Dakar is leaking. Mapping changes on the territory of urban drainage services through time.

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Throughout time, Dakar's urban landscape has been shaped by ever-renewing infrastructures to meet its growing societal needs. Along with this transformation, stormwater and waste-water drainage services are put under pressure. As flooding events take over various parts of the city throughout the year, urban planning strategies urge to find a response to health and living issues. Hereby, attempts are made to address environmental challenges like drought and pollution. Though these changes are being pushed by institutionalized systems, numerous movements in which alternative actors participate, have emerged. A historical tracing of hidden layers of the urbanized area reveals the significant role of citizens in drainage services. Yet, marks on the territory have faded over time. A better understanding of these transformations in the past could contribute to tackle current and future challenges. In the role play between citizens and the drainage system, the urban setting proves its undisclosed importance. The impact of the spatial characteristics (e.g., density, connectedness, and morphology) of these transformations is to be understood.

Environmental challenges in the Sahel. Senegal is flooding

During the past 40 years, major floodings have been occurring in numerous African countries (Leclercq 2020; World Bank Group 2010). Specifically, West African areas in the semi-arid Sahelian[1] region suffer more and more from changing environmental circumstances. Due to population growth and the strong urbanization trends, these flood-prone areas are increasingly at risk (Sy, Frischknecht 2020; Wade, Faye 2009; World Bank Group 2022). This problematic inextricably involves drought, pollution, and recharging shortages of aquifers. In Senegal, floods have affected up to 600.000 people annually between 1980 and 2008, seriously harming private property as well as urban infrastructure (World Bank Group 2010). Since, this calamity appears to have made a permanent home, wiping off the map entire neighborhoods (IFRC 2022). In 2009, more than 88 million euros in damage was noted, of which the biggest part affected peri-urban[2] areas (USAID 2017). Ten years later, heavy rains forced almost 9.000 citizens to abandon their homes (World Bank Group 2022). In addition to the increase in scale, a growing frequency of flooding occurrences is notable over time (Leclercq 2020). The expected growth in Senegal's urbanization pattern – moved by climate migration and a substantial demographic growth of 2.5 percent per year – will continue to put pressure on the water demand and disposal (Wade, Faye 2009). The needs of people and nature are intertwined. Without careful planning that takes the water supply and drainage into account, the expansion of urban areas may make environmental issues problematic. The segmentation of actors makes it difficult to determine who is responsible for implementing preventive measures, leading to a lack of clarity in water governance.

Two trends of transformation: towards alternative actions and integrative operations

Globally, institutional drainage systems prove little flexible solutions in response to the growing environmental challenges. Therefore, two trends of transformation can be identified in the management of urban water drainage (Dobre, Vinke-de Kruijf 2018; Grassini 2017; Mahaut 2009; Schaer 2015). As the technocratic (centralized) drainage systems generally show high maintenance costs, the first trend moves towards the implementation of alternative actions (e.g., the gradual renovation of infrastructures through revitalization projects). Hereby, more attention is drawn to the ecological circumstances and physical setting by the implementation of small-scale and site-specific actions (de Graaf and van der Brugge 2010; Dobre, Vinke-de Kruijf 2018). The second trend is characterized by the inclusion of citizens in integrative operations. During the years, academics started to acknowledge the importance of the citizen as active participant in service production (Brandsen, Steen 2018). Reinforced by literature recognition, opportunities of

1 The Sahel is a region of Africa bounded on the north by the Sahara Desert and on the south by savannas.
2 The peri-urban is a mixed territory immediately adjacent to a city or urban area.

interaction with local policies got conducted (Benjamin and Brudney 2018; Ostrom 1973). As a result, neighborhood resilience and safety prove to enhance. Jaglin (2004) describes the objectives of integrative operations – applied to water governance – as follows: to meet the demand of population effectively, to promote flexible social learning methods, and to guarantee long-term commitment of population in management. However, it is still unclear how these trends affect the long-term viability of urban drainage systems (de Graaf and van der Brugge 2010; Faldi, Rosati 2021; Schaer 2015).

