Chapter 1

Vulnerability, Urban Design and Resilience Management

Bruno Barroca

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.78585

Abstract

After 30 years without any serious flooding, and over half a century without any major floods (the river Seine's last "important" flooding in Paris took place in January 1955), the 2016 event questions our capacity to evaluate the flood hazard and its impacts. For the Ile-de-France region, the hazard occurred outside defined periods of vigilance, as a result of heavy rains downstream of the main protection structures formed by reservoirs. For this reason, these large protection works only had a very moderate influence on the event. Management of the 2016 event has been analysed on the basis of local measures whose effectiveness varied depending on the context. Among the positive lessons to be drawn, the 2016 floods revealed the high level of resilience of the Matra district in Romorantin. This resilient district, which has high urban qualities, has shown that, in the French regulatory context, flood risks can be treated effectively by appropriate development projects.

Keywords: urban resilience, urban design, flood, vulnerability, Romorantin, Matra district, critical infrastructure

1. Introduction

In both civil society and scientific fields, the frequency with which the term "resilience" is used has increased dramatically since 2005 [1, 2] in discourses on climate change, natural risk management and urban and territorial development. Etymologically, the word "resilience" comes from the Latin "resilio, resilire," which means taking a step backward and having the ability to restart. Coming from fields as varied as psychology, ecology and materials sciences, it has also been adopted by disciplines such as economics, information technology, and so on with varied meanings revealing not only polysemous wealth but also many contradictions [3]. Currently, the field of resilience covers a great deal more than just post-disaster questions; resilience applies to all aspects of temporality and the actions related to risk management.

For this reason, if the term of resilience has invaded the risk management landscape, as far as urban floods are concerned, this gives rise to two complementary dynamics: on the one hand, "adaptation" by local strategies that integrate flood risks for sites in urban development projects, and, on the other hand, "resistance" by means of protection strategies based on so-called structural measures (anti-flood walls, dikes, dams) aimed at reducing flood risks in urban areas.

This chapter reviews the floods that affected France in June 2016. It analyses national and regional strategies. The chapter also presents a resilient local experience that has shown all its effectiveness during the flood period. The singularity of the hydrological situation and flood prevention in the Ile-de-France region implemented by development work are covered in Sections 2.1 and 2.2. Section 2.3 focuses on the limits of this flood-prevention strategy and reveals its impacts and effects. In Section 2.4, positive elements are highlighted, including innovative experiences for adapting urban forms and local strategies for resilient development.

2. Urban vulnerability and local resilience design

2.1. France in the face of flooding

In France at present, flood risks cost an average of 250 million euros per year or 80% of the total cost of damage attributable to natural hazards. One "commune" in three is concerned, including some 300 major towns and cities. A total of 17.1 million people reside in "approximate potential flood areas" and are exposed to the various consequences of overflow floods, including 16.8 million in mainland France [4]. Regarding coastlines, which are undergoing considerable urban growth, 1.4 million inhabitants are exposed to risks of marine submersion (without taking account of seasonal populations), and more than 20% of them live in single-floor buildings.

It is surprising to see such sizable and ever-increasing stakes at issue in flood zones because, after decades of strategy for protecting land against flooding that was applied until the 1980s, flood risk in new developments has only been taken into account since the mid-1990s mainly through Flood Risk Management Plans (FRMPs). FRMP planning regulations are compulsory for all urban planning documents. On the one hand, FRMP comprise a study of the hazard that uses the largest historical flood known as a reference if it is at least a 100-year flood, or a model of a 100-year hazard, which is the most common place solution. On the other hand, FRMPs categorise issues affected by the hazard, an operation defined by national guidelines. In fact, when compared, FRMP offer different solutions for grouping issues depending on the territories concerned, either by their economic damage potential or by the danger levels for large numbers of populations, or by vital networks concerned, and so on [5]. The FRMP regulatory map is the result of a correlation of maps covering hazards and major issues. It indicates risk areas ranging from low, medium and high to very high levels (very high being associated with 100-year events). Regulations are also created per zone. They specify any constraints liable to prohibit new constructions (homes, services, shops, equipment …) or make recommendations and exclude certain functions (bans on homes or establishments open to the public for example).

