources and Energy Directorate, 2009. 6. Cooper Chris et Kiyotaka Matsuda, 2013. 7. World Bank, 2012b. 8. A. Kryżanowski, M. Brilly, S. Rusjan, and S. Schnabl, 2013. 9. A. Kryżanowski, M. Brilly, S. Rusjan, and S. Schnabl, 2013.

Significant potential impacts of a major Seine flood today

8. The Ile-de-France region represents about one third of 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 would have direct and indirect impacts on almost 5 million people and a large number of companies, with significant economic, human and social effects. Electricity distribution would be substantially affected with almost one quarter of power sub-station 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 out of 250 km of the 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 subscribers could suffer extended water cuts and 1.3 million a deterioration in quality.

9. 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 matter of public policy.

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

10. 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 (Box 1). They would then come under severe pressure, and may suffer corresponding deterioration over a long period. The damage from such a catastrophe has been estimated at from 3 to 30 billion euros for direct damage according to flood scenarios, together with a significant reduction in GDP which, over five years, would reach 1.5 to 58.5 billion euros, i.e. a consolidated total of 0.1 to 3%. The reduction in companies' business as a result of the flood would have a significant effect on the demand for labour; up to 400,000 jobs could be lost in the extreme case. Even if the rebound in business could rapidly reduce some of these effects after a year, the harmful consequences of a major Seine flood could be felt over the long term and weigh on public finances. In the case where the impact exceeds the reserve available to cope with it through the national catastrophe compensation system CAT-NAT and the Central Reinsurance Fund (*Caisse Centrale de Réassurance - CCR*), the State would be called on to fully play its role of ultimate guarantor.

11. Even if these effects are significant, it should be emphasised that the analysis is an exploratory one, and that it does not however mean a systemic risk with irreversible effects: a variety of budgetary response mechanisms could be set up – rapidly if they are anticipated and planned in advance. Some of the consequences would be alleviated by social safety nets and shock absorbers. Nevertheless, there is considerable uncertainty and the effect could also be accentuated by the impact of the flood on the rest of the Seine basin.

Box 1. 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 two problems to be examined: 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. 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 geodistributed 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 the 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. In view of the weight of the Ile-de-France region in the French economy (30% of GDP in 2011), 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 the Ile-de-France in the long term

12. In light of these issues, such a situation is in no way inevitable: an effort to recalibrate, better coordination, and refocusing public policies would enable the consequences of the risk to be decreased and resilience to be increased. Apart from longstanding investments made over the century, additional anticipation and investment efforts may enable the risk to be managed better and contained. 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. In view of the risks incurred, and 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.

13. Policies for the 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 three concerns:

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

RISK GOVERNANCE FOR THE PREVENTION OF THE SEINE FLOOD IN ILE-DE-FRANCE

Towards a shared strategy: distributing efficiently roles and responsibilities

14. 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 at organising public policies to improve resilience. Experience in other OECD countries shows that risk management requires a large number of organisations and resources to be co-ordinated at various administrative levels, with 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 everyone's obligations supported by incentive and sanction mechanisms to effectively reduce exposure and vulnerability. In terms of governance, the key points concern the coherence of the legal and regulatory framework and the institutions' mandate to the benefit of 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 consistency – between the various administrative levels – and horizontal – between the various spheres of public policy – in the distribution of roles and responsibility by avoiding duplications of effort and favouring synergies.

The institutional context did not facilitate the emergence of an ambitious and coherent strategy for preventing Seine floods in Ile-de-France

15. Despite an advanced legal body (Acts of 1982, 1995 and 2003) and an exemplary set of regulatory, financial and contractual tools (Risk Prevention Plans, CAT-NAT insurance system, 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 following successive waves of decentralisation. This partially hampered the emergence of encouraging signs, despite the risks faced by the region. The lack of any overall strategic vision for risk management in this strategic territory – contrary to other major French rivers such as the Loire or the Rhône – reveals a governance weakness in view of the issues at stake, even if awareness is currently starting to appear. The tools developed on a national level in the past struggled to find a practical and effective application in this territory with extraordinary issues at stake.

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

16. 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 the area of flood prevention creates poor governance particularly among the various administrative levels. As a rule, in France, Mayor and the Prefect of the department are solely responsible for managing risks, both for prevention or crisis management. In the case of the Ile-de-France region, its specific nature of the capital's region and the resulting institutional characteristics, adds another complexity in decision-making. The large number of stakeholders involved whether nationally, in the river basin, the region, the departments, the municipalities or the metropolitan area makes it difficult to manage the interdependencies between the various levels.

17. Apart from the 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 at their level independently of a certain territorial solidarity also vary.

