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PARIS, LONDON, BERLIN: 3 METROPOLISES FACING THE CHALLENGES OF URBAN WATERS

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HIGHLIGHTS

- Since the industrial revolution urban development increased the pressure on hydro-systems
- European cities have to invent a new model of urban water management
- London and Paris follow similar trajectories for water management since the 19th century
- Due to its history and geography Berlin is in line with its aquatic environment
- Urban planning projects do not yet take sufficient account to characteristics of hydro-sites

ABSTRACT

European great cities are now facing four major challenges. The first one is about managing drinking water in urban areas (distribution, prices, access and supply). Water management has become the main tool to protect water extraction areas or manage the ground- and surface water in unpolluted areas out of the city. The second challenge concerns the sanitation of waste- and rainwater. The long-term goal implies separation storm water and rainwater more efficiently, without congesting municipal networks during rainy periods and modernizing the processes used to purify industrial and domestic waste water. The third challenge refers to water courses and small urban rivers. Cities now strive to reclaim rivers that were once buried, through reopening them. That goes along with a transformation of riverbanks to large public spaces by pushing back roads and economic activities. The last challenge deals with the urban resilience to flood risks as a new alternative to local flood risk management policies, which are still very much focused on standard and heavy flood protection (dykes, dams, etc.). The first two topics are about the "little water cycle" (water management from the collecting points to the treatment plants before returning to the natural environment). The last two issues relate to the big "natural" cycle of water. The following paper proposes a reflection on strategies by three of the biggest European metropolises in regards to their water management policies and their proceeding -via urban planning projects- to merge the two "water cycles". The article is based on the result of international projects in which two of the authors have been involved in.

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1. INTRODUCTION

Europe experienced a major turning point in its history in the 19th century. The Industrial Revolution has contributed to the relationship reversal between the city and the countryside. Since then, cities have been expanding at the expense of rural peripheries and urban development has consistently increased pressure on surface waters (rivers, lakes, ponds, etc.) and groundwater. They have harnessed "natural" water under the impulse of hygienists and engineers (e.g. Figure 1) (Mauch et al., 2008; Fournier & Massard-Guilbaud, 2016).

Today, European metropolises are facing a double challenge: on the one hand, it is crucial to enhance great river landscapes to bring people closer to nature by creating new public spaces and neighborhoods as those cites claim to be greener and more respectful of the environment. On the other hand, it is necessary to modernize the aging underground water systems (due to leaking) (Grafton et al. 2015). Urban project can bring the "little cycle" and the "big cycle" of water closer together, because of their large perimeter, their location near the rivers and the nature itself that guides the development of the urban project: the new paradigm is that it is nature itself that dictates the project and not the project that imposes itself on it (Brun & Adisson, 2011).

European cities have been experimenting over the last fifteen years with urban solutions which they present as "exemplary", after trying domestication projects for many decades (Apur, 2010). Some short-term operations, such as the "Paris Plage" - project initiated in 2002 - are gaining great popular success (Webster, 2007). The London docks stand for a remarkable example of reinvestment in urban waste land (Zehner, 2008). But those examples, as good as they can be, do not integrate large-scale water management in their functioning.

The trajectories cross-analysis of London, Paris and Berlin do show how the urban project is privileged by municipalities to reconcile the city and its water. At the same time, classical engineering remains fixed in a metropolitan culture and only a few integrated urban planning projects are settled in. Those are the ones that lead to real innovations in urban and water management.

2. THE BIRTH OF THE LITTLE "WATER-CYCLE"

In the Industrial Revolution context, the construction of a sewer and drinking network water system was among the most important projects. For more than half a century, between the 1820s and the 1880s, the Paris water department engineers looked up to London's engineering to create innovative and efficient systems. At the end of the 19th century, London's water management was claimed - mostly by the French engineers - as a "universal model" that therefore should be established in Paris (Chatzis, 2010). With the Baron Haussmann, the Seine Prefect and the influence of the engineer Belgrand, the Paris sewerage system and drinking water supply was created. The purpose was to create a double water distribution system (drinking water and non-drinking water) and a sewerage network, whose length reaches 600 km in 1878 (Clément & Thomas, 2001).