Generally, recommendations indicate the super-elevation of occupied levels and hydraulic transparency (the ability not to block the water flow). Despite the many criticisms concerning the elaboration of FRMP [6], the opacity of technical selection stages and expert negotiation processes [7], FRMP regulations impose significant constraints on local planning. Faced with these constraints, which are difficult to accept locally, especially when the effectiveness of FRMPs is regularly challenged, other approaches have come into being, born by the will to live with water and to integrate risk not in terms of controlling the use of land, but in terms of regional planning and organisation aspects [8]. The increasing use of the term "resilience" is part of this shift, and government authorities are now looking for ways for taking better account of resilience in specific regions. In 2015 [9] and 2016, the Ministries of Housing and Ecology even launched a Grand Prix for urban development on building land liable to be flooded. In terms of the regulations for this prize, the ministries want to promote "urban development or […] buildings designed for undergoing frequent or rare floods and which are respectful of urban, environmental and heritage constraints in areas with low to medium hazard levels where building operations have not been prohibited "[10].

2.2. How does the Ile de France area protect itself?

With nearly 500 km^2 of its area flooded in the event of a 100-year flood, large areas of the Île-de-France region are likely to undergo flooding for exceptionally long periods (12 days of rising water levels and 5 weeks of receding water levels in 1910). Ninety-four per cent of the flood zones in Paris and neighbouring departments are already built-up areas [11].

The increase in the number of homes in these flood-prone urban areas more particularly stems from demographic pressure that is reflected just as much in plots exposed to flood risks as elsewhere [12]. In the last few decades, departments of the Ile-de-France region have built largely in flood-prone areas. The Val-de-Marne department, more particularly prone to flooding by the river Seine and its tributary, the Marne, is one of the three departments that stand out on national levels for the largest number of constructions they have in flood-prone zones. In this respect, over 8000 homes were built between 1999 and 2006. Before 1999, the Val-de-Marne department already had a large number of homes built in flood zones. The result of these phenomena is an increase in exposure not only to extreme events, but also to events that were considered in the past as being common place.

Until the beginning of the twentieth century, there were no major protection works in the Paris region and only local measures and suitably designed constructions made any form of risk management possible. At the beginning of the twentieth century, works were carried out on improving the flow of the river Seine by digging out the river bed and limiting obstacles where it crossed Paris.

Four reservoirs, created in the Yonne valley for diverting the Seine, Marne and Aube rivers (tributaries of the Seine upstream of Paris) were also built between 1950 and 1990 to limit their high flows.

These reservoirs serve a dual purpose, first to reduce the effects of flooding by the river Seine and its main tributaries, and second to replenish low-water levels so that they remain sufficiently high for maintaining regular water supplies to downstream regions, including the Paris area. These four reservoirs can store and release up to 830 million cubic meters of water. In this way, each one of them can influence the flow of the river Seine in the Ile-de-France region and further downstream. Locally, structures in the form of dikes or small walls along water courses complete the reservoirs' action by protecting land against so-called "frequent" flooding in the departments around Paris and "medium" flooding" in Paris [13]. Unfortunately, these walls sometimes suffer from lack of maintenance and are in poor condition or even have gaps in them.

Climate change in the Ile-de-France area is likely to lead to more extreme and more frequent flood and low-water situations in the coming years, both of which are liable to cause malfunctions in all urban networks [14], especially for critical infrastructures (**Figure 1**). Critical infrastructures form the backbone of modern societies [15], and the vulnerability of critical infrastructures will become a major issue in urban risk management [16] as and when it generates collective vulnerability due to relationships with and between these infrastructures. Interdependencies can cause cascade-effect failures because the failure of one infrastructure can directly or indirectly affect other infrastructures and thus impact large geographic areas [17]. The study of natural hazards applied to critical infrastructures is currently focused on notions of vulnerability, i.e., "the propensity of exposed elements such as physical or capital assets, as well as human beings and their livelihoods, to experience harm and suffer damage and loss when impacted by single or compound hazard events" [18].

For the Ile de France region, the economic stakes in Flood Risk Territory (100-year flooding) concern 107,200 companies (13.2% of all companies) and 745,900 jobs (18.4% of all jobs in the region). However, we must also add 119,350 companies and 636,100 jobs located in areas where the electricity grid is fragile, i.e., areas liable to be deprived of electricity in case of a 100-year flood (**Figure 1**).

