Proposing a new strategy to minimize domestic wastewater under the influence of human factor in Antananarivo, Madagascar

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Abstract. Water pollution happens when organic or inorganic materials, even solid materials are poured into the water which degrades its physicochemical quality. The purpose of this study is, to identify, to describe and to highlight the major source of wastewater, and proposing a new strategy for minimization in Antananarivo, Madagascar. Antananarivo is one of the dirtiest cities on the African continent according to the classification made by Forbes magazine and Afrikmag. To know the current situation, an in-situ analysis of the physical parameters: colour, odour, turbidity and electrical conductivity using the turbidimeter and the conductometer are measurable parameters in the field. Major elements analyses, BOD₅ using Oxytop method analysis, COD using Potassium dichromate, suspended solids using membrane filtration are measured in the laboratory. The turbidity of the discharges fluctuates from 127 NTU to 421 NTU). For electrical conductivity, it varies from 217 to 977μS.cm⁻¹, BOD₅ is of the order 3 to 88mg.L⁻¹, while COD diverges from 279mg.L⁻¹ to 730mg.L⁻¹ and suspended matter oscillates from 400mg.L⁻¹ to 60mg.L⁻¹. Some parameters and concentrations exceeded the discharge standard Malagasy and the international Standard. The best solution for the management of water quality in the face of domestic pollution is the treatment of wastewater before discharge into receiving environments and the sensibilization of the population to take their responsibility.
1. Introduction

1.1. Presentation of the study area

1.1.1. The urban municipality of Antananarivo (AUC). Antananarivo is an urban commune located in the Analamanga region, one of the 22 regions of Madagascar. This region is part of the Central Highlands of the country with a tropical climate above 900 meters. Located in its center, and extending over an area of 17,464 km², or about 3% of the surface area of Madagascar, the Analamanga Region has 134 communes and 8 districts: Antananarivo Renivohitra, Antananarivo Atsimondrano, Antananarivo Avaradranano, Andramasina, Anjozorobe, Manjakandrina, Ambohidratrimo and Ankazobe. “It is bounded by 5 regions: Betsiboka in the North, Vakinankaratra in the South, Alaotra Mangoro in the East, Itasy and Bongolava in the West. The Urban Commune of Antananarivo is made up of six districts [1].”

1.1.2. Geographic characteristic and population of the AUC. The Analamanga region is marked by the dominance of alluvial soils. The latter occupy only a limited place, meeting in the basins, like the plains of Antananarivo containing rice cultivation, cressiculture and vegetable crops.

Antananarivo is a tropical city of altitude (1250 to 1450 m) with a topography marked by marshes, hills and lowlands. The AUC has an area of 107 km², or 1% of the area of the Analamanga Region.

According to INSTAT - RGPH2018 the last general population census (in 2018), “the urban municipality of Antananarivo Renivohitra has a total of 1,274,225 inhabitants [2], which is given in Table 1.”

| Antananarivo Renivohitra District | Amount of population | Surface area (in km²) |
|-----------------------------------|----------------------|-----------------------|
| First district                    | 111 154              | 231 166               | 8.89 |
| Second district                   | 91 519               | 190 171               | 14.02 |
| Third district                    | 58 582               | 122 906               | 6.69 |
| Fourth district                   | 140 865              | 288 993               | 13.00 |
| Fifth district                    | 146 827              | 303 417               | 23.94 |
| Sixth district                    | 66 712               | 137 572               | 19.45 |
| Total District                    | 615 659              | 1 274 225             | 86   |

Source. MDG - INSTAT - RGPH2018

The population is highly intense in the AUC. This demographic pressure marks from the phenomenon of urbanization which charms people from other regions [2].

1.1.3. Delimitation of the study area. Our study area is part of the urban municipality of Antananarivo, show in Figure 1. It is positioned in the second and fourth arrondissements. It is limited to the north by the district of Ambanidia, to the south by the village of Ankaditoho-Tsimbazaza, to the east by the districts of Volosarika, Ambatoroka, Fenomanana, Andraranga, Morarano and to the west by Miandrarivo, Manakambahiny, Marohoho. To carry out the study, the site is sectioned into three plots because it has a large cultivable area and is irrigated by domestic wastewater.

1.2. Background problems

Water is one of the fundamental elements of our environment and of primary necessity for living things. It is also essential for human activities: domestic, agricultural and industrial.