Integrative operations in Senegal: key actors and the decentralization process

Since its independence in 1960, Senegal knows an institutionalized water management separating water in three different flows – drinking water, waste-water[3], and stormwater (Galletta, Mouhoub 2021). From 1983, the state-run *Société Nationale d'Exploitation des Eaux du Sénégal* (SONEES) was responsible for both the distribution of drinking water and the implementation of waste-water networks (Ba 2006). Local authorities were however responsible for management and maintenance. In 1995, a policy reform marks an important turning point (Galletta, Mouhoub 2021). In response to the dysfunctionality of the water sector, the World Bank invested in stormwater drainage infrastructure. It aimed to break the public sector's monopoly by bringing water in the category of market goods (Banque Africaine de Développement 2012). To this end, SONEES was divided into three structures: a public establishment responsible for managing the national water resources (*Société Nationale des Eaux du Sénégal* or SONES), a private company producing and distributing drinking water (*Sénégalaise des Eaux* or SDE – now Sen'Eau), and a public establishment in charge of collecting and treating waste-water (*Office National de l'Assainissement du Sénégal* or ONAS) (Galletta, Mouhoub 2021; Guéyé 2012; Leclercq 2020). However, the restructuring to privatization is questioned as it leads to a model in which profit is prioritized (Ba 2006). Peri-urban and rural zones require more infrastructure costs than urban poles, where billing and collection of water rates are more effective. Thus, urban areas gain the most from the investments. Accordingly, while ONAS oversees primary and secondary waste-water networks, peri-urban areas are left out. Here, actors at municipality level are in charge – despite having few resources (Schaer, Thiam 2017). Regarding stormwater management, the *Commission Nationale de Gestion Prévisionelle des Inondations* was established in 2001, integrating all agencies involved in flood management (Lo 2013). Its goal is to facilitate stormwater drainage out of the city. These concerns are mainly addressed through urban restructuration projects (Bottazzi, Winkler 2019). *Agence de Développement Municipal* (ADM) is responsible for creating a master plan in flood-prone areas (Schaer, Thiam 2017). Founded in 1997, its aim is to curb corruption and centralize the management of large-scale drainage projects. Recently, the *Direction de la Prevention et Gestion des Inondations* (DPGI) was established to create a political environment that brings together all departmental actors involved in flood management (Bottazzi, Winkler 2019). Yet, peri-urban neighborhoods are largely excluded. The lack of resources of local municipalities forces other actors – such as citizens and non-governmental organizations (NGOs) – to operate (Schaer and Hanonou 2017). As a result, Senegal is marked by an entangled dynamic between local and institutional water managers. Accordingly, community management slowly became a standard approach (Galletta, Mouhoub 2021). The trend towards integrative operations is therefore further elaborated in the scope of the text. Senegal embarked on a decentralization process[4] with benchmark acts in 1972, 1996, and 2013 (Faye 2008). In doing so, the regionalization of urban planning was encouraged (World Bank Group 2018). Following programs indicate how this decentralization process got translated in water management policies over time: for decades, the *Plan Directeur d'Assainissement* (PDA) promoted participation of citizens in planning and management of waste-water systems (Leclercq 2020). Issued from 2002 to 2006, the *Programme d'assainissement des quartiers péri-urbain de Dakar* (PAQPUD) aimed to put in operation a co-management model between ONAS, municipalities, and civic organizations (Norman, Scott

3 Research on water comes with a specific jargon. In literature, wastewater is considered both a polluted waterflow and a flow in which water is used as a means of transport for waste. In the latter case, water is rather considered a 'flushing agent'. The use of language varies, allowing friction between different interpretations. A reflection about the meaning of wastewater brings forward its problematic artificiality. To question its impact, the non-natural identity of the word is stressed in this text through its notation – as waste-water.

4 A controversy arises between the introduction of a centralized infrastructure and the decentralization process. This will not be elaborated further in this text since the focus lies on participatory management that is in line with this decentralization.