Under these circumstances, a total of 226,550 establishments (28%) and 1.38 million jobs (34.1%) are liable to be affected by the direct consequences of flooding. It must be noted that more than half of the companies deprived of electricity are located outside the flood zone [19]. Power cuts will affect 1.5 million people. A total of 140 km of public transport networks (Metro, RER, Train) will be impacted as well as three major railway stations. Many bridges and five motorways will be cut and 5 million Ile-de-France inhabitants will be affected by drinking water problems, as well as 295 schools [20].

Relatively recent awareness of the numerous interactions fostered between each other by networks, infrastructures and urban services recognised as being critical, essential or vital has totally modified methods of risk management for urban environments. Current research in urban engineering leads to a more systemic approach that takes shape via the concept of resilience and gives rise to studies of critical infrastructures on more local levels [21].

2.3. The 2016 floods, a hazard that reveals the limits of the protection system

Flooding caused by tributaries in the central Seine and Loire basins, which, for the most part, took place between May 25 and June 6, 2016, has brought the question of summer floods

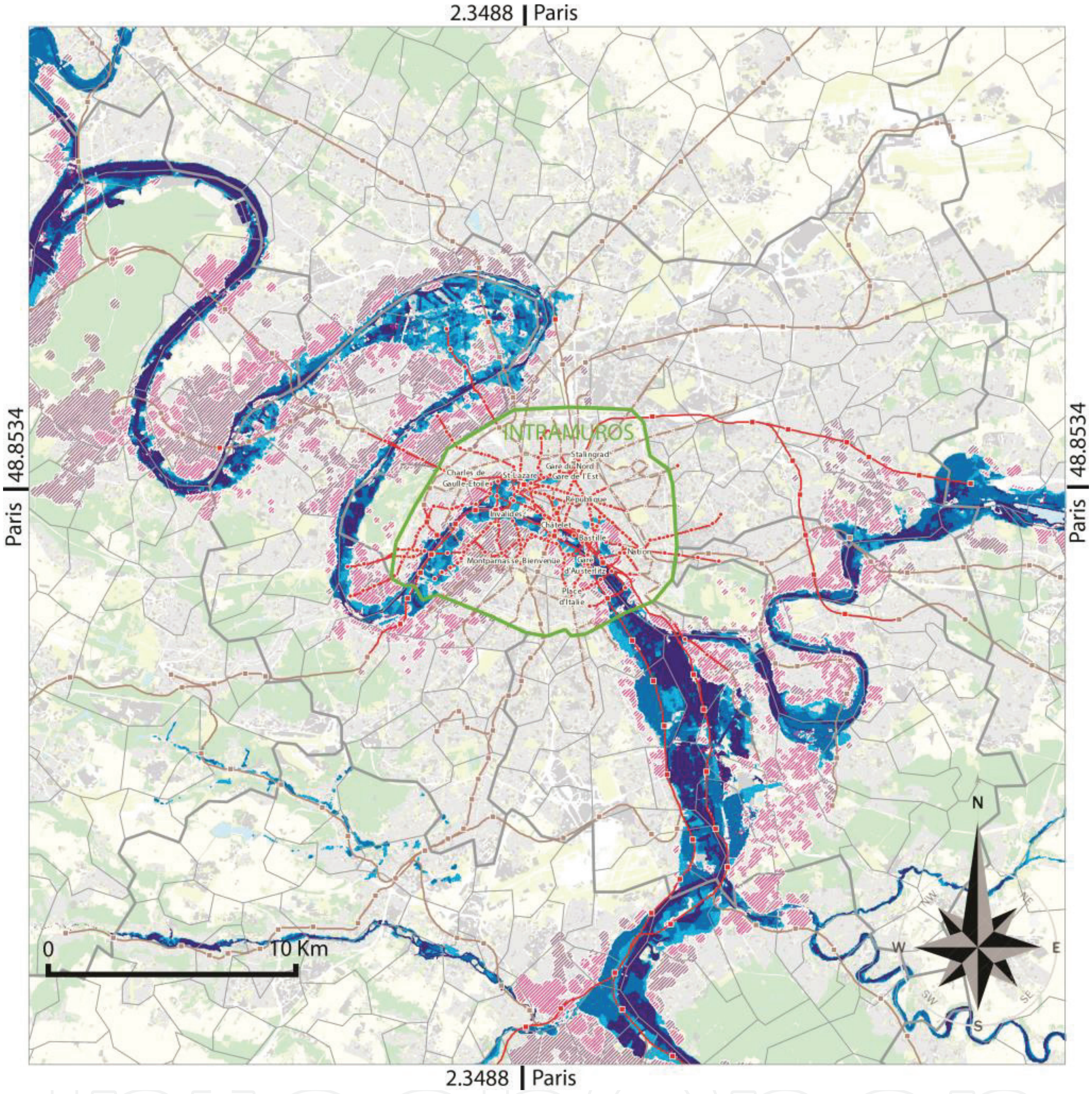

Figure 1. The impact of major flooding on the electricity network. Blue areas represent flooding, and pink areas represent electricity grid fragility (areas without any power connections during a 100-year flood). Source IAU and Ludovic Faytre.