The volume of water used in the world has grown at twice the rate of population growth. It is estimated that over the next 50 years more than 40% of the world's population will live in countries facing water stress or water scarcity [3]. Problem with water treatment and distribution typically in
developing countries could be categorized in three problems i.e water availability [4], loss of water particularly in distribution [5], and supply imbalances [6]. As in Madagascar, population growth continues to increase, water consumption is becoming very important.

Urbanization is characterized by high water consumption as well as the quality of domestic wastewater discharged into natural environments. Water pollution occurs when organic or inorganic materials, even solid materials (example: plastic waste) are poured into the water which degrades its physicochemical quality, which makes its use dangerous and disturbs the aquatic environment.

Antananarivo is at the head of the dirtiest cities on the African continent [7]. The latter monopolizes 60% of this ranking. But in addition to being the winner of unsanitary conditions in Africa, the capital of Madagascar is also in third place in the world, after Baku, Azerbaijan in first place and Dhaka, Bangladesh in second [7]. At this point, the City of Miles is close to running for Baku for the next ranking if things don't change.

Scandalous thing for Antananarivo, but however comprehensible given the management within the urban municipality. Insalubrity is part of the regular lot of the population of the capital, which nevertheless mirrors the country and its international image. This classification would then extremely alert the leaders within this municipality who should rank the management of sanitation instead of concentrating on other partnerships that do not even profit the population.

![Figure 1. Figure of study area. Source. Antananarivo Development Office, 2011](image-url)
1.2.1. Wastewater management. For the upper part and the slopes, part of the population is pleased to take advantage of the sloping topography of the land to discharge its wastewater without personally suffering the costs. This easy solution, which the inhabitants of the upper part of the country use and abuse, distracts them from any collective wish to appeal better public service. As a result, it appears, sanitation works are not among the urgencies of local officials. An unhealthy situation has thus settled in which administrators and administrators apparently rise themselves. However, the inhabitants of the lower part are wedged year-round.

The worst occurs during the whole rainy season. With each storm, household garbage, material debris of all kinds, metal, plastic, wood, cardboard, paper or quite simply vegetation debris and all kinds of waste are encumbered by runoff and rush down at full speed the hills. Almost all the inhabitants even take gain of these providential storms to carry out their pit discharging in the open gutters without spending a penny and get rid of all their household waste cheaply. This problem of the savage discharge of human excreta springs its real dimension to the importance of wastewater management in this area and in the lower area where these insanities have been dropped.

Indeed, in the end, the lower part is the receptor of all the insanities of the inhabitants of the upper with the consequences that all this involves.

The districts of the lower portion have a sanitation network in place since the colonial period. But this network is no longer well-matched with the number of populations. So far, minim rehabilitation and upgrading has been made there. Added to these problems is the disorder of solid waste which is dispersed almost everywhere.

1.2.2. Excreta management. Personal sanitation is the most common for excreta management. 45.16% of the households plotted use the septic tank latrine, 41.93% use the lost pit latrine against ¾ of the inhabitants for the entire AUC [8].

However, the population is not very observant when it comes to the management system for these excreta. A form of regulatory emptying does not practically happen given the inability of the Municipality. 29.63% regularly empty septic tanks captivating benefit of gravity runoff. Sometimes the emptying of pits is carried out principally by private operators, working informally in unsanitary conditions.

In the case of lost pits, households left them when they are full to build new ones. However, in this area, one cannot dig profound enough because of the rocky nature of the terrain. As a result, for those who use this kind of toilet, the building of a new latrine takes place quite often, especially when the user family is large enough or when households share the same latrine.

Apart from that, there are homes that lack the infrastructure for collecting excreta. 3.22% of households are in this category. In this case, families fire themselves at the level of the current public toilets. At night, they store their excreta in containers such as pots for disposal at public toilets or at open gutters very early the next morning. Others even throw their droppings enveloped in plastic bags into the garbage bins or they throw the sachet containing the faeces directly into nature. We must not forget the people who evacuate in nature without worrying about the pollution of the nearby environment.