2011). Most recently, the *Projet de Gestion des Eaux Pluviales et d'Adaptation au Changement Climatique* (PROGEP) tried to reduce flooding risk in peri-urban areas, focusing on a drainage system per watershed[5] (ADM 2013). Hereby, it put in place a local committee to coordinate the PROGEP and maintain realized infrastructures. Citizen initiatives (e.g., collective savings for drainage pipes and local maintenance actions) are thus deployed progressively for the creation and maintenance of secondary and tertiary drainage systems (Bottazzi, Winkler 2019; Galletta, Mouhoub 2021; Pezon 2018). Despite the launch of the decentralization process, its competence is not fully implemented in the drainage and sanitation sector. The institutional nature of the framework does not allow a fully operational principle of participation at the local level. Citizens still express dissatisfaction in the quality of services (i.e., pollution and drainage systems congestion resulting in water stagnation) (Galletta, Mouhoub 2021).

Unraveling the urban décor. Towards a balanced urban 'water machine'

A better understanding of integrative water management throughout the transformation to resilient urban areas is being developed (Dotti 2016). Considering that cities continue to expand while crossing nature's boundaries, the interrelation between citizens and the territory is a crucial subject of study. The spatial context in which drainage services are embedded plays a significant role in this participative service production (Ranzato and Moretto 2018). Yet, it is still unknown how. This study aims to advance knowledge on the setting of the changing 'water machine'[6]. An analysis with respect to the theoretical transition framework is done to more accurately detect and examine changes over time.

Transition theory. The spatial dimension of change in integrative water drainage management

The idea of 'moving toward sustainability' is connected to transition in literature on societal development (Geels 2011; Köhler, Geels 2019). According to Markard et al. (2012, pp.956), this sustainability transition is generally defined as "a long-term, multi-dimensional, and fundamental transformation process through which established socio-technical systems shift to more sustainable modes of production and consumption". Various studies discuss and recognize the link between flooding problems and urbanization (Leclercq 2020; Nguirane 2016; Wade, Faye 2009). The metropolitan area of Dakar is by far the largest urbanized area in Senegal and thereby the biggest victim of floodings (Galletta, Mouhoub 2021). A projection of this framework on Dakar's drainage system and its changes over time can provide insights into its sustainability. One of the approaches of sustainability transition is the multi-phase concept (Loorbach and Rotmans 2006). The transition is hereby divided into four phases – namely predevelopment, take-off, acceleration, and stabilization. This division helps to observe the changing system and allows to identify useful patterns that lead to success or breakdown. However, to comprehend changes in the production of an urban drainage system, an understanding of how they relate to their territorial context is essential (Geels and Schot 2007; Köhler, Geels 2019). Academic research on the geography of sustainability transitions is lacking (Coenen, Benneworth 2012; Markard, Raven 2012). It is thus still challenging to gain understanding of the spatial context and scale of practices going through a sustainability transition (Gimenez-Maranges, Breuste 2020). This work is therefore approaching the changes in Dakar's urban area from a spatial perspective, supported by the claim that more work needs to be done to integrate the socio-ecological and geographic dimensions of change (Raven, Schot 2012). As research on societal transitions lacks a general understanding of the role of scale and geography, a study across space and time is required (Köhler, Geels 2019). Here, the spatial characteristics from the co-production framework like settlement type, housing density, morphology, and connectedness are used as guide (Faldi, Ranzato 2022; Faldi, Rosati 2019). Consequently, the research interest is the selection of place-specific examples in which the spatial characteristics of these transformations are detectable. This work thus aims to develop an understanding of how and at what scale the spatial configurations of the urban area (i.e., change in building morphology, density, network, access to service, etc.) influence the waste-water and stormwater services and

5 A watershed is an area of land that drains into one body of water – such as a river or lake.
6 The 'water machine' refers to the intertwined network of artificial and natural water flows.

conversely. In addition, it also looks for the internal changes of the drainage service (i.e., the device and technology).

Methodology: the historical tracing

The first signs of flooding in Dakar only date back about 30 years (Wade, Faye 2009). Yet, the aim is to understand this issue looking at its long-term history – inextricably intertwined with the urbanization process. The link between the urban environment and flooding can be perceived in space and time. Nevertheless, it is still unclear what scale and which spatial configurations to look at to get a comprehension of change according to the transition framework. Therefore, 'layers' of spatial information on the scale of the urbanized area of Dakar are collected and superposed. This accumulation or 'palimpsest' consists of layers from different source types. An introductory map serves as base layer and shows the most recent areas that are prone to flooding. An excavation of historical layers of the urban fabric aims to give the outline of the history of Dakar's urbanization and most impactful infrastructural changes. Adding this to a collection of geographical and hydrological layers and the base layer allows to put in relation the floodable areas, the natural drainage system, and urban infrastructure. Then, problematic zones are highlighted and categorized according to three main causes. The spatial superposition is done through literature review, supplemented with (historical) maps and information gathered from fieldwork experiences (i.e., photo series, and drawings during urban walks). Subsequently, key actors are identified for the areas that experienced flooding. For two of the causes of urban flooding, an example is briefly discussed in which citizens play an active role. Hereby, the scale and spatial configuration are defined. One of these cases is further elaborated, identifying the change in the spatial characteristics of the built environment and the drainage system through map analysis.

