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## Causes of Cyclical Flooding in Maputo: climate change or poor public land-use planning policies?

### Introduction

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This article demonstrates that the causes of the cyclical flooding in Maputo city are not necessarily natural phenomena associated with climate change, as the government has been arguing. The floods that occur in the city of Maputo every rainy season are mostly caused by the poor implementation of public policies in the territorial and environmental planning sector, which is manifested through non-compliance with the existing land-use plan, by the lack of construction and rehabilitation of infrastructures for the drainage of rainwater adequate to meet the current population demand, the lack of supervision of the construction of public and private works in areas prone to flooding, and even due to the destruction of vegetation in sensitive ecosystems, such as mangroves in coastal areas<sup>1</sup>.

Mozambique is a country located on the south-eastern coast of Africa, characterised by a tropical to subtropical climate, vulnerable to climate change. The country has an extensive area exposed to tropical cyclones, droughts and river/coastal flooding. The country's capital, Maputo, is cyclically plagued by floods, with an average annual rainfall that varies between 800 and 1200 mm<sup>2</sup>. Floods cause socio-economic and environmental damage, particularly the destruction of public and private infrastructures, as well as the forced displacement of people, and the emergence of diseases associated with poor sanitation, and even deaths. The rainy season, which runs from November to March, is the time when heavy rains occur most frequently<sup>3</sup>, an

<sup>1</sup> In March 2023, CIP published an investigative report showing that mangroves were being destroyed in Costa do Sol for the construction of a private luxury condominium, and that the work had been approved by the Maputo City Council and the Ministry of Land and Environment (MITA). See the article available at <https://www.cipmoz.org/wp-content/uploads/2023/03/Município-de-Maputo-e-Ministério-do-Ambiente-1-1.pdf>.

<sup>2</sup> Food and Agriculture Organization-FAO (2016). AQUASTAT Country Profile – Mozambique. 17pp. Rome, Italy.

<sup>3</sup> World Bank Group - WBG (2021). Climate Change Knowledge Portal: Climatology-Country Mozambique. Available at: <https://climateknowledgeportal.worldbank.org/country/mozambique/climate-data-historical>, accessed on 30 March, 2024.

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event repeated year after year. Although this phenomenon is in the domain of the government authorities, they have not been able to provide satisfactory answers or solutions.

The most recent of these phenomena was caused by the Filipo storm in March 2024, which devastated the central (Sofala) and southern areas of the country (Inhambane, Gaza and Maputo). Around 48,116 people were affected, resulting in 2 deaths and 25 injuries. In terms of infrastructures, 13,255 houses, 146 schools and 48 health centres were affected. The damage also includes poles for power lines that caused an interruption in the electricity supply<sup>4</sup>. In the same month, one week after the storm Filipo, the city of Maputo was hit by intense rains, with precipitation exceeding 150 millimetres, which resulted in thousands of families being displaced. Around 46,555 people, corresponding to approximately nine thousand families, were affected. According to the National Meteorological Institute (INAM), heavy rains will continue to fall in the coming days of April 2024, that will further aggravate the socio-economic and environmental problems.

The government explains the frequent flooding that occur in Maputo as a result of climate change. For example, the Minister of Foreign Affairs and Cooperation, Verónica Macamo, informed UN News in 2023, during a visit to New York, that "climate change is creating increasingly serious problems for us (...) and concrete problems like the ones we have in Maputo are occurring", referring to the floods of February 2023 in the Grande Maputo region.<sup>5</sup>

To a lesser extent, government authorities recognise, especially at a technical level, that floodings in Maputo "result from the high housing density combined with deficient drainage systems in the cities of Maputo and Matola".<sup>6</sup>

The government's most recent explanation was that "due to population density, the soil is compacted and this reduces its infiltration capacity, hence, no matter how little rain falls, the soil gets quickly saturated, causing runoff and starting to create flooding scenarios (...)" and "the other situation is aggravated by the poor rainwater drainage system, due to the intensity of extreme rainfall".<sup>7</sup>

This article demonstrates that the causes of flooding in Maputo go far beyond the natural phenomena mentioned by the government, being floods mainly caused by the poor implementation of public policies in the environmental and territorial planning sector, manifested by the lack of implementation of the existing land-use plan; the lack of construction and rehabilitation of rainwater drainage infrastructures, capable of

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<sup>4</sup> Instituto Nacional de Gestão e Redução do Risco de Desastres (INGD) (15 de Março de 2024). "Filipo" causa dois óbitos nas últimas 24 horas. [Filipo causes two deaths in the last 24 hours]. Available at: <https://www.facebook.com/INGD.Mocambique/>. Accessed on 30 March, 2024.