1.3. Literature review
Domestic wastewater can include many substances, dissolved or in solid form, as well as many microorganisms. Liable on their physical, chemical or biological characteristics and the health hazard they illustrate, these substances can be classified into four groups: suspended solids, microorganisms, mineral or organic trace elements and nutrients.
1.3.1. Suspended Solids (SS). Suspended solids make up all of the mineral and organic elements in water, of a non-biodegradable or biodegradable nature. Most of the pathogenic microorganisms checked in wastewater are transported by Suspended solids. The growth in suspended solids in surface water origins the medium to darken. Thus, this loss of light leads to a decrease in photosynthetic activity. In addition, the organic matter (OM) confined in SS promotes the activity of aerobic microorganisms.

1.3.2. Microorganisms. The use or quite simply the presence of wastewater in an environment grants a permanent danger for the environment and the populations. The microbiological danger is due to pathogens carried by wastewater. These agents involve of parasites, viruses and bacteria often leading to inhibition of biological mechanisms. Microbiological pollution develops jointly with organic pollution, by a proliferation of germs of human or animal origin, some of which are highly pathogenic.

1.4. Goals and objectives research

1.4.1. Research purpose
1. Identification of the pollution source
2. Description of the wastewater under the influence of natural and human factors
3. Quantification of main source of pollution and hazardous substances
4. Proposing of new strategies to minimize wastewater effect in environment

1.4.2. Research goals. The objectives of this paper are to evaluate the major source of pollution in the capital, priorities of minimization and to recommend the urgency solutions for now and for the future policy, by give a driver of change the existing knowledge of the people, ongoing importance measures.

2. Methodology

2.1. Choice of specimen sites
Appropriate to be able to make a record of the study area, analyses of the water quality along the area are made Some places were chosen for this study, for example the place where we observed domestic discharges, points where samples have already been taken and founded on existing data. Upstream, downstream and point-of-release measurements were taken. We took nine (9) samples from the three (3) plots.

2.2. Analysis methods
An in-situ analysis of the physical parameters: color, odor, turbidity and electrical conductivity are quantifiable parameters in the pitch using devices and specific methods. The turbidimeter for defining the turbidity, the conducti meter for measurement of the conductivity. It is important to measure these parameters in-situ because its values can vary easily and very sensitive to environmental conditions [9).

Table 2. Parameters and analysis methods used in-situ.

| Parameter       | Symbol and Unity      | Analysis method | Equipment  | Precisions |
|-----------------|-----------------------|-----------------|------------|------------|
| Turbidity       | NTU (Nephelometric Turbidity Unit) | Nephelometry | Turbidimeter | ± 0.02     |
| Electrical Conductivity | EC (μs.cm⁻¹) | Conductimetry | Conductimeter | ± 0.02     |
| Organic Solid   | Manganimetry          |                 |            |            |

Bacteriological analysis aims to find germs by Membrane filtration method also.

2.3. Laboratory analysis of samples
The samples taken are subjected to good packaging conditions and are transported to the analysis laboratory. Major elements analyses, BOD₅ using Oxytop method analysis, COD via Potassium
dichromate, suspended solids, bacteriological analyses with membrane filtration, nitrogen and phosphate pollution with HacH DR / 4000 molecular absorption spectrometry method are unhurried in the laboratory. Then, the data is processed in Excel and will be the subject of interpretation in the next part.

2.4. Sampling and collection
Samples were taken during the dry season. The four sampling points were chosen at the discharge point, that is to say in the wastewater evacuation sewers of the outlying districts of the study area.

In our study, the intervention area is segmented into three plots like in Table 3. Plot 1 is made up of the out-of-the-way districts: Ambavahadimitafo, Faliarivo, Ambanidia, Ambatoroka, Volosarika, Miandrarivo, Manakambahiny and Fenomanana. Plot 2 is made up of two districts: Andrangaranga and Morarano. And plot 3 is confined by the districts of Tsimbazaza-Marohoho and Ankaditoho.

2.5. Presentation of essay
The majority of irrigation water in our study area originates from domestic wastewater. The sample (Ref sample) is considered as a reference which derives from the spring water located in Ambavahadimitafo. Essay E1, E2, E4 and E9 represent domestic wastewater used in agriculture. These releases come from the outskirts of the study area. Essay E3, E5, E6, E7 and E8 are representative samples of domestic wastewater.