Dakar as forerunner in a 'water-shy' story

Since the end of the 1980s, the popular neighborhoods of Dakar have been affected by floods (Wade, Faye 2009). A combination of human and natural factors is to blame. It is notable that earlier floods are mainly situated in the west of the peri-urban area while recent floods occur in the east. A significant mobilization of civic organizations has intervened to provide solutions (Diop 2010; Streule, Karaman 2020). Although the delineation of the study area is further explained, a clarification can be made and visualized when explaining the stated boundaries of Dakar [fig.1]. With respect to the discussed flooding problems, the peri-urban area of Dakar is mainly at stake. Four out of the five departments are covered by this area, namely Guédiawayé, Pikine, Keur Massar, and Rufisque – referred to as the peri-urban. The department of Dakar falls outside the discussed area because of its high elevation and extensive drainage system.

A historical tracing of Dakar's natural water system

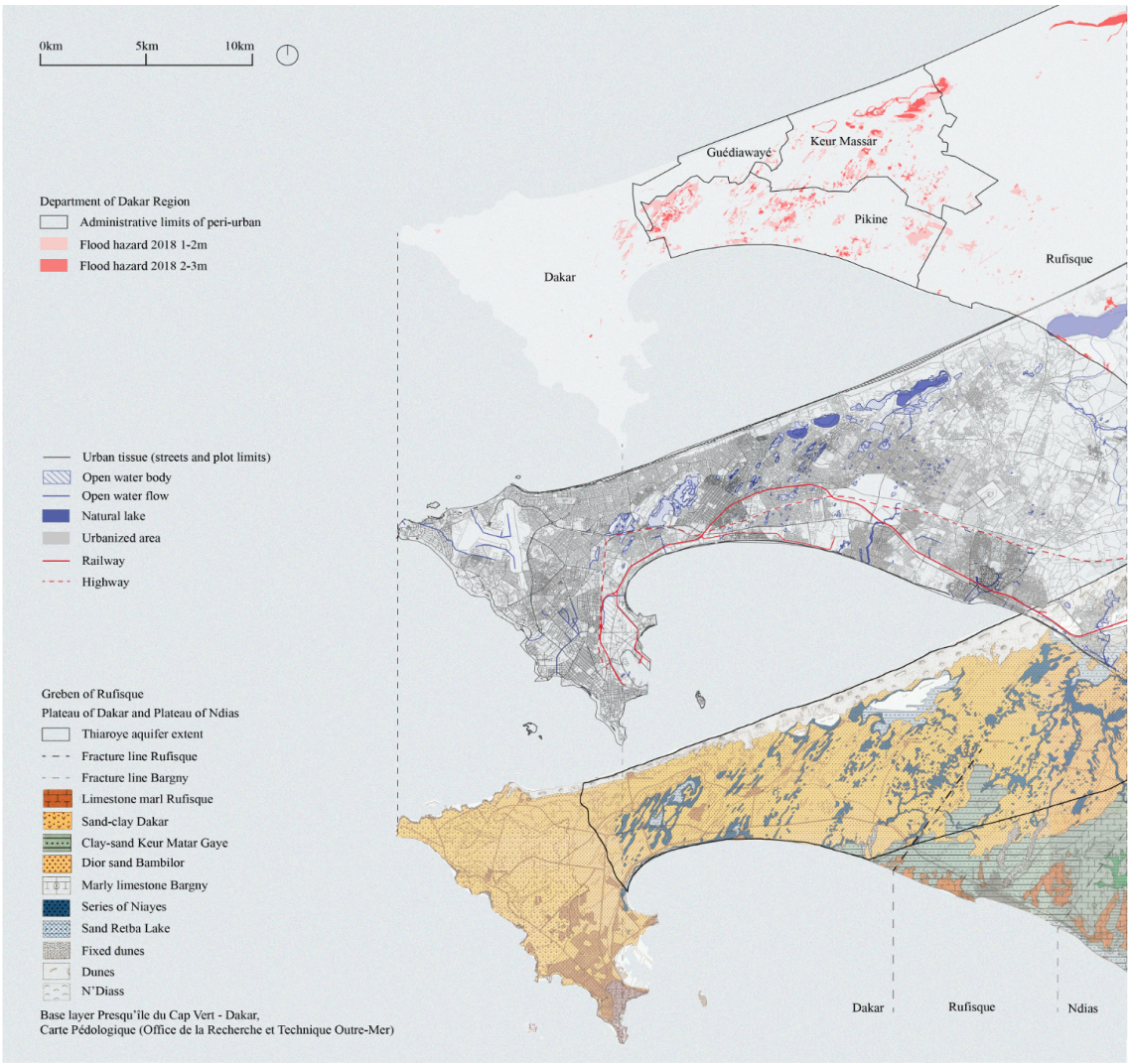
Regarding the floods, a description of Dakar's natural geographic and hydrologic system is elaborated, based on map analysis and the works of Faye et al. (2019), Laaroubi (2017) and Nguirane (2016) [fig.1]. The urbanized area has continued to spread regardless of its geologically diverse surroundings. The topography of the Cap Vert is the result of several million-year-old volcanic activity. The western point lies 20 meters above sea level. Because this plateau consists mainly of a thick layer of volcanic deposits, little flooding problems are experienced. The remaining part of the peninsula which connects the Cap Vert's plateau to the continent can geographically and hydrologically be divided into a northern and southern watershed. A freshwater aquifer – known as Thiaroye[7] – maintains humidity in the middle of this area's depressions – called Niayes – for most of the year. The drainage of the Niayes reaches from the inland towards the northern and southern estuaries into the sea. The northern part – mainly covering the department of Guédiawayé and Keur Massar – is characterized by a series of dunes along the coast. These dunes prevent drainage of inland water towards the sea. This 'congestion' in the low-lying inland areas forms a succession of lakes that stretch along the coast like a pearl string. This series of lakes is naturally interconnected and extends into the north of the continent up to almost 100 kilometers outside of Dakar. The southern part mainly corresponds to the administrative limits of the department of