<sup>5</sup> ONU News (14 de Fevereiro de 2024). Moçambique quer amplo debate sobre crise do clima no Conselho de Segurança. [Mozambique wants broad debate on climate crisis in the Security Council]. Available at: <https://news.un.org/pt/story/2023/02/1809872>. Accessed on 02 April, 2024.

<sup>6</sup> Agência de Informação de Moçambique (AIM) (24 de Março de 2024). Cidades de Maputo e Matola inundadas devido a chuva. [The cities of Maputo and Matola flooded due to intense rains]. Available at: <https://aimnews.org/2024/03/24/cidades-de-maputo-e-matola-inundadas-devido-a-chuva/>. Accessed on 02 April, 2024.

<sup>7</sup> Idem: Agência de Informação de Moçambique (AIM) (24 de Março de 2024). Cidades de Maputo e Matola inundadas devido a chuva. [The cities of Maputo and Matola flooded due to intense rains]. Available at: <https://aimnews.org/2024/03/24/cidades-de-maputo-e-matola-inundadas-devido-a-chuva/>. Accessed on 02 April, 2024.

meeting the current population demand; the lack of supervision of public and private works construction in areas prone to flooding; and the destruction of sensitive ecosystems, such as mangroves in coastal areas.

The article aims to identify and describe the causes and impacts and propose recommendations for addressing the recurrent floods that devastated the city of Maputo. It results from a literature review and documentary consultation, which included scientific articles, official documents, manuals, reports, newspapers, websites and other documents relevant to the topic.

The article maps the main existing rainwater management infrastructures in Maputo city, which were built during the colonial period for a population of around 750,000 inhabitants in the 1970s. Almost 50 years later, there has been no construction or rehabilitation of hydraulic infrastructures (INE. 2017), while the population of Maputo city has increased to 1,118,378 inhabitants<sup>8</sup>.

The article is structured in three sections: this introduction presents the problem, the objectives, the methodology and the main argument. Next, the causes of cyclical flooding in the city of Maputo are discussed, based on the history of land management, from colonial times to the present. The third section describes the socio-economic and environmental impacts of flooding in Maputo city, and, finally, specific recommendations are provided to reverse the problem. The recommendations can be applied to other cities in Mozambique that suffer from the same problem of cyclical flooding, taking into account the particularities of each location.

## Causes of flooding in Maputo city

In order to understand the causes of the cyclical flooding that occurs in the city of Maputo, it is necessary to take a brief look at the history of the city, from its conception to the present day.

Maputo was elevated to city status in 1887<sup>9</sup>, designed to accommodate around 750,000 inhabitants. It basically consisted of two main highways and railways, one that brought products and raw materials to the city's downtown and the other that transported them to neighbouring countries. Both railway and road infrastructures were built with an efficient drainage system in mind.

The city's downtown, being prone to flooding, had different afforestation, especially eucalyptus, casuarinas and different types of grass, which helped to absorb rainwater and prevent erosion, and the buildings in this area had suction pumps.<sup>10</sup>

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<sup>8</sup> Instituto Nacional de Estatística (INE) (2018). I. E. M. Indicadores Sociais. /[Social Indicators]. Instituto de Estatística de Moçambique, 2017. Available at <https://www.ine.gov.mz/web/guest/d/maputo-cidade-1>. Accessed on 02 April, 2024.

<sup>9</sup> Associação Nacional dos Municípios de Moçambique (ANAMM) (s.d.). Maputo Cidade/Maputo. Available at: <https://www.anamm.org.mz/index.php/component/k2/item/38-maputo>. Accessed on 02 April, 2024.

<sup>10</sup> Interview to an anonymous architect.

At the time, a Masterplan and Structural Plan were drawn up to guide the occupation of urban land according to the needs. The Structural Plan included the various road and railway and public sewerage infrastructures. It also distinguished between areas for permanent occupation, areas for temporary occupation and municipal reserve areas. This plan included the delimitation of coastal protection zones, where the destruction of mangroves was prohibited, and other areas that showed the zones defined for the planting of eucalyptus and casuarinas to minimise the impacts of marine abrasion and rainwater.<sup>11</sup>

In addition to these areas, many others were also identified for the construction of gardens, where different types of trees would be planted. Plantations of different types of trees were also planned along the avenues and streets, from acacias to palm trees and more, which would serve to ventilate the city, absorb water and reduce noise impacts. This structural plan was followed until national independence. From then on, both the Master Plan and the Structural Plan were ignored by the new urban managers.

In the transition of urban management from the government of the colonial period to the government of independent Mozambique, there was no continuity in the implementation of the Master Plan and the Structural Plan that had been implemented in the colonial period. The management of the city of Maputo, as well as other post-independence cities and towns, began to observe some deficiencies<sup>12</sup>.