Overcoming administrative fragmentation to facilitate interaction between various public policies

18. Beyond these 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 scales, as well as logics which may be in conflict or confront each other. Up to now, isolated logics 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 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 the governance at the local level through town planning,
- the water management policy with its financial stakeholder, the Seine-Normandy Water Agency (*Agence de l'Eau Seine-Normandie*), which collects taxes on water and finances projects and infrastructures aiming at preserving water resources in the Seine basin, and its operational stakeholder, the Basin Organisation Seine Grands Lacs (*Etablissement Public Territorial de Bassin Seine Grands Lacs EPTB-SGL*), which historically manages four large dams upstream of the Seine basin with combating floods and supporting low flows as its objectives.

Well-identified governance deficiencies may be overcome...

19. Ultimately, the governance of flood risk management and prevention appears to be complex and lacks coherence. The risk is one of dispersion, and that efforts, which nevertheless have been made, cannot be fully effective. The imperfect distribution of responsibilities and resources among stakeholders at various levels prevented the emergence of a related leadership as well as a common view with shared objectives for flood risk prevention. The strategic planning documents on the Seine basin, the river development, or the development of the Ile-de-France region up to now have not been capable of organising a genuine multi-stakeholder approach or aligning 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 was capable of unifying the stakeholders of the metropolitan area on the development of the emergency response plan.

20. 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 will be one of the conditions 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 allocating responsibilities and resources for risk prevention efficiently. Subsidiarity, local ownership, monitoring and evaluation of the measures undertaken, as well as the information of the public and its participation in decision-making are the principles of good governance which enable increased responsibility and accountability of the various stakeholders.

... by seizing opportunities that arise, particularly from the European flood directive and the Grand Paris project.

21. Today there is dynamic in progress on the implementation of the European Directive on assessing and managing flood risks. The 2013-2015 period is a key one for implementing the directive: a national strategy on the management of flood risks is being developed and a priority territory for flood risk management in the Ile-de-France region was determined recently. Comprising 141 municipalities, this Paris urban area High Risk Territory (TRI) seems to be the appropriate scale to address the issues of vulnerability. A flood risk management strategy must be developed by 2015 in this TRI, together with governance for its implementation. This is being established through a partnership, taking shape under the auspices of the State, between the actors in prevention and crisis management, with which local stakeholders such as EPTB SGL will be associated within its area of jurisdiction. Furthermore, a Flood Prevention Action Programme (*Programme d'Action pour la Prévention des Inondations - PAPI*) for this major risk was also developed 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.

22. Opportunities also arise 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 envisage this question of flood risk on 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 actors in the territory. Opportunities for the development of the Grand Paris in the coming decades will be fully realised through a transparent and assumed approach on the question of risks.

Box 2. Recommendations on governance

1. **To ensure the appropriate linkages between the various scales – from the exposed Ile-de-France metropolis to the river basin – when implementing the flood directive.** This will mean engaging in a differentiated logic both the stakeholders at local level in the risk basin in the Ile-de-France and the upstream territories by means of a specific partnership from which they will also benefit. 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. **To define an ambitious and mobilising vision over the long term together with actionable principles.** A long-term vision will 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 the policy on risk management. The principles for action in the national strategy for the management of flood risks may be adapted and stated 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. **To break down this vision into precise objectives and to 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, which seem too many to be genuinely effective. The definition of performance criteria should make it possible to analyse the respective contributions made by the various stakeholders towards flood risk prevention and to monitor the performance of the various initiatives set up, to establish more rational distributions of responsibilities and resources.
4. **To create effective gateways between the flood risk management strategy and related public policies.** This involves incorporating the question of floods in a multi-hazard approach incorporating other aspects of the resilience for the development of the Grand Paris (environment, green economy, well-being). On the other hand, it means ensuring that the various initiatives and sectoral policies (water management, regional planning) actually incorporating the issue of flood risk management with a view to synergy and sharing benefits.

INCREASING RESILIENCE OF ILE-DE-FRANCE BY FLOOD RISK PREVENTION

Structural and non-structural prevention measures

23. 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 local level, in the river basin, in exposed territories, in planning and development projects, within companies on two major types of actions: hazard control and vulnerability reduction. Structural measures aimed at limiting exposure by means of engineering works were given priority in the past. Their financial, social and environmental limits lead to risk control approaches being more aligned with environmental protection. Reduced vulnerability will also be 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 whatsoever. 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 effects of a catastrophe being multiplied. On a wider scale, the resilience of firms and individuals should also be developed, for instance through approaches aimed at business continuity.

Synergies between preventive measures could be better used through a coherent resilience approach

24. A wide range of measures play their part in preventing the risk of a Seine flood in the Ile-de-France region, even if their application is very heterogeneous. Whether they are regulatory or voluntary, set up by the State, the local authorities, citizens or firms, opportunities for improvement and numerous synergies could be better used, both on risk awareness and culture, resilience of the territories, public services and firms, and the options for reducing the hazard through protective measures. This particularly includes incorporating resilience in policies on the Grand Paris development, the link between the river culture and the risk culture, the processes of the river banks restorations and reinforcing the protective infrastructures, 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 for the capital.