7 The Thiaroye lies underneath the Niayes, largely covering the departments of Guédiawayé, Pikine, and Keur Massar.

Pikine. It knows a different type of drainage from the inland. Here, the Niayes are connected to the sea with several river branches. Finally, the urbanized area of Rufisque is situated in the south-eastern part of Dakar and characterized by a half-open depression or *demi-cuvette*. It lies exactly on the fault line between the plateau of Dakar and the inland plateau of Ndias.

A historical tracing of Dakar's urban infrastructure

The delicate water system in this diverse peri-urban territory is manipulated through time. An overview of changes in the urban tissue is subsequently described and visualized [fig.1]. Starting from the 15th century, the urbanization of the Cap Vert concentrated mainly around the poles of Dakar and Rufisque. Due to a long drought period in Sahel during the seventies, rural inland population migrated in the seventies to the urban coastal areas (Laaroubi 2017). Situated at the extreme point of the Cap Vert, Dakar has since only known an eastward expansion. The entire peninsula gradually urbanized to such an extent that the city of Rufisque has now been 'swallowed' by the capital (Doyle 2019). The limited resources of this migrant population resulted in the emergence of self-constructed spontaneous neighborhoods, established in lowlands (Schaer, Thiam 2017). Water supply and sanitation services were non-existent (Nguirane 2016). Until the 1980s, the drinking water was largely supplied by pumping the Thiaroye aquifer (Bottazzi, Winkler 2019). The infiltrating nitrates from septic tanks that came with the settlements polluted this underlying aquifer. This induced the stop of exploitation. Drinking water was henceforth obtained from a lake 250 km outside the city, leading to two impactful consequences. Firstly, the pumping stop caused pressure on the Thiaroye aquifer. Secondly, used household water was added to this through infiltration, causing the groundwater table to rise (Ministère de l'Énergie et de l'Hydraulique 