Table 3. Location of sampling points.

| Rating | ESSAY | LOCALISATION |
|--------|-------|--------------|
|        | Nature         | District          | Longitude  | Latitude     |
| Eréf   | Spring water   | Ambavahadimitafo | 47°32'11.52"E | 18°55'19.13"S |
| Plot 1 | E1   | Domestic wastewater | Faliarivo - Ambanidia | 47°32'15.58"E | 18°55'18.85"S |
|        | E2   | Domestic wastewater | Ambatoroka - Volosarika | 47°32'20.64"E | 18°55'27.67"S |
|        | E3   | Domestic wastewater | Antsahondra - Volosarika | 47°32'15.24"E | 18°55'20.67"S |
|        | E4   | Domestic wastewater | Miandrarivo - Manakambahiny | 47°32'18.84"E | 18°55'36.56"S |
|        | E5   | Domestic wastewater | Fenomanana | 47°32'23.09"E | 18°55'56.86"S |
| Plot 2 | E6   | Domestic wastewater | Andrangaranga | 47°32'14.86"E | 18°56'6.95"S |
|        | E7   | Domestic wastewater | Marorano | 47°32'11.43"E | 18°56'15.85"S |
| Plot 3 | E8   | Domestic wastewater | Marohoho - Ankaditoho | 47°31'51.48"E | 18°56'12.88"S |
|        | E9   | Domestic wastewater | Marohoho - Ankaditoho | 47°31'43.24"E | 18°56'9.55"S |

Source. Antananarivo Development Office

3. Results and discussion

3.1. Pollution indicators
Laboratory analyses of domestic discharges were performed during this study. The indication of the overall parameters (pollution indicators) allows us to assess the degree of pollution on the site.
3.2. The quality of the effluents

3.2.1. Organoleptic parameters

3.2.1.1. Odour. Visits to the study area allowed us to determine the organoleptic properties of the wastewater. Odour is the set of sensations perceived by the olfactory organ; it is due to volatile substances, suspended matter, protozoa” [10]. Domestic waste has foul odours. The effluents coming from Manakambahiny and Volosarika have very bad odours because these discharges are mainly composed of sewage.

3.2.1.2. Colour. The colour is due to certain mineral impurities (such as iron) but also to certain organic matter. The organic matter resulting from the decomposition of plant or animal matter is the first responsible for the colour of wastewater. To these compounds are added microorganisms such as bacteria, plankton, algae and viruses. The colour of the waters coming from the Volosarika (E2) and Manakambahiny (E4) districts has a gray colour. The excessive growth of algae changes the colour and increases the turbidity of surface water.

3.2.2. Physicochemical parameters. The grades of the analysis for the discharges from the three plots indicate the overall parameters that are indicators of pollution. The purpose of these analyses is to estimate the pollutant loads and the toxicity of certain ions in the effluent which may affect the quality of the receiving environments (water and soil) and to propose new strategies for minimizing wastewater.

3.2.2.1. Turbidity. Suspended particles are responsible for the turbidity or opacity of the water. Turbidity gives a first indication of the content of colloidal matter of mineral or organic origin [10].

![Figure 2](image-url). Turbidity of wastewater in the Plot 1.

![Figure 3](image-url). Turbidity of wastewater in the Plot 2. 
The turbidity of domestic waste is very high. In plot 1, the water turbidity ranges from 127 NTU (E2) to 421 NTU (E1). These values show that the discharges are highly polluted and do not meet the Malagasy standard for liquid effluent discharges (25 NTU) [11,12]. The reject from Plot 3 (E9) also has a turbidity 6 times higher than the Malagasy standard for rejects. These values indicate the magnitude of the pollutant load, characterized by organic and inorganic matter dissolved and suspended in the releases.

3.2.2.2. Electrical conductivity. The values of the electrical conductivities obtained highlight the very significant mineralization of the wastewater, with a maximum value of 977 μS.cm⁻¹ for Plot 1 and 217 μS.cm⁻¹ as the minimum value for Plot 3. These values greatly exceed the norm Malagasy (200 μS.cm⁻¹) [11,12].

Figure 4. Turbidity of wastewater in the Plot 3.

Figure 5. Electrical conductivity of wastewater in the Plot 1.

Figure 6. Electrical conductivity of wastewater in the Plot 2.
Figure 7. Electrical conductivity of wastewater in the Plot 3.