After independence, many properties remained unoccupied due to the exodus of the previous occupants, Portuguese citizens or of Portuguese origin. For a few months, the city was left with few residents until nationalisation was decreed in 1977. From then on, many properties began to have new tenants, some of which had an urban culture, but most of them had never lived in a property of this nature, where the bathrooms and kitchen were inside the property.<sup>13</sup>

Due to a lack of urban culture, the new tenants of the capital hardly knew how to properly use the sewage and sanitation systems. Most of the waste generated was deposited in the sewage systems, causing them to become blocked. In addition, gullies, drainage ditches and some pipes were seen as rubbish dumps, which made the deplorable situation even worse. As the sanitation systems were not properly maintained, this situation worsened under the eyes of city managers.

The lack of maintenance, regular cleaning and rehabilitation of the drainage ditches made this area more vulnerable to physical wear and tear. As a result, they became a dumping ground for liquid and solid waste, causing their malfunctioning. This situation was aggravated during the rainy season, when their inoperability was notorious. Therefore, rainwater was unable to drain through these ditches, causing rapid flooding that ended up overflowing these ditches and consequently causing floods. The other aspect is related to the ageing

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<sup>11</sup> Idem.

<sup>12</sup> Maloa, J. M. (2016). A urbanização Moçambicana: Uma proposta de interpretação. / [The Mozambican Urbanisation: a proposal for its interpretation]. 373pp. Tese de Doutoramento - Universidade de São Paulo, Programa de Pós-Graduação em Geografia Humana, São Paulo.

<sup>13</sup> Araújo, M. (2003). Os espaços urbanos em Moçambique. *GEOSP- Espaço e Tempo*, 7(2), 165-182. / [The urban spaces in Mozambique]. Available at: <https://doi.org/10.11606/issn.2179-0892.geosp.2003.123846>. Accessed on 02 April, 2024.

of these infrastructures, caused by a lack of routine maintenance. Since they were built in the colonial period, they have never benefited from major rehabilitation.

To deteriorate the emerging urban management crisis, the city of Maputo began to observe "urban implosion". Part of the population left the countryside fleeing the 16-year war and another part moved from the countryside to the city in search of better living conditions. Due to the war situation, the internally displaced people settled in any space they found unoccupied. As a result, many areas that constituted the city's reserve and others, were taken over by these displaced people, forcing the creation of spontaneous occupation zones.<sup>14</sup>

The new neighbourhoods of displaced people did not offer habitable conditions, and those such as Xipamanine, Chamanculo and Micadjuni, which already existed during the colonial period, were expanded to temporarily accommodate the internally displaced people, who built houses made of precarious materials without observing the urbanisation plan<sup>15</sup>. Some of these areas are watersheds, thalwegs (a portion of land through which a watercourse passes), areas where drainage ditches and their branches were planned. And, to make matters worse, in many areas of these neighbourhoods no car access was provided, limiting them to pedestrian access.

In areas of transitional occupation, like the non-urbanised neighbourhoods projected for the natives, such as Maxaquene and Polana Caniço, and those of mixed occupation, such as Mafalala, only the construction of wooden and zinc buildings and other housing that did not use conventional materials was allowed<sup>16</sup>.

All of these factors contributed to the accumulation of rain and other surface waters that causes the inevitable and constant stagnation of water and flooding in these areas. Associated with the above, the porosity, slope of the land, soil saturation and constant paving in the backyards of these neighbourhoods make it difficult for water to infiltrate into the subsoil, thus contributing to the constant flooding.

The lack of monitoring and enforcement of adequate measures against offenders, by city managers, has led to greed on the part of economic agents and others with considerable economic power. They also began to construct imposing buildings in risk areas (low-lying areas, watershed areas and thalwegs), increasing the already existing crisis in the natural flow of groundwater and rainwater. To make matters worse, access roads were opened without observing the topography of the land or opening drainage ditches capable of draining the existing water as well as rainwater.

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<sup>14</sup> Idem: Araújo, M. (2003). Os espaços urbanos em Moçambique. *GEOUSP- Espaço e Tempo*, 7(2), 165-182. / [The urban spaces in Mozambique]. Available at: <https://doi.org/10.11606/issn.2179-0892.geousp.2003.123846>. Accessed on 02 April, 2024.

<sup>15</sup> Idem: Maloa, J. M. (2016). A urbanização Moçambicana: Uma proposta de interpretação. / [The Mozambican Urbanisation: a proposal for its interpretation]. 373pp. Tese de Doutorado- Universidade de São Paulo, Programa de Pós-Graduação em Geografia Humana, São Paulo.

<sup>16</sup> Idem: Interview to an anonymous architect.

The city's downtown area has always been affected by instantaneous flooding during periods of torrential rains, even in colonial times. But these floods occurred when it rained at a time of high tide, and, as soon as the tide receded, the water would quickly drain away, thanks to the greater flow of water into the bay<sup>17</sup>.