2004). Another change at the scale of the peninsula is the series of infrastructural interventions for transportation. Over time, new transport networks have been introduced into the urban landscape of Dakar. A highway was constructed from 2005 until 2013 to promote rural and urban development (Diop and Mbeguere 2006; Graftieaux 2017). This road connects the Cap Vert with Rufisque to continue to the international airport. A few years later, in 2019, a railway was inaugurated. This line also crosses the entire peninsula from Dakar city to the east outside the region and parallels – just like a part of the highway – the southern coastline. Furthermore, the downside of some infrastructural projects against flooding cannot be denied. Powered by the PROGEP, retention basins have been constructed in Pikine and Guédiawayé, which buffered stormwater in the city during heavy rainfall. Entire neighborhoods were evacuated to give place to these basins. The concerned citizens got assigned a new location a few kilometers eastwards (Ministère de l'Habitat, de la Construction et de l'Hydraulique 2010). Although these new neighborhoods were built with a sanitation and drainage network, new construction zones 'branched' to them for which no drainage system was provided. Now, the unfortunate outcome of these new poles is already visible. The new built-up areas have been the most recent affected by flooding (Schaer, Thiam 2017). On top of that, the lack of maintenance by ONAS and the users of the various urban infrastructures is a reinforcing factor for the natural drainage obstruction. Although organizations at different levels (e.g., ONAS, NGOs, and citizens) are cleaning of canals, basins, and pipes, the drainage network is heavily polluted. In addition to waste, the large number of water plants and sand clogs the drainage system (Leclercq, Diongue 2023).

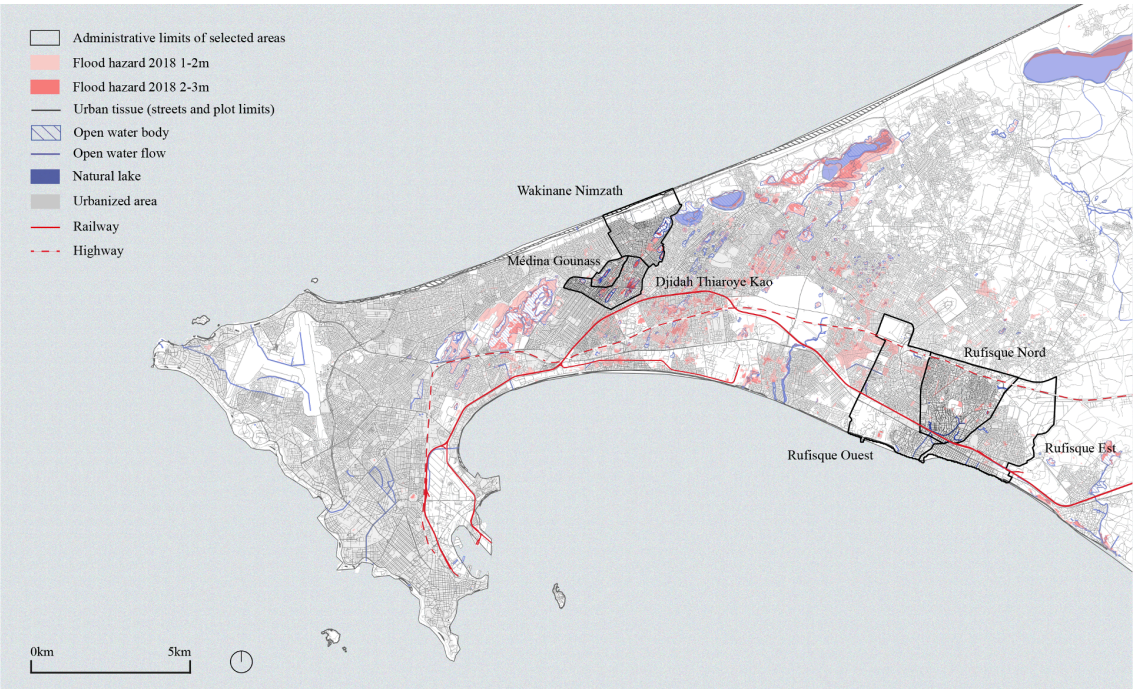


[fig.1] Superposition of flood prone areas, urban infrastructure and natural water system in the Cap Vert and peri-urban Dakar. Source: elaborated by author from IRD, ORTOM, OSM, and TWB.