These two European cities are pioneers in the field of urban water management. The water network construction and modern project such as the subway and the electrification of the city contribute to their international influence. On the industrial front, the world Exhibition in 1851 moved London into the spotlight of international advertising (Bédarida, 1968). In the same way, the Paris world exhibitions - specifically the 1900 one - holds the French water engineering in high regards by spotlighting the river.

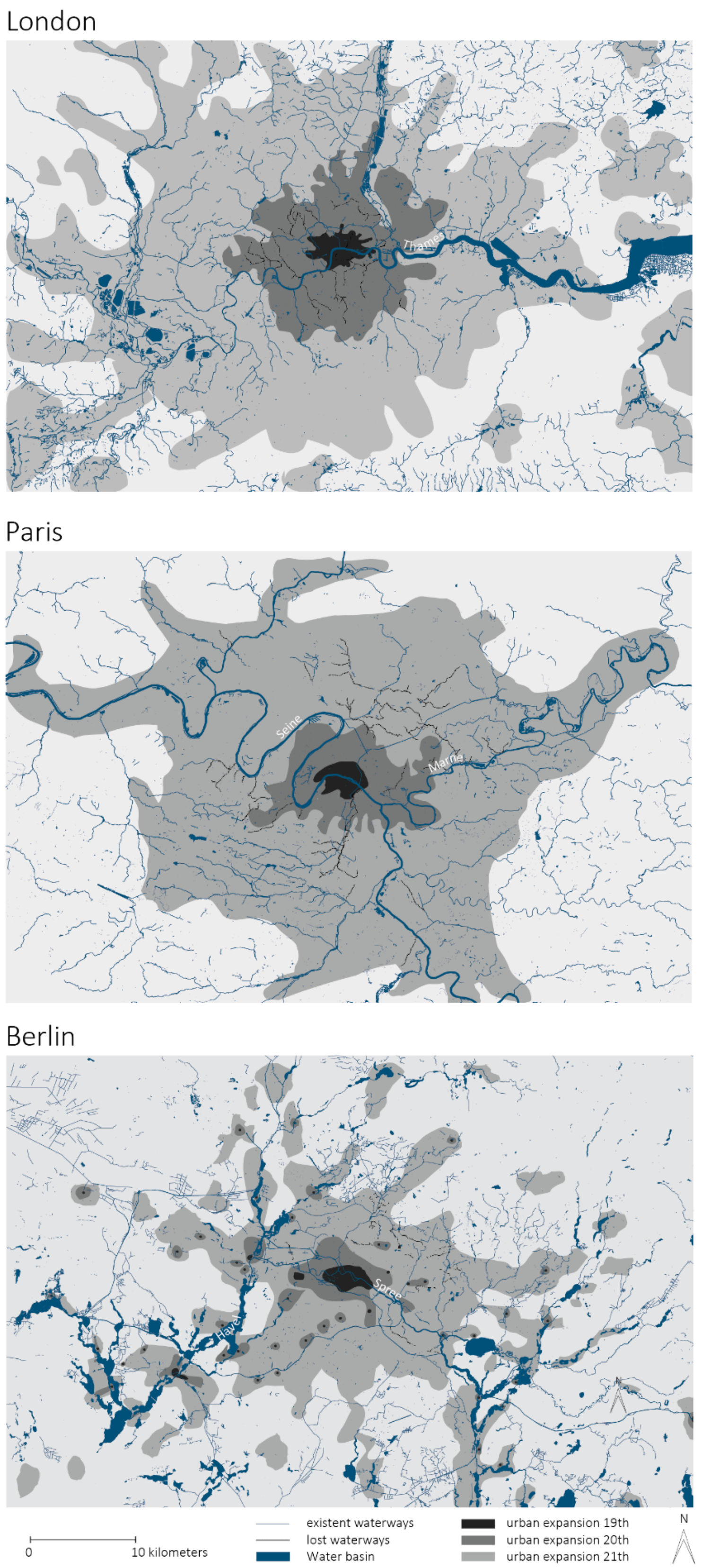

Figure 1: Urban historic expansion of London, Paris and Berlin *Source: UMR 5281 CNRS, 2016*