What can be observed is that flooding in Maputo city is due to the obstruction and lack of maintenance of gullies and drainage ditches, aggravated by the felling of trees, such as casuarinas, eucalyptus and other species, to make way for the construction of buildings. For example, there were eucalyptus plantations in the city centre, which not only held up the barriers but also helped to absorb water into the soil. These trees have now been removed and various projects have been built, such as the JAT and the Millennium BIM buildings.

The trees helped to absorb surface water and that from the water table close to the surface, thus allowing the absorption of greater volume of rainwater. With this cutting of trees and subsequent occupation by buildings and pavements on the surrounding land, combined with the non-existent and/or deficient drainage system, flooding and erosion are created whenever it rains.

The other cause that contributes greatly to urban flooding is ground cover, which is generally done by removing vegetation to make way for urban and informal settlements. Vegetation has the function of protecting the soil and facilitating water infiltration. When this is removed due to the development of cities, the rate of water infiltration into the soil is reduced, increasing the volume that runs off the surface of the land<sup>18,19</sup> (see Fig. 1, for illustration).

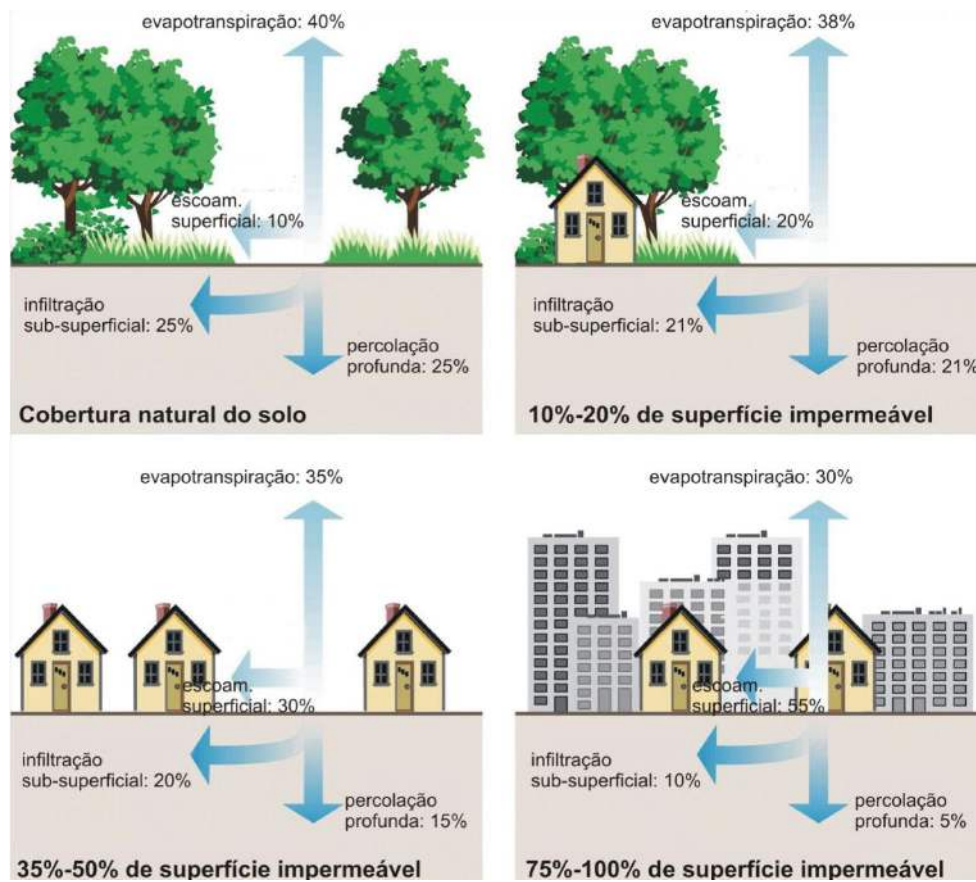
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<sup>17</sup> Idem: Interview to an anonymous architect.

<sup>18</sup> United States Environmental Protection Agency - USEPA (1998). Stream Corridor Restoration – Principles, processes, and practices. 648pp, USA.

<sup>19</sup> Tucci, C.E. M. (2004). Gerenciamento integrado das inundações urbanas no Brasil. / [Integrated Management of Urban Floodins in Brazil] *REGA*, 1 (1), 59-73.

**Figure 1. Water balance affected by urbanisation**



Source: USEPA (1998)<sup>20</sup>.

The rainwater drainage system in the city of Maputo is part of an area where most of the population lives in around 20 neighbourhoods with informal settlements, areas prone to flooding due to the elevated water table and reduced water infiltration into the soil<sup>21</sup>.