Three momenta of change in the peri-urban territory

A superposition of the discussed maps on floodable areas, the natural drainage system, and the urban infrastructure [fig.1] in Dakar reveals different zones of conflict [fig.2]. They can be categorized according to three explanatory flooding causes. The first cause is the widespread use of natural water flows as means of transportation for waste. Liquid waste is dispersed into natural waterflows through clandestine pipelines or open canals, made by citizens themselves. This phenomenon – or 'rinsing' strategy – can be found in other departments of the peri-urban area. This movement is initiated to prevent disease spread. Yet, solid waste disposal causes the congestion of these canals whereby water stagnation occurs. Although this waste-water drainage method offers a short-term solution for the citizens, the environmental sustainability is still at stake. The second cause implies the dwelling densification. This eventually results in a greater amount of water to be consumed and drained. This becomes even more significant when the respected area is a crucial element of the natural water system (e.g., a wetland, floodplain, riverbank, or some type of water buffering zone). Superposing the hydrological network, the densifying urban fabric, the flooded zones, the citizen initiatives, and the extent of the Thiaroye aquifer, the northern watershed appears critical. Several neighborhoods of Guédiawayé are built on former wetlands. The growing land demand in this area provoked soil hardening. The reduced possibilities of surface water infiltration cause an increase in runoff water and need for drainage systems. The water table rises due to the returning rain, reduced infiltration possibilities and water for drinking and household activities. In 2016, *Vers un Mouvement Citoyen des Quartiers Précaires de la Banlieue de Dakar* was set up.

This program included the three municipalities of Médina Gounass, Djidah Thiaroye Kao, and Wakinane Nimzath. The neighborhoods in the intervention area are essentially informal[8]. Most of them are affected by regular or permanent floods and suffer from a lack of urban planning, insufficient solid waste management, insufficient infrastructure for rainwater drainage, or problematic governance. Due to a lack of structure and resources, institutionalized actions are poorly coordinated. The involvement of the populations appears to be a credible solution to enable the fundraising for and creation of tertiary networks and the management of existing networks at street and neighborhood level. The proposed model of coordination and financing of projects allows the realization of micro-projects at different scales: individual, semi-collective and collective. These scales are precisely those that are not attainable by state projects. The third cause is the punctual or linear disruption of the natural drainage system (e.g., a river, creek, or underground stream). This phenomenon occurs where natural rivers or streams are put underground, diverted, or disrupted (e.g., 'cut through' by a road or railway). The superposition of the mobility infrastructure, soil types, urban fabric, flooded zones, and topography highlights the disruption of the natural drainage by transport infrastructure. The *demi-cuvette* of Rufisque's urban area covers a succession of north-south oriented watersheds. The central and most low-lying watersheds are marked by dense urbanization. The sprawl of housing lead to the modification and disappearance of several watercourses, redefining the limits of these watersheds. The sanitation of the city of Rufisque is characterized by an open-air canalization – dating from the colonial period. This network follows the natural logic of gravity and water drainage and is still in use, despite little maintenance. The railway and autoroute are recent infrastructural interventions that complicate Rufisque's drainage system. These infrastructures are constructed perpendicular to the gravitational drainage network. At the intersections, pipes are installed but the bottlenecks still largely hinder the natural run-off. Additionally, the stormwater that ends up on the highway flows towards the lowest areas, flooding entire neighborhoods. Since ADM does not yet have a program a centralized drainage system and ONAS is limited to the primary waste-water networks, citizens are forced to act. Through a collection of money, they are organized on neighborhood level to buy pumps and build a secondary and tertiary drainage network for stormwater and domestic water. In some cases, the overflow of the septic tank is connected.



[fig.2] Peri-urban flooding palimpsest and critical zones. Source: elaborated by author, from OSM and TWB.