back to the forefront. Temporal and spatial aspects were abnormal. In the case in question, flooding occurred exceptionally in late spring, while management of flood crises in the Seine basin—and more particularly in the Ile-de-France area—is centred on the probability of major flooding occurring during the winter, a period during which reservoirs' efficiency is the maximum, as regulations require them to be almost empty at this time of the year (December–January), unlike the spring when they are filled up for anticipating low-water levels during the summer. As stated before, reservoirs have a dual function inasmuch as they protect against flooding but they also replenish low-water levels during dry spells. This dual function considerably limited the role played by reservoirs[1] during the 2016 floods. A year

[1]Reservoirs only enabled water-levels in Paris to be lowered by a few centimetres at the most.

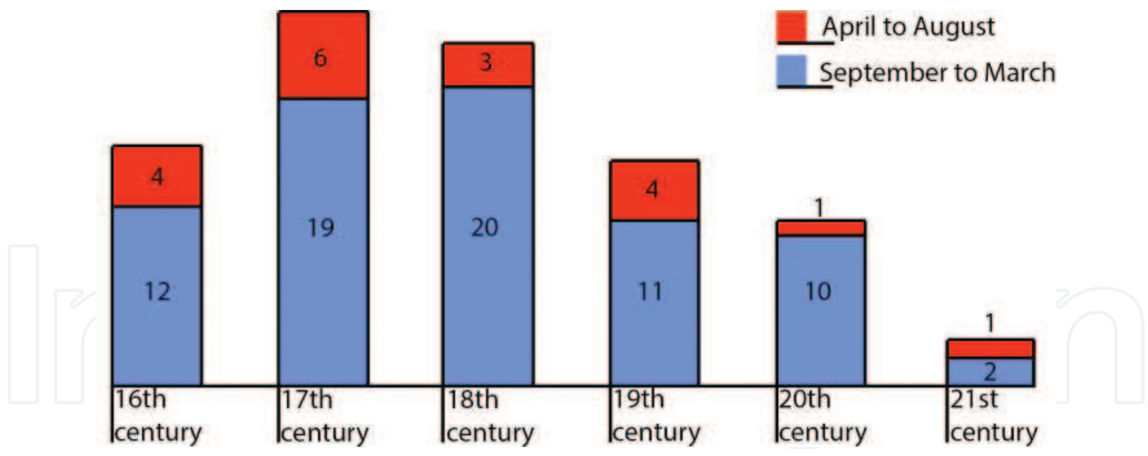

Figure 2. The number of floods in Paris between April and August (1500–2016). According to National Archives, H2 1778–1880. Register of deliberations drawn up by the Bureau of the City of Paris. Source [22].

later, in early June 2017, the reservoirs even needed to release water to maintain the flow of the river Seine, which was very low at the time. Contrary to June 2016, the release of water from the reservoirs for replenishing low flow-levels in June 2017 constituted a record of precociousness. As far as flooding is concerned, an analysis of the events that have occurred over the last four centuries shows that, with just a few exceptions, very large floods (above 7 m in Paris-Austerlitz) most often occur between December and January. This forms an initial limit for reducing spring flood levels because reservoirs are full at the time so that they can carry out their low-water replenishment mission between June and November. Three years earlier, during the period of May 7–10, 2013, flood levels had completely saturated the reservoirs[2]. Although they are less frequent than winter floods, summer floods are not uncommon, as shown in **Figure 2**. However, they do not seem to attain either the frequency or the heights of the great winter floods. Even so, the Seine basin hydrological manual, written in 1884, enables us to relativize this assertion as the book indicates that at least two summer floods over 7 m high have occurred in Paris since 1650 (June 1693: 7.55 m and June 1697: 7.35 m) together with two others that were close to 6 meters, in May 1836 and September 1866 [22].