Some of the settlements that do not have a drainage system, have their backyards completely or largely paved, which makes it difficult for rainwater to infiltrate, leading to flooding. The people of these neighbourhoods, feeling themselves in a disastrous situation, open holes in the lower part of their fences to drain the water onto public roads, which also do not have any drainage system, or open them into the neighbouring yards in order to share their misfortune with those who have nothing to do with their technical incompetence. In addition to this, buildings are being constructed in places where the soil has a low water infiltration capacity, such as areas with an elevated water table (see examples of some of the neighbourhoods

<sup>20</sup>Idem: United States Environmental Protection Agency- USEPA (1998). Stream Corridor Restoration – Principles, processes, and practices. 648pp, USA.

<sup>21</sup> Conselho Municipal de Maputo-CMM (2021). Diagnostico Integrado Componente-1: Melhoria integrada dos Assentamentos Informais. 2, 453. / [Integrated Diagnosis Component - 1: Integrated Improvement of Informal Settlements]

mentioned below), which makes these soils quickly saturated. The soils in these places became saturated very easily, causing flooding where these settlements have been built. In some cases, it is the urban management structures that assign the Rights of Use and Benefit of Land (DUATs) to these locations.

In the neighbourhoods of Triunfo, Costa do Sol, Pescadores and Mapulene, hundreds of hectares of mangroves have been cut down, either under authorisation or with the impassive gaze of municipal managers, to create roads and buildings. Apart from causing serious environmental problems, the destruction of these mangroves also leads to flooding. The roads that were built here do not have appropriate gutters or functional draining ditches. As a consequence, after intense rains, houses in these neighbourhoods remain flooded for a long time.

To worsen this deplorable situation, works are being authorised in mangrove areas, and the local population, seeing the potential of land exchanges, is now giving up their land for construction in areas where the building of conventional structures was previously prohibited.

The combination of these factors results in the occurrence of floods in some areas of the city whenever there is precipitation, even if it is not intense. Therefore, it can be understood that the non-implementation or consideration of the existing Masterplans and Structural Plans and their adaptation to the new reality, the population density, the lack of supervision and failure to implement urban management policies based on scientific knowledge on the part of urban managers, all contribute to the flooding that occurs in the city of Maputo.

## Impacts of floodings in Maputo

As the country is located in a region prone and vulnerable to extreme weather events, preventive measures should have already been taken to avoid recurring socio-economic and environmental problems. The cyclical rains that we observe year after year have a very negative impact, especially on low-income households.

These problems are evident due to the government weak capacity to respond to the floods and to meet the needs of the affected population, who end up depending on humanitarian aid to satisfy their basic needs: shelter, food and clothing.

The recent intense rainfall (around 150 millimetres) observed in Maputo city in March 2024 demonstrated this situation. Floods occurred in almost all urban districts. The flow of rainwater dragged a lot of sediments and organic matter that were spread along its path. These rains caused human casualties, totally or partially damaged many private and public infrastructures and left many neighbourhoods flooded.



In Maputo, the floods have aggravated environmental degradation and the socio-economic structure of the population. They have caused the destruction of schools, hospitals, homes, workplaces and roads; they have caused the loss of animals, agricultural crops and other means of subsistence. The number of homeless families has increased, leaving low-income populations in a situation of extreme vulnerability. As a consequence, they have created difficulty in accessing drinking water and health services, increased the prices for agricultural products and, in short, the poverty and dependence on international aid. Water contamination leads to the outbreak of water-borne diseases, environmental degradation and the loss of ecosystems. These problems are having a negative impact on the country's economy, frequently causing an additional budget to be allocated to repair the damage caused. This fact should draw the attention of responsible authorities to prioritise preventative measures rather than mitigation.<sup>22,23</sup>

The lack of basic sanitation and domestic waste water collectors in neighbourhoods with informal settlements, such as Xipamanine, Maxaquene, Malhangalene, Mafalala, Aeroporto, favours the spread of pollutants such as nitrates and *Escherichia coli* bacteria<sup>24</sup> into the environment, compromising public health and the environment. Flooding can pose a risk to public health as some areas have latrines in poor sanitary conditions, which are managed on an individual basis, increasing the likelihood of residents to contract water-borne diseases such as cholera and malaria<sup>25</sup>, thus increasing costs for health services to treat illnesses.

Some access roads in Maputo were damaged, others even cut off, making transit and transfer of goods and services difficult. Furthermore, flooding on public roads makes it difficult for vehicles and pedestrians to travel, subjecting them to the risk of being swept away by water currents or even falling into gullies or existing drainage ditches. These problems on the roads entail costs, such as moving the population from risky locations to safer ones, rehabilitating damaged access roads and building new infrastructure to alleviate individual expenses.

Floods negatively affect the vulnerable population, especially those with low income, since, in order to ensure their survival and that of their families, they have to go out everyday to obtain some monetary value to buy food, pay for transport and meet other needs.