8 Informal areas contain spontaneous settlements with little cadastral organization or access to public services.

Exploration of the spatial dimension of waste-water and stormwater services in Rufisque

The strata of the territory of Rufisque are further examined to identify spatial changes. The focus hereby lies on changes in the territory and changes in the drainage system itself. The identification of originally wet zones through old maps is challenging. Yet, a superposition of topography, the urban fabric, the water network, soil types, and observations from urban walks reveals that the paved flanks of the *demi-cuvette* and run-off water from the highway have problematically moistened several habited parts. Looking closer to the zone affected by flooding, the area covered by the commune of Rufisque Nord is particularly affected, revealing the consequences of the new road and railway infrastructure [fig.3]. Cut through in the north by the highway and in the south by the railway, several neighborhoods are under pressure. Atop the watershed, a large water basin collects the runoff water from the highway. Before the rainfall, water is regularly pumped away through a large pipe that meanders between the houses to the sea. It follows the bed of the natural stormwater drainage. Along this bed, the rise of groundwater and the degradation of housing is clearly visible [fig.4]. The built environment can be described as irregular and dense. The buildings have an average of two to three stories. They mainly dispose waste-water individually through septic tanks. Although the old canals are still managed by ONAS, the network does not reach most dwellings of Rufisque Nord. Due to the increasing floods, citizens are organized among themselves to create a stormwater system. The structure of their community serves as a backbone to this. The municipality of Rufisque Nord is divided into several districts, each of them guided by a delegee. This delegee is elected by the citizens and maintains an overview of the most affected zones. In district Darou Rakhmane, a sub-level – the sector – emerges. This community-level is formed to produce a secondary drainage system. The sector here contains of around 100 houses and consist of about seven streets. This is determined by a delegee in cooperation with local associations to allow smooth operation and payment. The sector has the size of one project application and execution. The access and price to the service depends on the size of the project. Little changes are observed in land use, tenure, and technology of the drainage system. Only the zones that are too wet are abandoned after years. Although the natural drainage network is part of the Thiokho watershed, human manipulations over time have pushed these limits, complicating with this the definition and determination of the scale.

[fig.3] Scale of citizen intervention in Rufisque Nord. Source: elaborated by author from OSM and Laaroubi (2007).

Water basin collecting runoff water from highway.

Waterproof walls in front of dwelling.

Stormwater pipe draining water from basin to canal towards sea.

Self-dug drainage system and connection to dwelling.

Stormwater pipe draining water from basin to canal towards sea.

Permanently flooded wasteland.

Street with underground drainage installed by residents of one sector.

Vacant dwelling, affected by the raising aquifer.

[fig.4] Observations of drainage network in Darou Rakhmane. Source: elaborated by author.

Conclusion

In Dakar, flooding issues have been pushing planning strategies towards a facilitation of urban water drainage. Over the last two decades, floods have become entrenched in water governance, encouraging management and prevention into major construction works. Together with the housing and transport infrastructures, these spatial interventions have caused an – already delicate – natural drainage system to be seriously disrupted. The main strategies applied in urban planning consider (underground) stormwater drainage systems as the nearest solution. Policies appear to be leading every drop as fast as possible towards the sea. In this way, the relationship between the landscape, the water, and urban development is characterized as one-sided and 'water-shy'. This can be metaphorically described as an outflow or 'leakage' of water – an elsewhere precious commodity – from the city. Although it offers a solution for the citizens, the environmental sustainability of this vision should be elaborated further. The 'too much' or 'too little' water in a certain place at a certain time have encouraged the hygienic 'rinsing' strategies. The example of Rufisque demonstrates that the spatial changes over time have mainly been caused by major infrastructural interventions. Institutional water drainage systems have major shortcomings, which pushes citizens into distress. As a result, an appropriate scale is being sought for local communities to set up their own drainage system. This scale is important to further explore the sustainability transition. Although government agencies work according to a strategy of gravity and natural drainage, the built environment proves to already have influenced the natural drainage system to such an extent that this is difficult to achieve. Meanwhile, citizens' initiatives have come into effect. Tracing the water flows, the peri-urban territory appears to be in a stormwater and waste-water acceleration strategy. The impact of the loss of water on the natural environment is put behind.

Note

This work is part of an overarching research project, funded by FNRS – called WaSCoT. The research studies change in waste-water and stormwater co-production through time and is conducted by Université catholique de Louvain in collaboration with Université Libre de Bruxelles.

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