Risk knowledge is progressing thanks to harmonising approaches

25. 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 Flood 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 the economic standpoint. The questions of probability, improved damage functions, taking into account floods by the groundwater going back through the subsoil are all subjects for which improvements and closer relations would be relevant. Initiatives carried out at national level could play their part 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 while the memory of historical floods disappears

26. The citizens' and decision-makers' risk perception is very low while vulnerability remains high. 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 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 system, 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 try to set up preventive measures. A voluntary approach to raising awareness in Ile-de-France is necessary to develop the risk culture.

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

27. The development of the 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, it does 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 the risk culture. This reveals a limited awareness of the risk since flooding continues to be considered unlikely.

28. 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 they had become aware, a strong demand came from companies on access to precise 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 hamper the development of a genuinely shared safety culture.

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

29. With regard to the territory's resilience, the 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 business real estate in these often 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 were built on in the floodplain, as well as some major infrastructures.

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

30. The Grand Paris development 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 for that of the whole region

31. 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, transport). Investment in infrastructures planned for the next 30 years could be used to improve the networks' resilience. There is in fact 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

32. 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

33. The difference between the levels of protection provided by dykes and clay walls, their maintenance and investment between the centre and the outskirts of the urban area would not ensure uniform protection for the Ile-de-France citizens, 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.

Hazard control depends on the effectiveness of the management of the multiple uses upstream dams

34. The hazard is also managed by four dam-reservoirs built upstream of the basin in the past. With a storage capacity of 800 million m³, together they can 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 managing water and floods. Since their construction, without any major flood, the functions of these structures became somewhat focussed on other uses (low-flow support, leisure activities). The establishment of a new tax 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 structures with respect to the different uses represents a key issue which should be regularly discussed, particularly in the context of climate change.

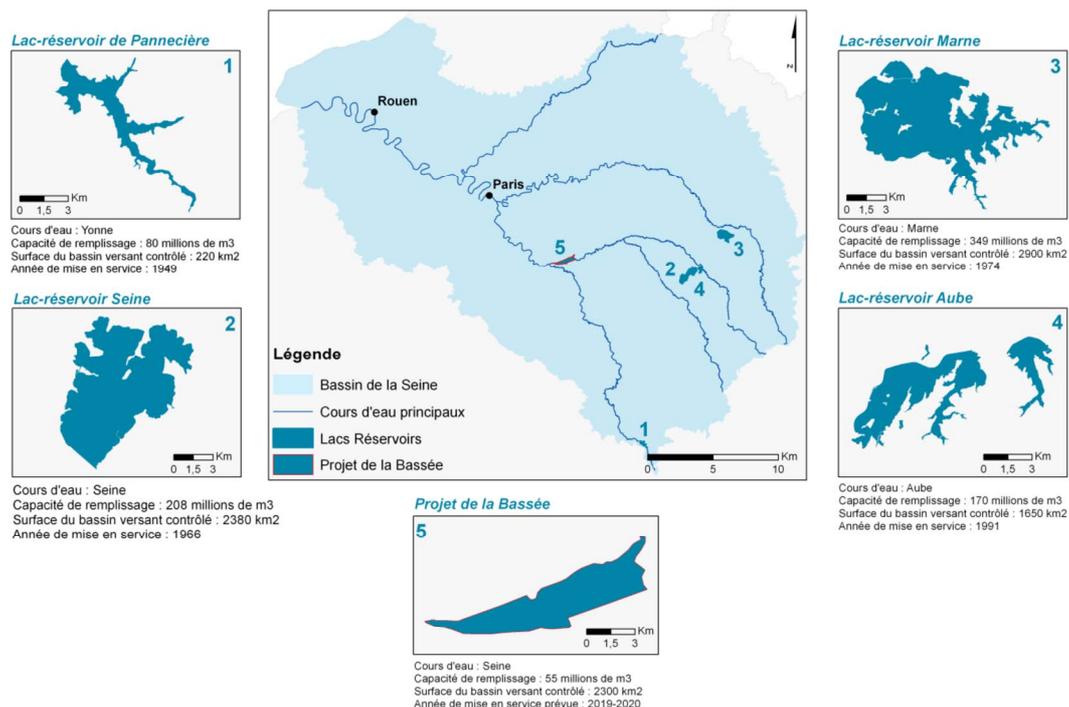
The issues of an innovative but costly new infrastructure in La Bassée

35. 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 into storage basins installed along the river. Even though this project was developed with a state-of-the-art approach, including the association 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, apart from the financial aspects, this project must demonstrate its operational utility and respond to some key questions related to the definition of its operational rules and the related decision-making in time of crisis. The solution to realise this project by 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.