The conductivity is due to the solubility in water of inorganic acids and bases, mainly detergents. In solution, these products generate ions such as sulphates, chlorides, sodium and calcium [3]. The values of the electrical conductivities obtained highlight the very significant mineralization of the wastewater, with a maximum value of 977 μS.cm$^{-1}$ for Plot 1 and 217 μS.cm$^{-1}$ as the minimum value for Plot 3. These values greatly exceed the norm Malagasy (200 μS.cm$^{-1}$). “The conductivity is due to the solubility in water of inorganic acids and bases, mainly detergents. In solution, these products generate ions such as sulphates, chlorides, sodium and calcium [3].

In addition, high Electrical Conductivity disrupts the absorption by plants of essential nutrients, due to antagonism with sodium, chloride and sulfate ions.

Table 4. Simplified classification grid for surface water [13].

| Parameters | EC [μS.cm$^{-1}$] |
|------------|-------------------|
| Very good  | < 400             |
| Good       | 400 - 1 300       |
| Average    | 1 300 - 2 700     |
| Bad        | 2 700 - 3 000     |

By referring to the surface water classification grid of the DRPE, the electrical conductivity found in the sources E1, E2, E3 and 4 are of "good" quality, the values are between 400 to 1300 μS.cm$^{-1}$.

3.2.2.3. Polluting loads. The parameters used in the regulator of organic pollution from sewages are biochemical oxygen demand (BOD), chemical oxygen demand (COD) and suspended solids (SS). The Figure 8 show the annual variation of these parameters [14].

Figure 8. Temporal variation in BOD, COD, SS and OM found throughout the study site.
3.2.2.3.1. Suspended Solids. In the control site (Reference Essay), the value found in this plot complies with the Malagasy rejection standard (around 60 mg.L\textsuperscript{-1}) [11].

Plot 1 is complete by three sources of wastewater (E1, E2 and E3), the suspended solids content in these three sources is high equated to that measured. The values of suspended solids SS in domestic discharges fluctuate from 400 mg.L\textsuperscript{-1} (S2) to 605 mg.L\textsuperscript{-1} (E1), while in wastewaters 9 mg.L\textsuperscript{-1} (E5) and 24 mg have been found. L\textsuperscript{-1} (E3). The content of suspended solids in domestic discharges significantly surpasses the Malagasy standard from which it is needed to treat these effluents before discharging into surface water [11,12]. These values show the significant occurrence of polluting loads, whether inorganic or organic, in the water. It therefore appears that the site is contaminated by non-biodegradable products. The high SS values in the three essays (E1, E2 and E3) are probably connected to the load of mineral matter, namely sand, silt, clay.

The water taken from plot 2 has normal suspended solids SS values compared to the Malagasy standard for discharges [11,12] and the Food and Agriculture Organization standard (<70 mg.L\textsuperscript{-1}) for irrigation water. They vary from 5.5 mg.L\textsuperscript{-1} (S7) and 23.5 mg.L\textsuperscript{-1} (E6). The content of suspended solids SS in watercress water complies with the Malagasy standard for discharges.

The contents of suspended solids SS in plot 3 are 345 mg.L\textsuperscript{-1} (E9) and 11 mg.L\textsuperscript{-1} (E8). S9 characterizes the sample of domestic wastewater from the Tsimbazaza-Maroroho district, and the content of suspended solids SS measured is high related to the content of suspended solids SS in other samples.

3.2.2.3.2. COD and BOD. According to decree n° 2003/464 of the Ministry of the Environment for the regulation of liquid effluent discharges, the discharges must respect the values in COD (> 150 mg.L\textsuperscript{-1}) and in BOD (> 50 mg.L\textsuperscript{-1}) [12].

In plot 1, the COD diverges from 278.4 mg.L\textsuperscript{-1} (S2) to 730 mg.L\textsuperscript{-1} (E1). While in plot 3 we found a value of 430.2 mg.L\textsuperscript{-1} (E9). The high COD values initiate in these two plots are due to the draining of valve water from the outlying districts and the discharges from public washhouses. Wastewater from samples E1, E2, E4 and E9 is used to irrigate vegetable crops. The CODs for the wastewater in the site range from 19.2 mg.L\textsuperscript{-1} (E3) to 78.4 mg.L\textsuperscript{-1} (E5), these values comply with the Malagasy standard for discharges (<150 mg.L\textsuperscript{-1}).