The second singularity was due to the location of flood-generating rainfalls, which mainly occurred downstream of the reservoirs and upstream of Paris. The 2016 event was exceptional in local terms with accumulated rainfalls of 100–150 mm over the week of 28/05/2016 to 3/06/2016, which led to significant increases in water levels in the river Seine's tributaries (especially the river Loing) as well as those of the river Loire. This exceptional meteorological situation, which caused the Seine to flood due to heavy rain downstream of the reservoirs, made it impossible for them to reduce flood water levels. This phenomenon forms the second limit to a risk management system that is based on the use of reservoirs.

Assessment forecasts on the impacts made by this type of flooding carried out a few years earlier in 2014 also illustrated significant limits because reality was very different from

[2]An exceptional section comprised of reservoirs (excepted for the Pannecière reservoir which was undergoing renovation works at the time.

economic forecasts. In fact, following the flood, damage to insured property amounted to approximately 1.2–1.3 billion euros, but, according to the insurers, these figures needed to be doubled to take uninsured damage (such as assets belonging to the French state) into account. The real amount of damage was certainly between 3.6 and 3.9 billion euros for the Seine and Loire basins, while the heart of the Greater Paris area was relatively spared by surface water overflows [22]. Studies made over recent years did not provide for such high amounts of damage for this type of flooding [11]. Although they caused a great deal of damage, the May–June 2016 floods cannot be considered as constituting major floods caused by the river Seine, (a 20-year flood-level at Paris-Austerlitz), while this was the case for some of its tributaries, such as the river Loing (higher than the 100-year level), the Yvette (the 50-year level) or the rivers Almont and Yerres further upstream [22].

All things said and done, flood levels caused by the river Seine were relatively modest in Paris *intramuros* (the physical space outlined by the green line in **Figure 1**) and in the most built-up areas of the Ile-de-France metropolis. The maximum water level on the Paris-Austerlitz scale was 6.10 m, while the 1910 level (the so-called 100-year flood) was at 8.62 m. However, the actual volumes for the 6 m 10 water level, which did not over-run local protections, are comparable to those envisaged during studies published in 2014 for flood-levels 7 m 30 high[3]- or a flood level 1 m20 higher than the event of June 2016!

2.4. Resilience assessed by experience: The example of Romorantin

Less than a month after the floods, on June 27, 2016, the Minister of Environment, Energy and the Sea, and the Minister of the Interior asked the General Council for the Environment and Sustainable Development (CGEDD in France) and the General Inspectorate of Public Administration (IGA) to conduct a feedback mission. The report [23] that followed this mission came back on the points presented above, and it proposed a series of recommendations on crisis management, evacuation of inhabitants, a return to normal, and so on. Two recommendations strongly influence urban planning aspects. In this respect, it was stated that "to take account of the fact that a policy of prescriptive zoning does not cover all the realities of exposure to risk, and that, on the other hand, manufacturers need relatively simple and reproducible rules to be able to industrialize construction processes, the mission proposes that rules for building be drawn up in the form of 'Unified Technical Documents (UTD),' which would more especially make buildings more resilient and lead to a faster return to normal."

Without naming it, this recommendation introduces the concept of resilience, as it concerns "living in the city with risk, understanding, and knowledge." Prescriptive zoning follows a completely reversed logical process, which consists of separating building land from flood areas. A second recommendation specifies the importance of local circumstances: "[In plans and strategy it is necessary] to introduce the need to explain protection objectives, quantified in terms of frequency and adapted to local circumstances. To differentiate these objectives and the measures that respond to them for the protection of persons, goods, and economic activities." The shift from a hazard control approach to an integrated approach to urban planning

[3]7.30 m is the maximum level of the January 1924 flood recorded at the Paris-Austerlitz station.

and construction is emphasised by this report and its ensuing recommendations. This is consistent with what is gradually being initiated in Europe with the construction of resilient districts. For France, current regulations strongly limit "urban innovations" of this type, but the stakes in Île-de-France, a particularly vulnerable region, encourage changes to be made to the current framework. It is not a question of reducing risks by physical protections in the form of dikes whose effectiveness is highly questionable, but of reducing risks by integrating watercourses into the urban system. This will create a risk management system that works on the aspects of vulnerability and resilience within urban forms and urban programming and which is more especially applicable on the scale of urban planning operations [24, 25]. The influence of urban design on risk is therefore fundamental, and urban design is sometimes studied on the basis of moderate to extreme risks [26]. Over recent years, resilience through urban design has been highlighted in New York by the "rebuild by design" operation. In Europe, redevelopment of the old German ports of Hafencity in Hamburg, Zollhafen in Mainz or Westhafen in Frankfurt is also evident of the potential for implementing development projects in floodplains [27]. Even though France is not deeply involved in these approaches, the 2016 floods have revealed a little-known district located in Romorantin which has undergone extreme local flooding without damage (**Figure 3**).