The intense rains last March paralysed the activities of some sectors, such as the transport sector to which the company Caminhos de Ferro de Moçambique (CFM) and Metrobus companies are part. The paralisation

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<sup>22</sup> In the first semester of 2019, the country was affected by the cyclones Idai e Kenneth, which caused financial and economic loss estimated in around 773 and 100 million dollars, respectively. See article available at: <https://www.researchgate.net/publication/372350823>.

<sup>23</sup> The Matola City Council is investing 250 million meticaís (around 3.9 million dollars) in repairing roads and access routes affected or destroyed during the passage of tropical storm Filipo and the heavy rains in this southern Mozambican city. Article available at: <https://aimnews.org/2024/03/30/municipio-da-matola-desembolsa-250-milhoes-de-meticais-para-a-reparacao-de-vias-destruidas-pelas-intemperies/>.

<sup>24</sup> Nhantumbo, C., Cangi, Vaz N., Rodrigues, M., Manuel, C., Rapulua, S., Langa, J., Nhantumbo, H., Joaquim, D., Dosse, M., Sumbana, J., Santos, R., Monteiro, S., & Juízo, D. (2023). Assessment of Microbial Contamination in the Infulene River Basin, Mozambique. *Water*, 15(2), 219. <https://doi.org/10.3390/w15020219>.

<sup>25</sup> Idem: Conselho Municipal de Maputo-CMM (2021). Diagnostico Integrado Componente-1: Melhoria integrada dos Assentamentos Informais. 2, 453.

of these companies may have had a negative impact on the country's economy, since, in addition to the companies not earning income, the population's transport problems worsened, given the difficulty for people to reach their daily places of activity.

In addition to the transport sector, these rains have also affected the education sector. As a preventative measure against human harm, the Deputy Minister of Education and Human Development suspended face-to-face classes at schools and technical vocational training institutes (public and private) from 25 to 29 March in the city and province of Maputo. Furthermore, some universities, such as Eduardo Mondlane University and Maputo Pedagogical University, chose to reduce labour services. Since the early hours of 24 March, access roads have become problematic to travel and some teaching and learning facilities have been flooded.

Apart from the socio-economic problems, the floods in the city of Maputo are also associated with worsening of environmental problems, as well as to the enormous losses that affected the agricultural sector, with crops being flooded and destroyed. And that's not all: due to the increased surface run-off that occurs during the rainy season, there is greater mixing and dispersion of contaminants from various sources, such as manure, fertilisers and agricultural pesticides, from informal and urban settlements, from the rainwater drainage ditches, domestic and industrial wastewater, which can cause food insecurity, increased poverty and public health problems.

A recent study about the water quality of the Infulene river basin, a very important river for the irrigation of vegetables that are consumed in the cities of Maputo and Matola, concluded that the water used for irrigation lacks the desirable chemical and bacteriological quality and that pollution levels worsen during the rainy season, due to the higher rate of surface run-off that drags pollutants from domestic and industrial wastewater into the river, combined with the precarious and inadequate sanitation of the informal settlements.<sup>26</sup>

During the agricultural production process in areas associated with contaminated water resources, irrigation constitutes a vector of exposure and contamination in the agricultural supply chain, from the production process, processing, storage,<sup>27,28</sup> sale and subsequent consumption of agricultural products.<sup>29</sup>

The factors mentioned above increase the levels of environmental contamination, especially soil and water contamination. The adverse impacts that can be caused by soil contamination include the elimination of animal and plant species, soil desertification, contamination and death of crops, among others, while the

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<sup>26</sup> Rodrigues, M., D., Juízo, C. Nhandumbo, A. Mussagy & R. Kouta (2023). Evaluation of the Water Quality of the Infulene River Basin. 73pp. Dissertação de Mestrado. Universidade Eduardo Mondlane, Moçambique.

<sup>27</sup>Uyttendaele, M., Jaykus, L. A., Amoah, P., Chiodini, A., Cunliffe, D., Jacxsens, L., Holvoet, K., Korsten, L., Lau, M., McClure, P., Medema, G., Sampers, I., & Rao Jasti, P. (2015). Microbial Hazards in Irrigation Water: Standards, Norms, and Testing to Manage Use of Water in Fresh Produce Primary Production. *Comprehensive Reviews in Food Science and Food Safety*, 14(4), 336–356. <https://doi.org/10.1111/1541-4337.12133>.

<sup>28</sup>Dhananjayan, V., & Ravichandran, B. (2018). Occupational health risk of farmers exposed to pesticides in agricultural activities. In *Current Opinion in Environmental Science and Health, Elsevier B.V.*, 4, 31–37. <https://doi.org/10.1016/j.coesh.2018.07.005>.

<sup>29</sup>Truchado, P., Hernandez, N., Gil, M. I., Ivanek, R., & Allende, A. (2018). Correlation between *E. coli* levels and the presence of foodborne pathogens in surface irrigation water: Establishment of a sampling program. *Water Research*, 128, 226–233. <https://doi.org/10.1016/j.watres.2017.10.041>.

harmful impacts of water contamination are related to damage to the ecosystem, including changes in the structure and dynamics of aquatic organisms, especially fish and primary producers.