The water network construction was carried out as part of major urban development projects designed to embellish the two capitals and facilitate the transport of passengers and goods within the congested old districts. The technical and urban decisions/choices in London as in Paris were mainly a matter of political power due to social issues. It was necessary to fight against possible revolts and push poverty outside of the capitals to ensure their stability and good image. State engineers such as Eugène Belgrand in Paris were at the time zealous servants of the established power by contributing to projects that were therefore so much political then technical.
The process that prevailed in Berlin is not fundamentally different. However, the German capital geography and the political upheavals that have marked its history are very specific (Salian, 2010). Unlike London and Paris, there is no great river in Berlin. 5 rivers (Spree, Havel, Dahme, Panke and Wuhle) passing the city, which counts 360 km of waterfront (rivers and canals) (Künzel, 2004). Since Berlin was largely rebuilt after the Second World War, it has retained generous natural spaces. For example, the green space per capita is 150m^2 in comparison to 15m^2 in Paris (Apur 2011; City of Berlin, 2017).
The first attempts to construct a sewage system date back to the 1850s. The influence of British engineering is, again, remarkable, as English engineers supervise the construction. The private enterprise called "Berlin Waterworks Company" is thus commissioned by the municipal authorities of Berlin and by royal support. However, the established network did not prevent the city from cholera epidemics. Aware of the existing system limitations, the King of Prussia entrusted the Berlin mayor James Hobrecht with the implementation of a vast plan for the technical water networks construction and extension (as part of the Hobrecht-Plan) (Werle, 2015). As in Paris and London, the underground part of the city evolution reflected the metamorphosis also occurred on the ground level. The latter is concerned by an urban plan which is characterized by large buildings alignments (boulevards, etc.) according to the Haussmannian models. Water supply, on the other hand, is more convenient than in Paris or London, given the variety, quality and proximity of the sources of supply. Over the next decades, a vast sewer network has been established in the city of Berlin and its closed surroundings (Boschek, 2002).
In summary, the challenge of providing drinking water was achieved since tap water is accessible to all and has never been as good in terms of quality than today. Therefore, water engineering (particularly French- and English models) was exported to southern countries which are characterized by a deficit in terms of expertise. The waste water and drinking water supply implementation in the 19th century led to the birth of a "water market" and a very competitive European water industry (Schneider-Madanes, 2014).

3. LIMITATION OF URBAN WATER MANAGEMENT

Many problems today arise from the technical choices made two centuries ago. The economic and commercial successes of water engineering hide the difficulties of a political nature. In fact, technical success has a price, which is too high in the eyes of consumers. Many municipalities transferred urban water management to the private sector because of capitalist ideology or simply with the aim of saving money, due to the controversy over water pricing. However, the increasing price of water can be explained. First, water systems changed over time (for example, with the creation of specific storm water drainage systems), resulting in increasing costs of modernization and exploitation. Secondly, it is necessary to reduce water leakage, which is intensifying due to the aging network (33% in London, 8% in Paris and 2% in Berlin) (Van Leuuwen, 2017). Finally, surface and underground waters are contaminated by intensive agriculture. This requires innovative actions by a new pollution control processes.