The district is located on the banks of a tributary of the river Cher (in the Loire basin) and is the result of recent development of an old industrial area closed in 2006. In June 2016, the district was flooded to levels well beyond what had been projected by models and what regulations required. The industrial zone, mainly comprised of the old Matra factory, was located close to the town centre on a large floodplain shared with various old abandoned industrial

Figure 3. Romorantin, in the foreground marked by a red dotted line, the "Matra" district flooded in June 2016.

buildings. The global project was designed by the architect, teacher and researcher Eric Daniel Lacombe from the EDL architectural firm, which was awarded the Grand Prix for architecture in constructible zone floodplains in 2015 [9]. The project defined risk adaptation objectives by proposing building foundations that served to channel floodwater, creating a situation where road vehicles were not washed away and causing serious damage as is unfortunately common, and with accesses to buildings for pedestrians, even disabled, which remain accessible during flood periods. Design work maintained architectural objectives at flood levels 50 cm higher than those imposed by regulations. As a result, the newly built district complies with FRMP recommendations on the height of flooring and hydraulic transparency and has established other, even more demanding restrictions (**Figures 4** and **5**). If water levels exceed FRMP models by more than 50 cm, the area has been architecturally designed for enabling rescue boats to access buildings without difficulty. In this way, urban design has developed resilience by implementing sustainable urban development measures integrating risk at the heart of development projects over and above existing scenarios. Therefore, contrary to an elaborate form of protection applicable to just one water-level threshold, the district's design consisted of studying to what level of urban, technical, morphological, programmatic and social configurations its resilience could be imagined for covering frequent to very rare hazard events.

Figure 4. Romorantin, "Matra" district in non-flood conditions, pedestrian paths in black and old factories in light grey. Source EDL - Eric Daniel Lacombe.

Figure 5. Romorantin, a study of hydraulic transparency during a 100-year flood in "Matra" district (the flow of water through the district marked in red). Source EDL - Eric Daniel Lacombe.

The new district also stands out for the wide range of architectural solutions it proposes for foundation supports. Old buildings that have been kept have deep hard stone foundations that have already withstood a number of flood episodes, and new collective buildings are raised off the ground and protected from rises in water levels by long "floodable" parking lots that form a water retaining channel. Detached houses are also raised off the ground on piles which enable water to pass through without restriction. In this way, we can imagine the future movement of any water liable to invade the district by observing the meeting points between facades and ground: the protective dike on the boundaries to the north and west, the water retaining channel in the centre and the vertical piles to the south. It is certainly simpler to understand this by walking through the district during flood periods, but which is undoubtedly easier to do outside flood periods. Inhabitants of the town can cross the area by two parallel ways, one alongside the public square to the north, and the other skirting the detached homes to the south. Pedestrians and residents in the district have pathways between homes and the garden. Each of these ways offers a different perspective of the whole project, and they all entwine with the watercourse in different ways depending on the frequency of rainfalls [28]. To the south, the route crosses buildings on piles and runs along islands with large trees heralding the proximity of the river. The results of any rise in water levels are easy to imagine. The situation is

Figure 6. View from the public garden of Matra district (in Romorantin) without flood.

different on the road to the north and in the public square, where only one residential building has a special construction system giving the impression that it "floats" above the ground. We can most certainly visit these routes and not pay any attention to this element of mystery, but, once it has been discovered, it invites us to imagine the route taken by water under flood conditions, to reflect on the height of the lowest balconies in private homes, to look at the marks kept by the town on the level of the last major flood and the future of the plants in the public garden during any forthcoming flood. The architectural project aims at making the answers provided by inhabitants to these questions become supports for the identity of the district and foster the creation of a new culture of relationships between the town and its river.