Primary producers, such as algae and aquatic plants, in the rainy season, due to better environmental conditions such as temperature, light, nutrient availability, among others, favour the growth of this group of organisms. However, due to the greater dispersion of contaminants on land surfaces, until they reach a body of water, these contaminants are often rich in nitrogen and phosphate compounds which, combined with favourable environmental conditions, will result in the proliferation of algae, that are, generally, from the cyanobacteria group.

Cyanobacteria are a group of microalgae (phytoplankton) responsible for providing oxygen through photosynthesis. They help fix atmospheric nitrogen, which is generally used to fertilise the soil. They present value in the pharmaceutical, agricultural and nutritional sectors, among others. However, the cyanobacteria group is also responsible for the production and release into the water of cyanotoxins, that are harmful to public health, aquatic organisms and water quality, jeopardising its use for public supply, the agricultural sector, recreation, pastoralism and even aquatic organisms, such as fish.

In addition to primary producers, heavy rains can cause damage to the ichthyological community (fish), which are important for regulating the aquatic ecosystem, guaranteeing livelihoods and generating income for populations.

## Conclusion

This article has demonstrated that the causes of flooding in Maputo city go far beyond the natural phenomena that the government mentions. In addition to the geographical position of the country, the drainage systems, the maintenance of vegetation and conservation areas, after independence, the Masterplan and Structural Plans drawn up in colonial times, that reflected the elements of risk, were not fully considered. Combined with this situation, other adversities, such as the migration of the population from the countryside to the city, the lack of urban culture on the part of many city dwellers, the lack of construction and rehabilitation of rainwater drainage infrastructures capable of responding to the current population density and in covered and paved areas, the allocation of DUATs in areas prone to flooding (watersheds and thalwegs), the lack of supervision over the construction of public and private works in areas prone to flooding, up to the destruction of sensitive ecosystems, such as mangroves, all contribute to the constant flooding that is observed in the city of Maputo, as well as in similarly managed Mozambican cities.

## Recommendations

In order to mitigate the gloomy state observed in the city of Maputo after the intense rains, urban managers urgently need to reform the old forms of urban management and adapt the existing structural plans to the new reality. These structural plans should have a scientific rather than political nature. To this end, they should consider the following:

- Reconsider the existing Master and Structural Plans and adapt them to the current reality;
- Requalify neighbourhoods prone to flooding, which would consist of constructing high-rise buildings in safe areas, transferring the target populations and allocating them to some of the flats in these buildings;
- The relocated families could pay a symbolic rent to guarantee the maintenance of these buildings;
- In the areas where these families will have been removed, any unauthorised occupation could be strictly prohibited, and they could be used as water drainage areas to the nearest retention basin;
- There could be created green spaces in neighbourhoods and expansion areas, where various tree species could be planted for protection and recreation purposes (gardens and/or parks);
- Opening of new efficient drainage ditches and capitalising 100% on existing drainage;
- Introduce a regulation that requires the construction of drainage ditches in all public works;
- Build several retention basins/wetlands. These basins should be built in well-located areas to avoid creating new social and environmental problems;
- Carry out constant cleaning and maintenance on the new and existing drainage ditches;
- New access roads should be built in accordance with the road layout, including sidewalks, road shoulders, slopes and the respective drainage ditches;
- In floodplains and riverside areas, the destruction of vegetation to make way for new urban settlements should not be authorised;
- To not authorise settlements in water basins, slopes, thalwegs, low-lying areas and/or areas prone to flooding;
- Ensure constant and permanent monitoring in order to avoid new buildings in prohibited locations;
- Ensure the removal and regular treatment of solid and liquid waste and safeguard due regular inspection;
- Impose appropriate fines on offenders.