36. Apart from this potentially large-scale project, other hazard reduction options were also identified, such as renovating the Joinville-Le-Pont bypass valve, which would protect a large number of the inhabitants at a low cost, reflections on the optimisation of existing structures 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. The establishment of the local flood management strategy and the Flood Prevention Action Programme (PAPI) project supported by the *EPTB Seine Grands Lacs* are together an opportunity to make a reasoned choice between the various options and to assume it with full transparency with all the stakeholders.

Figure 4. The dal-reservoirs on the Seine basin



Source: CCR, 2013

Box 3. Recommendations on the resilience measures

5. **To continue to improve and harmonise risk knowledge and to 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 the economic point of view. All information concerning the risks could be centralised abiding by questions of confidentiality, security and competition. This could go hand in hand with the provision of modelling tools and related data according to needs and to take inspiration from the risk observatory established at national level.
6. **To 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 viewing, 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. **To improve the territories' resilience, using the opportunities offered by the Grand Paris project.** The definition of a level of resilience for the Grand Paris, 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: they should use the latest risk assessments as a basis and their control should

be improved. Incentives aiming at reducing the vulnerability of existing constructions could also be envisaged, by using opportunities such as the replacement of electricity meters.

8. **To improve the critical networks' resilience level gradually and to act for 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 come back to the sectoral regulator. A mechanism supporting companies in their business continuity approach, and particularly the SMEs, could also be developed, for instance the development of a risk-diagnosis service, a dedicated label or the development of risk awareness guides.
9. **To put 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. 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. **To encourage experimentation with regard to the La Bassée storage project.** Rolling out the 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.

FINANCING FLOOD RESILIENCE IN ILE-DE-FRANCE

How to finance resilience be within a constraint budget context?

37. 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 a difficult economic situation, 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 leads to a lack of actions which would enable a collective resilience surplus to be funded. Allocating resources to prevention is a challenge in this context which requires to demonstrate that public funds are used as efficiently as possible.

Tools for financing flood risk prevention exist, particularly through insurance

38. For 30 years now, France has engaged significant flood risk prevention efforts of. A series of 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 CAT-NAT system, based on a public-private partnership between the 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 the risk prevention funding without a direct impact on public finances and particularly for flood risks. 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.

39. 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 dams. Other sources of finance exist which could 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 flood directive.

The financing of flood prevention from the Seine in Ile-de-France benefited from existing resources to a limited degree

40. 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 logical to envisage that the prevention effort should be up to 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 as satisfactory in view of the public

expenditure effectiveness criteria, if it is ensured that these funds are allocated as a priority to preventive actions 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 have mobilised the authorities and the funding for prevention, in particular measures to protect human lives, still leading to a certain delay in funding the prevention of this major risk. Up to now, the allocation of resources nationally has not been based on criteria giving priority to resources according to the level of risk. This is changing with the implementation of the European flood directive which led to territories at risk of substantial flooding being identified, of which the Ile-de-France urban area is one.

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

41. There is a margin to define a financing approach for prevention to adapt to the issues identified. In a context of strained public finances, the question of additional resources and the sharing of everyone's efforts (State, local government, companies, citizens, European funds) may be addressed by raising a number of principles on an overall financing strategy. The improved governance being established could enable a risk level to be determined as the shared objective on which a financial approach could be defined. The general principle of beneficiary-payer for prevention efforts leads to identifying the sources of funding to be raised firstly for such a strategy. Prevention funding must aim at being the 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* : the generalisation of the costs-benefits studies and the multi-criteria analysis, apart to judge the relevance of a specific project, could enable a comparison to be made of all the various options available and their benefits, including non-structural measures,
- *Long term*: long-term investment planning makes it possible to introduce flexibility in the 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 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

42. A large number of existing financial mechanisms may be 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. 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 tax on real –estate added value, local taxes or on the tourist sector could also be explored as sources of funds. Resources in the form of taxes established for low-flow

support by the EPTB-Seine Grands Lacs could also be inspirational for a similar system to the benefit of flood protection, particularly for network operators.

Box 4. Recommendations for financing prevention

11. **To support the local of Seine flood risks management strategy in the Ile-de-France by a clear financial strategy.** This could focus on the following elements: sustainability and long-term vision; principle of responsibility and proportionality among the beneficiaries of the measures taken and the financiers; best effectiveness and consideration to equity in resource allocation; synergies with the other sectoral strategies (drought, water, development, crisis management).
12. **To 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 structures, particularly by bringing together the insurance, real estate and water management sectors.
13. **To clarify the priority criteria for prevention funding from State resources as well as the perspectives of European funding** which can be mobilised for implementing the European Flood Directive in the high flood risk areas such as the Ile-de-France.
14. **To re-examine the impact of the CAT-NAT system 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.