Just as the district opens at the west onto the river, here too the concern for removing any limits is combined with the refusal to impose any separation of the urban district from nature. Different water-inspired metaphors are integrated into architectural design with "ripples" on the facades and sinusoids formed by the eaves of roofs, and where raised ground floors are reached via sloping wooden footbridges (that look like pontoons). These floating paths lead to pontoon terraces offering just as many opportunities for looking over the flood gardens (**Figure 6**), which are transformed by successive passages of water [28]. In this way, the architectural, urban and landscape make-up creates a dialogue with water's regular or exceptional presence on the site.

3. Conclusion

Although the Ile de France region has managed to create structures for limiting the most frequent floods and droughts over the last 60 years, it is clear that large structures show their limitations in the face of less frequent events. As such, the 2016 flood was a remarkable indicator of dysfunctions, whereas the climatic event was not very intense in itself. Various options exist for coping with more significant events, and creating an additional storage facility in the area of La Bassée is part of this objective. If the project is realised, storage capacity will be increased, but by themselves, these works will not be capable of protecting downstream areas from flood risks. The French version of the 2007 Flood Directive [13] gives more prominence to local flood risk management strategies and resilience dynamics are intensifying. The Ile de France region has developed a strategy [20] on a scale corresponding to the size of the high-risk area. The strategy has eight targets, one of which (Target 6) deals specifically with "Resilient Neighbourhood Design." Moreover, since December 2014, Paris has been part of the global network of resilient cities[4], an initiative launched by the Rockefeller Foundation and it has also set up a multi-hazard resilience strategy [29].

The case study presented in this chapter deals with a sector subject to slow floods and proves the existence of a capacity to manage exceptional events at local levels. From a historical point of view, this is all the more interesting because the possibility exists, very credible in view of the great floods of 1846, 1856 and 1866 [23], 1910, and so on that most of the major French rivers may be in spate simultaneously and that many large urban centres can be flooded in a matter of weeks. It shows that it is possible to manage floods effectively by means of urban design, even floods that are very significant at local levels, without losing qualities of architecture and urban planning. By means of its local response, Romorantin has illustrated that the examples usually published on resilient neighbourhoods can also be conceived in economically less privileged areas and within the framework of French regulations. Will architects, town planners, and decision-makers know how to take advantage of current evolutions and will this experience to innovate towards urban forms of resilience be capable of meeting all the very significant challenges seen during the 2016 floods?

Author details

Bruno Barroca[1,2]*

*Address all correspondence to: bruno.barroca@univ-mlv.fr

1 National Center for Scientific Research - Research Centre on Technologies, Territories and Societies (LATTS), Marne-la-Vallée, France

2 Paris-Est University –Urban engineering, Environment and Housing (Lab'Urba), Marne-la-Vallée, France

[4] In this network, urban resilience is defined by "the capacity of persons, communities, institutions, companies and systems to survive, adapt themselves and grow, irrespective of the types of chronic tensions and acute crises they may undergo."

http://dx.doi.org/10.5772/intechopen.78585

References

[1] Serre D, Barroca B. Preface "natural hazard resilient cities". Natural Hazards and Earth System Sciences. 2013;**13**(10):2675-2678

[2] Barroca B, Di Nardo M, Mboumoua I. De la vulnérabilité à la résilience: Mutation ou bouleversement? EchoGéo. 2013;(24) [En ligne]

[3] Reghezza-Zitt M, Rufat S. Resilience imperative. In: R.a.D. Uncertainty. 1st ed. Elsevier & ISTE Press; 2015

[4] Ministère de l'écologie du développement durable et de l'énergie, Première évaluation nationale des risques d'inondation; 2012. p. 15

[5] Gralepois M, Rode S. Flood resilient city and urban distortion. Urban Risks. 14 December 2017;**1**(2). Available at : DOI: 10.21494/ISTE.OP.2018.0205 [Accessed 12/06/2018]

[6] Hubert G, de Vanssay B. Le risque d'inondation et la cartographie réglementaire. Analyse de l'efficacité, des impacts et de l'appropriation locale de la politique de prévention. In: Programme "Evaluation et Prise en compte des Risques naturels et technologiques". Paris: Ministère de l'Ecologie et du Développement Durable; 2005. p. 188

[7] Hubert G, Reliant C. Cartographie réglementaire du risque d'inondation: Décision autoritaire ou négociée? Annales des ponts et chaussées. La gestion des risques naturels; 2003. pp. 24-31