Therefore, the "model/design" of urban water management has its limits. Five failures/ dysfunctions of human origin to the "big cycle" of water leads questioning of the "watermodel".
First dysfunction: the path of waterways is no longer natural within metropolitan areas. The multiplication of water systems has changed the natural water flow system at the scale of the watershed. Schematically, a drop of water that falls into a watershed can be consumed in another basin because of those diversions. Around Paris, for example, there are numerous water diversions established by Baron Haussmann (Husson, 1996).
Secondly, many rivers disappeared during the remediation work in favor of the sewer system. As well as at the metropolitan level, this is also true at the scale of smaller cities such as Lyon or Marseille in France (Vidal-Naquet 1993; Brun et al., 2014). These extinct rivers tend to "reappear" during heavy rainfall. This causes damage due to urbanization. It had been ignored that buried river under roads or even canalization and straightening of streams were meant to limit flood risks. In other cases, including recent concreting of the riverbed of the Lez in Montpellier as part of the Antigone project in the 1980s and 1990s, watercourses have been artificialized as an extension of work for commercial navigation and construction of roads along the waterfront (Volle, 1996).
Thirdly, municipal unitary networks are saturated because of rainwater. For example, in Paris, the flows received by factories during rainy weather can be multiplied by three during these periods and raise, for example at the Seine downstream plant, from 20 m^3 per second to more than 60 m^3 per second. The public water utility (SIAAP) has built 12 water storage facilities, eight reservoir tunnels and four basins, with a total capacity of 900,000 m^3. By associating the large transport emissaries, it stores almost 1,910,000 m^3. Once rainy season has passed, the water is reinjected into the network and transported to the SIAAP wastewater treatment plants (SIAAP, 2017).
Fourthly, urban water policy remains more curative and preventive, as public action is still often too limited to "washing water" through sewage treatment plants. The proceeds of water taxes have so far been used to finance the treatment of wastewater. On the contrary, the evolution of European standards favors the protection and the rational use of water resources. The directive 2000/60/EC even encourages the implementation of integrated water management at the level of a major river basin (European Parliament, 2006). Planning and programming tools for studies and work of a regulatory or contractual nature have been experimented since the 1960s and 1970s in Europe (Schemes for the development and management of water in France, the river contract in Italy, etc.). However, the results are disappointing in view of the objectives set by the public authorities because urban water is a logic of networks, whereas, as Ghiotti (2007) has shown, rural water refers to a much more territorial system.
Fifth, metropolises concentrate domestic and industrial pollution, hence financial difficulties for the municipalities located downstream of these large "black spots". This situation explains the tensions between metropolises and their rural peripheries, or between clean upstream and polluted downstream, in the absence of a system of political and financial solidarity on the watershed scale. This asymmetry often doubles regarding inequalities in treatment in terms of flood risk management! The protection of metropolises such as Paris and London requires extending the flooding of upstream agricultural land at the expense of rural activities. Berlin escapes the problem by being mainly concerned with the storm water flooding (Zhang et al., 2015).

4. URBAN REGENERATION OF WATERFRONTS FOLLOWING THE DECLINE OF INDUSTRIAL METROPOLISES

Since the 1960s and 1970s, consecutive crises in the industrial economy sector, emerging competition from Asia and the transformation of Western economies (now more service-oriented than industry-

oriented) has contributed to the decline of industrial areas and ports. That lead to an immense "wasteland". The metropolises have for a long time abandoned these wastelands which contributed to their prosperity. At the turn of the 1990s regulations of sustainable development encouraged cities to turn themselves once more towards their waterfront, hence of the slow process of re-urbanization.
The sustainable city must be compact because the main objective is to reduce greenhouse gas emissions by limiting the distances between urban and rural areas. The second objective consist of stopping the rural land consumption by limiting the urban sprawl. However, land reservation is scarce and opportunities to put nature in scene uncommon. Thus, cities are transforming docks and densifying former industrial harbors to remain attractive. Local governments reinforce the status of "metropolises" of their cities by offering to the inhabitants and especially to companies a framework of life which combines public spaces, car-free traffic, green spaces and landscapes of rivers, the estuaries or the bays.
The real estate market supports the conversion of riparian plots formerly dedicated to industry, material storage or car parking. Cities accompanied the urban changes that the demand for offices and housing with a "view on the river" for more than thirty years (Sgobbo & Moccia, 2016). The investments made are very big. But the popular successes of recently established spaces are encouraging. From Lisbon to Glasgow via Lyon, waterfronts participate in the metropolitan regeneration. However, projects so far have tended to use water as a setting for a renewed urban landscape. In reality, the majority of urban projects do not call into question the principles of urban water management inherited from the 19th century. The ideology "Saint-Simonienne" and the belief in technical progress always guide developers and designers. But global warming is changing the situation. As early as 2050, the city-water relationship will be different even in rich on water countries of Europe, due to more frequent flooding. It is necessary to see water as a support of the urban planning project by anticipating the accentuation of future water.