![Figure 9. Assessment of pollutant loads in Plot 1.](image-url)
3.2.2.4. Organic matter. Most organic composites of human, animal or plant source in wastewater decay rapidly in soils. By aerobic conditions, decay is mostly faster, more complete than under anaerobic conditions. Stable, non-toxic organic compounds are formed, such as humic and fulvic acids [3].

The domestic wastewater in plot 1 contains high organic matter: its concentration varies from 7.2 mg.L\(^{-1}\) (E2) to 20.8 mg.L\(^{-1}\) (E4). Significant concentrations of organic matter in the wastewater coming from the Faliarivo-Ambandia, Ambatoroka-Volosarika and Manakambahiny districts cause a foul odor from domestic waste, especially when it stagnates on the surface. The excessive presence of organic matter causes difficulties in the transport and distribution of effluents as well as the clogging of irrigation systems [11], this is found in the Miandrarivo-Manakambahiny district.

Figure 10. Assessment of pollutant loads in Plot 2.

Figure 11. Assessment of pollutant loads in Plot 3.
3.3. Origin of wastewater. In urban areas, wastewater is produced daily by households, institutions, businesses. However, their characteristics vary depending on the type of use. But in general, here we can categorize wastewater in one of its origins: domestic water, runoff water.

3.3.1. Domestic sources. Wastewater from domestic sources comes from the use of water (drinking water in the common of cases) by each individual [12,13].

When hometowns are in shared sanitation zones, domestic water is settled into public sewers. Cooking water encompasses suspended mineral matter from washing vegetables, food substances based on organic matter (carbohydrates, protein lipids), and detergents. Laundry water, mainly containing detergents; bathroom water loaded with products used for personal hygiene, usually hydrocarbon fats. Black water from sanitary services, very loaded with nitrogen and phosphorus compounds, microorganisms and organic hydrocarbon materials (urea, uric acid and creatinine). In the urban area, domestic wastewater covers a high concentration of salts because of the existence of abundant public latrines, washhouses and garages in the neighbourhood of crop fields.
3.3.2. Runoff sources. Through the rainy season, rainwater is also a key source of surface water pollution. Rainwater converts loaded with impurities on contact with the atmosphere (for example: acidification of rain). Then during runoff, it brings away residues deposited on city roads (used oil, fuels, residues of plastics and heavy metals).

4. Conclusion

Visually, domestic wastewater is coloured affording to the products used in each household and the products to be washed. This coloration was detected and up to a few meters from the release points. This water origins pollution of sanitation structures and has impacts for aquatic organisms and especially for the local population who practice agriculture and laundry there.

It is therefore imperative to mobilize a budget for the construction of wastewater treatment plants before serious public health problems such as epidemic diseases caused by unsanitary water appear. The installations of this natural lagoon and of this infiltration-percolation sand bed are important to better protect the receiving environment. These low concentrations downstream are due either to the phenomenon of sedimentation or to dilution or both.

The government and the ministries concerned must request the application of the law and decrees on wastewater treatment before discharge, while considering the treatment of domestic wastewater from surrounding households because the majority of the local population discharges their raw sewage into the near river.

Most sewage disposal systems are blocked with solids and do not allow the collected water to drain normally. This is why it is necessary to make effective periodic cleaning at the level of these parts favorable to the accumulation of solid waste.

Greater awareness of the population to take responsibility to pay for a healthier environment should be also implemented. Most residents do not consider sanitation one of their priorities. They do not think about the effects of small everyday actions that attack the environment. A whole education therefore remains to be done for a real awakening of environmental awareness: at the level of households, in public places, various establishments, health centers, or even at the level of the various associations. It is necessary to make known the harmful effects of insalubrity and to generate the right reflexes and the right behaviors to preserve the drainage channels and the environment clean, put the garbage in the places reserved for them, build latrines that meet the standards, and drain them regularly. Follow-up evaluations will have to be carried out after the sensibilization.

The population must also take its share of responsibility. It is also essential to make significant investments in sanitation and wastewater treatment, as well as capacity building and technology transfer. Significant resources will therefore have to be mobilized, which should also enable water and sewage establishments to improve their services and extend them to unserved populations.

Like the essential financing needs, sanitation requires competent human resources, commensurate with the ambitions of the city and the challenges to be met. The treated water from the ponds can be used for agricultural purposes.

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