## Bibliographical references

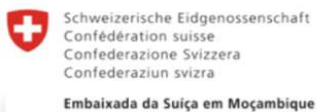
- Agência de Informação de Moçambique (AIM) (24 March 2024). Cidades de Maputo e Matola inundadas devido a chuva. Available at: <https://aimnews.org/2024/03/24/cidades-de-maputo-e-matola-inundadas-devido-a-chuva/> accessed on 02 de April 2024.
- Agência de Informação de Moçambique (AIM) (30 March 2024). Município da Matola desembolsa 250 milhões de meticais para a reparação de vias destruídas pelas intempéries. Available at: <https://aimnews.org/2024/03/30/municipio-da-matola-desembolsa-250-milhoes-de-meticais-para-a-reparacao-de-vias-destruidas-pelas-intemperies/>, accessed on 02 de April 2024.
- Araújo, M. (2003). Os espaços urbanos em Moçambique. *GEOUSP- Espaço e Tempo*, 7 (2), 165-182. Available at <https://doi.org/10.11606/issn.2179-0892.geousp.2003.123846>, accessed on 02 de April 2024.
- Associação Nacional dos Municípios de Moçambique (ANAMM) (s.d.). Maputo Cidade/Maputo. Available at: <https://www.anamm.org.mz/index.php/component/k2/item/38-maputo>, accessed on 02 April 2024.
- CIP (Centro de Integridade Pública) (30 March 2023). Município de Maputo e Ministério do Ambiente autorizam construção de condomínio de luxo no mangal da Costa do Sol. Available at: <https://www.cipmoz.org/pt/2023/03/30/municipio-de-maputo-e-ministerio-do-ambiente-autorizam-construcao-de-condominio-de-luxo-no-mangal-da-costa-do-sol/>, accessed on 02 de April 2024.
- Conselho Municipal de Maputo-CMM (2021). Diagnostico Integrado Componente-1: Melhoria integrada dos Assentamentos Informais. 2, 453.
- Dhananjayan, V. & Ravichandran, B. (2018). Occupational health risk of farmers exposed to pesticides in agricultural activities. In *Current Opinion in Environmental Science and Health. Elsevier B.V*, 4, 31–37. Doi: <https://doi.org/10.1016/j.coesh.2018.07.005>.
- Food and Agriculture Organization-FAO (2016). AQUASTAT Country Profile – Mozambique. 17pp. Rome, Italy.
- INE (2018). I. E. M. Indicadores Sociais. Instituto de Estatística de Moçambique, 2017. Available at: <https://www.ine.gov.mz/web/guest/d/maputo-cidade-1>, accessed on 02 April, 2024.
- Instituto Nacional de Gestão e Redução do Risco de Desastres (INGD) (15 March 2024). “Filipo” causa dois óbitos nas últimas 24 horas. Available at: <https://www.facebook.com/INGD.Mocambique/>, accessed on 30 March 2024.
- Macane, A. & Mate A. (2022). Efeitos das mudanças climáticas na economia de Moçambique. *Boletim GeoÁfrica*, 1(1), 25-40. Doi:10.59508/geoafrica.v1i1.51601.

- Maloa, J. M. (2016). A urbanização Moçambicana: Uma proposta de interpretação. 373pp. Tese de Doutoramento- Universidade de São Paulo, Programa de Pós-Graduação em Geografia Humana, São Paulo.
- Nhantumbo, C., Cangi, Vaz N., Rodrigues, M., Manuel, C., Rapulua, S., Langa, J., Nhantumbo, H., Joaquim, D., Dosse, M., Sumbana, J., Santos, R., Monteiro, S., & Juízo, D. (2023). Assessment of Microbial Contamination in the Infulene River Basin, Mozambique. *Water*, 15(2), 219. <https://doi.org/10.3390/w15020219>.
- ONU News (14 de Fevereiro de 2024). Moçambique quer amplo debate sobre crise do clima no Conselho de Segurança. Available at: <https://news.un.org/pt/story/2023/02/1809872>, accessed on 2<sup>nd</sup> April, 2024.
- Rodrigues, M., D., Juízo, C. Nhantumbo, A. Mussagy e R. Kouta (2023). Evaluation of the Water Quality of the Infulene River Basin. 73pp. Dissertação de Mestrado. Universidade Eduardo Mondlane, Moçambique.
- Truchado, P., Hernandez, N., Gil, M. I., Ivanek, R., & Allende, A. (2018). Correlation between E. coli levels and the presence of foodborne pathogens in surface irrigation water: Establishment of a sampling program. *Water Research*, 128, 226–233. <https://doi.org/10.1016/j.watres.2017.10.041>.
- Tucci, C.E. M. (2004). Gerenciamento integrado das inundações urbanas no Brasil. *REGA*, 1(1), 59-73.
- United States Environmental Protection Agency- USEPA (1998). Stream Corridor Restoration – Principles, processes, and practices. 648pp, USA.
- Uyttendaele, M., Jaykus, L. A., Amoah, P., Chiodini, A., Cunliffe, D., Jacxsens, L., Holvoet, K., Korsten, L., Lau, M., McClure, P., Medema, G., Sampers, I., & Rao Jasti, P. (2015). Microbial Hazards in Irrigation Water: Standards, Norms, and Testing to Manage Use of Water in Fresh Produce Primary Production. *Comprehensive Reviews in Food Science and Food Safety*, 14(4), 336–356. <https://doi.org/10.1111/1541-4337.12133>.
- World Bank Group -WBG (2021). Climate Change Knowledge Portal: Climatology-Country Mozambique. Available at: <https://climateknowledgeportal.worldbank.org/country/mozambique/climate-data-historical>, accessed on 30<sup>th</sup> March, 2024.



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