Figure 3: Thames-Waterfront-Development in London *Source: Alexandre Brun, 2016*

The first examples of redevelopment of industrial harbors and the spatial restructuring of waterfronts date back to the 1960s in the United States and Canada (Baltimore, New Orleans, San Francisco, Montreal). In the late 1970s, the United Kingdom, a country with a strong maritime vocation, began a process of redeveloping its ports (Liverpool, Manchester, Bristol ...) (Boscheck, 2002).
In Europe, the largest and media-attracted was the development of the banks of the Thames in London (e.g. Figure 3), which began in the early 1980s with the gradual recapture of the docklands (2,200 hectares) east of the City of London. The Government of Thatcher created a public development agency in 1981, the London Docklands Development Corporation (Zehner, 2008).

The city has a tool to revive the real estate market. Urban planning is not generalized throughout the area, it largely favors private action. There was a fast redevelopment of the site for the benefit of a private initiative. One of the most repeated criticisms regarding the transformation of the docks in London was the missing relation between public to private spaces. Nevertheless, the operation envisaged the consolidation of the banks and the depollution of the adjacent basins. In the same perspective, the London City stands today for ambitious projects in favor of the return of nature within the city. The 367m long London Garden Bridge proposes the creation of a vegetal bridge dedicated to pedestrians. The project originally planned for 60 million pounds is now estimated at 185 million (Michon, 2001).

While Berlin was challenging the post-war period and conserving very generous green spaces after the fall of the wall, Parisian projects have concentrated on the banks of the Seine since 1990. Development of "Paris Rive Gauche" on the Island Séguin, a dozen flood-proof programs supervised by well-known designers/urbanists were created at this time. Over twenty urban planning projects are being currently studied on the banks of the Seine in the Paris region. Real estate developers have sufficient fundings, but not enough building land (Brun & Gache, 2010).

The mutable parcels estimated at 20 000 hectares by the Greater Paris International Workshop are located at the borders of structuring networks (rivers, railways, highways, etc.). Their intensification is necessary for the public authorities. Therefore, the public facilities for the development of the Mantois in Seine Aval and Orly Rungis Seine Amont (EPA ORSA) were created in 1996 and 2007 under the impetus of the State.

The masterplan "Seine-Ardoines" covers 250 hectares 4 kilometers upstream from Paris. The project, conceived between 2008 and 2010 by the architect-urban planner David Mangin, envisaged two principles: to reduce the vulnerability of the new districts facing flooding and to renature the banks of the Seine (e.g. Figure 4). Still, the decisions made by the developers do not respect these principles.

However, the vast majority of programs delivered so far have not been designed to reduce their vulnerability to flooding. The tightening of environmental standards since the 2000s encourages developers to build "ecological neighborhoods". Water is saved more than in the past. But the operational modalities observed in Paris do not integrate the issues of water. Except for the Seine-Ardoines project conducted in 2010, and largely misguided since, most urban operations relate more to the classic recipe of real estate development as the process of the urban planning project (Brown & Addison, 2011). In London, the most famous operation is the Beddington Zero Energy (fossil) Development in the residential town of Sutton, located 40 minutes by train to the southwest of London. But again, the objective is not watered and the place given to the site is not central to the approach of the designers. From the beginning, the target of the project was reducing the neighborhood's ecological footprint.