[8] Daluzeau J, Gralepois M, Oger C. La résilience face à la normativité et la solidarité es territoires. EchoGéo [En ligne]. 2013;**24**:22

[9] Ministère de l'environnement de l'énergie et de la mer and Ministère du logement et de l'habitat durable, Comment mieux bâtir en terrains inondables constructibles ? In: Grand prix d'aménagement/Projets 2015. France: La défense; 2016. p. 102

[10] Ministère de l'environnement de l'énergie et de la mer and Ministère du logement et de l'habitat durable. Comment mieux bâtir en terrains inondables constructibles - Réglement. 2015; Available from: https://www.ecologique-solidaire.gouv.fr/sites/default/files/20160930_GPATIC_Reglement.pdf

[11] OCDE. Étude de l'OCDE sur la gestion des risques d'inondation : la Seine en Île-de-France 2014. Paris: OECD Publishing; 2014

[12] Commissariat général au développement durable, S.d.l.o.e.d.s., Croissance du nombre de logements en zones inondables, O.e. statisitiques, Editor. Paris; 2009. p. 4

[13] European Commission. Directive 2007/60/EC of the European Parliament and of the council on the assessment and management of flood risks. Official Journal of the European Union. 2007:8

[14] Serre D, Heinzlef C. Assessing and mapping urban resilience to floods with respect to cascading effects through critical infrastructure networks. International Journal of Disaster Risk Reduction. 2018

[15] Serre D. La ville résiliente aux inondations Méthodes et outils d'évaluation. Vol. 173. Marne-la-Vallée: Université Paris-Est; 2011

[16] Robert B, Morabito L. Réduire la vulnérabilité des infrastructures essentielles. Innovations - Sciences du risque et du danger, ed. TEC&Doc. Lavoisier; 2009

[17] Robert B, Morabito L. Interdependent Critical Infrastructures: From protection towards resilience. West Point, NY, USA: Critical Infrastructure Symposium (TISP); 2013

[18] Birkmann J et al. Framing vulnerability, risk and societal responses: The MOVE framework. Natural Hazards. 2013;**67**(2):193-211

[19] Faytre L. Evaluation des enjeux économiques exposés aux inondations dans le TRI de la Métropole Francilienne. Paris: Institut d'Aménagement et d'Urbanisme - Ile-de-France; 2017. p. 23

[20] Robert S, Montoya B. Stratégie locale de gestion des risques d'inondation TRI. Paris: Métropole francilienne; 2016. p. 79

[21] Serre D et al. Contributing to urban resilience to floods with neighbourhood design: The case of Am Sandtorkai/Dalmannkai in Hamburg. Journal of Flood Risk Management. 2018;**11**(S1):S69-S83

[22] Gache F. Comment la crue modérée de la Seine en mai-juin 2016 réinterroge les politiques franciliennes de gestion des inondations ? In: Barroca B, editor. Quelles stratégies pour quels risques ? La ville en question. Presses des ponts; 2018 (in press). p. 20

[23] Perrin F et al. Inondations de mai et juin 2016 dans les bassins moyens de la Seine et de la Loire - Retour d'expérience. Paris: Ministère de l'Environnement de l'Energie et de la Mer & Ministère de l'Intérieur; 2017. p. 210

[24] Barroca B et al. Considering hazard estimation uncertain in urban resilience strategies. In: Etingoff EBK, editor. Ecological Resilience, Response to Climate Change and Natural Disasters. Apple Academic Press; 2016. pp. 197-220

[25] Barroca B et al. Indicators for identification of urban flooding vulnerability. Natural Hazards and Earth System Sciences. 2006;**6**:553-561

[26] Raven J et al., Urban planning and urban design, in Climate Change and Cities, C. Rosenzweig, et al., Editors. 2018, Cambridge University Press. p. 806 p

[27] Balsells Mondéjar M et al. Analysing urban resilience through alternative stormwater management options: Application of the conceptual spatial decision support system model at the neighbourhood scale. Water Science and Technology. 2013;**68**(11):2448-2457

[28] Lacombe E-D. L'architecture aux risques de l'eau, in Quelles stratégies pour quels risques ? In: Barroca B, editor. La ville en question. (sous presse), Presses des ponts; 2018. p. 22

[29] Ville de Paris, Stratégie de Résilience de Paris. Ville de Paris et 100 resilient cities; 2017. p. 126. Available at: https://api-site-cdn.paris.fr/images/95335. [Accessed 11/06/2018]