Moreover, the renaturation projects of buried "lost" rivers are still few and very punctual in the Paris region. Thus, the upstream part retained its rural character, the Bièvre disappeared completely from the urbanized area: The river became and enclosed in the 19th century and was later transformed into a proper sewer. In the suburbs, it flows under concrete slabs, installed during the first half of the 20th century. In Paris, its waters were led into the great collector of the left bank, then into spillways which rejected them in the Seine before entering the capital. The renaissance of the Bièvre, from the source to the confluence, is therefore a project of regional scope (Simpson, 2004). L'Orge is also of interest at Athis-Mons near Paris.

The inter-municipality oversees the project of restoring the river bed to improve its self-purification and oxygenation. Less important than the costs of implementation are property issues and further the lack of governance at the scale of the watersheds that slows the projects.

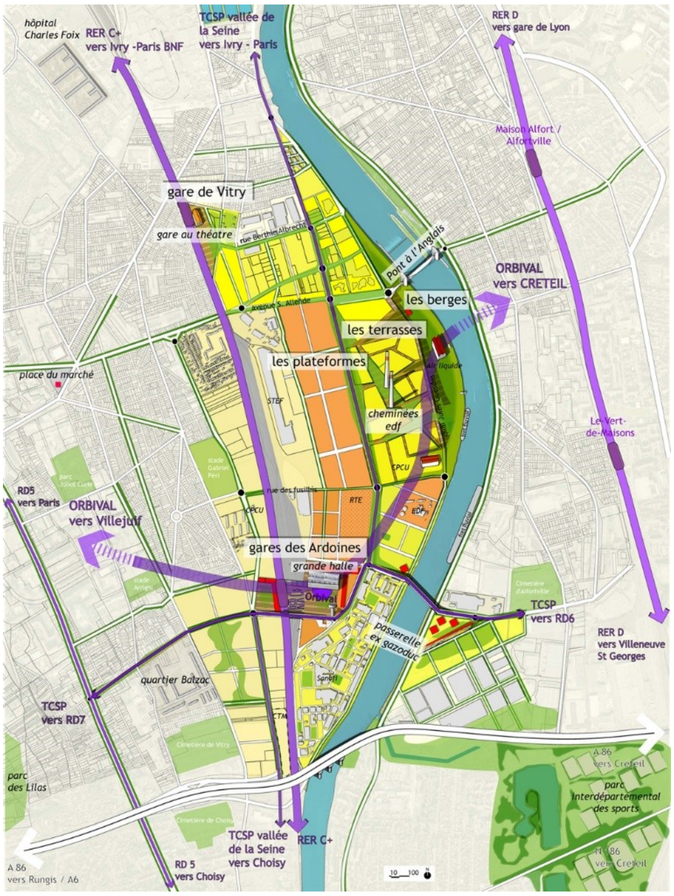

Figure 4: Masterplan "Seine-Ardoines" by David Mangin (SEURA, 2010) *Source: Brun & Adisson, 2011*

5. CONCLUSION

London, Paris and to a lesser extent Berlin inherited an urban water management "model" based on underground technical networks. These cities expansion to rural periphery was made possible by the water engineering progress. But this "model" is now discussed among ecological specialists due to the high rate of human interference – which has totally unbalanced hydro systems. Urban planning projects, often located on riverbanks, constitute the opportunity to restore nature through the site identity and its place at the center of the "urban factory" process. The management strategy study in each of these three capitals shows that the worship of technical progress is still very anchored in public and private developers. Even the most innovative urban planning projects like "Seines-Ardoines" in Greater Paris have not kept their promises. Insurance companies and city governments must therefore encourage experimental urban planning projects based on water by promoting a rather scientific ecological research to solve the water management mistakes made in the past and to build up a resilience to the increasing natural hazards. Developers should also be encouraged to change their practice by modifying, for example, local ecological taxation. It is also necessary to evaluate the interest of the project boundaries to see how these projects articulate water and development. It is crucial to increase the public awareness about the current situation and that most of the recent so called "ecological projects" only claim to solve the challenges even when they do not.

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