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RESEARCH ARTICLE

DIAGNOSES OF THE POTENTIAL SOURCES OF THE ANTHROPIC POLLUTION OF THE NIGER STREAM AROUND THE CITY OF NIAMEY (NIGER)

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Abstract

During its crossing in the agglomeration of Niamey, the Niger stream serves as spillway of the garbage as a dump for both solids and liquids generated by the industrial and domestic activities. The main objective of this study is to identify all garbage resulting from the activities of the population of Niamey bordering to the Niger stream. Some interviews have been led by the taking parts responsible for the production and the management of the urban garbage, followed by the investigations of the land through the observations of the states of the banks of the stream and the urban infrastructures of purification of the garbage. The gotten results reveal that on twenty-one (21) establishments investigated; only six (6) pre-treatment facilities for their effluents. Also, the network of purification of used waters of the city of Niamey is the unit type, and deprives functional works of purification of the urban worn-out waters. The city of Niamey rejects sewages of used waters in the Niger stream through thirty-seven (37) points of the dismissals identified along the banks of the Niger stream, of which thirty-four (34) on the left strand and three (3) on the right strand, therefore the less exposed to the pollution. On the other hand, the abduction of the solid garbage endures an insufficiency, of such sorts that garbage is evacuated in the gutters, the valley of Gounti-yéna " to be drained at the stream or poured directly on the banks of the Niger stream. Thus, thirty (30) points of stripping of the garbage near the course of the Niger stream have been identified of which seven (7) garbage dumps out of the right strand and twenty-three (23) on the left strand. Indeed, the anthropic sources of the pollution of water of the Niger stream in the city of Niamey result from dismissals of garbage and the worn-out water essentially bound to the activities of the city.

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Introduction:-

The flight of the extension of the big cities in the basin of Niger, started by the demographic and industrial growth, is the basis of the growing production of both solids and liquids garbage under various shapes (Kone and Kotschoubey, 2005). However, the elimination of the garbage out of the urban surroundings, endure an insufficiency. This situation is a lot preoccupying when one discovers that a big part of the garbage generated by the big cities in the basin of Niger, are rejected in the natural environments without any precaution (Dejoux, 1988; Kone and Kotschoubey, 2005). However, the failing of the system of purification of the agglomerations in this basin makes generate increasing fluxes of the garbage in the aquatic environments (the pools, the affluent and the stream) (Dejoux, 1988; Christophe and Dennis, 2008). Particularly, the Niger stream, main river of the basin, receives multiple dismissals of the garbage resulting from the nearest agglomerations, from the upper Niger (interior delta) until the lower Niger (maritime delta) (Cissé, 1997; Kone and Kotschoubey, 2005; Akpan 2004; Bah et al., 2016). Indeed, the Niger stream that collects the set of the dismissals of the urban garbage, is submitted to the anthropic pollution exercising unpublished pressures inevitably on the aquatic environments of this one (Mokaya et al., 2004; Christophe and Dennis, 2008; Sow, 2017). This anthropic pollution of the Niger stream by the dismissals of the garbage is more and more alarming in a lot of the cities crossed by this one, because limiting the access to water supply in healthy piscatorial products (Cissé, 1997). Otherwise, along the course of the Niger stream on its banks are strongly developed, the practices of irrigation with the use of the big quantities of the agro-chemical products (Besnier, 2005). However, these practices of irrigation generate fluxes of the polluting substances assorted by the sewages resulting from the drainages of the excess waters rejected directly in the Niger stream.

Niamey, capital of Niger appears among the big cities of the basin of Niger where the Niger stream serves as spillway of the urban garbage of all sorts and all origins (Tini, 2003; Alhou, 2007). These dismissals are the direct consequences of the excessive urbanization with a system of tributary faltering purification of the collective calamities of narrowness, obsolescence of the works of purification of the garbage and lack of the specific works of treatment of the worn-out waters (Issaka, 2010). The drastic insufficiency of the works of purification of the solids garbage in the city of Niamey and the absence of the actual sewer network, are felt distinctly, when one discovers that the garbage, the waters of the floodgates, the muds of draining are evacuated openly in the gutters and/or are poured directly on the banks of the Niger stream (Issaka et al., 1998). Given that the network of purification of the urban and pluvial residuary waters, unstop in Niger stream, while assuring the evacuation of all heterogeneities of the garbage (worn-out waters, solids and fecal matters) collected by the gutters.

Early several applicable studies led on the quality of the water of the Niger stream in the height of Niamey (Alhou, 2007; Tinder et al., 2011; Rabani et al., 2015), brought some knowledge on the pollution of water, without inquiring the real sources potential releases, in a deepened way. It is to palliate to this default, that the present work is led and aim to inventory the main sources of the anthropic pollution of the water of the Niger stream in Niamey.

Materials And Methods:-

Presentation and description of the survey zone

The zone of this survey corresponds to the agglomeration of Niamey, capital of Niger republic. Situated between the latitudes 13°28' and 13°35' North and the longitudes 02°03' and 02°10' East, the city of Niamey is localized in the western part of Niger (INS-Niger, 2018) Niamey covers a urbanized surface of 297,46 km², divided in five (5) local precincts with a population estimated to 1 026 848 inhabitants (INS-Niger, 2018). The Niger stream, the only permanent river, crosses the city on 31.089 Km and divides it in two unequal parts: the left strand and the right strand. The left strand, the most extended and the more urbanized is crossed by a talweg, the Gounti-yéna, following which is drained at the stream the pluvial waters and the urban worn-out water (Tankari Dan-Badjo and al., 2014). The right strand, the last extended and the last developed economically, is partially floodlight in wintry season and in period of big rises in the water level of the stream. During its crossing in the agglomeration of Niamey, the Niger stream presents some numerous advantages, notably, the water supply of the city (for the consumption of the population and for the irrigation); the everlastingness of the faunistics and piscatorial environment; the fluvial transportation; the case of the dismissals of the urban worn-out waters and the solids garbage of the city (Abdoulkarim et al., 1994). The figure 1 shows the geographical localization of the survey zone.

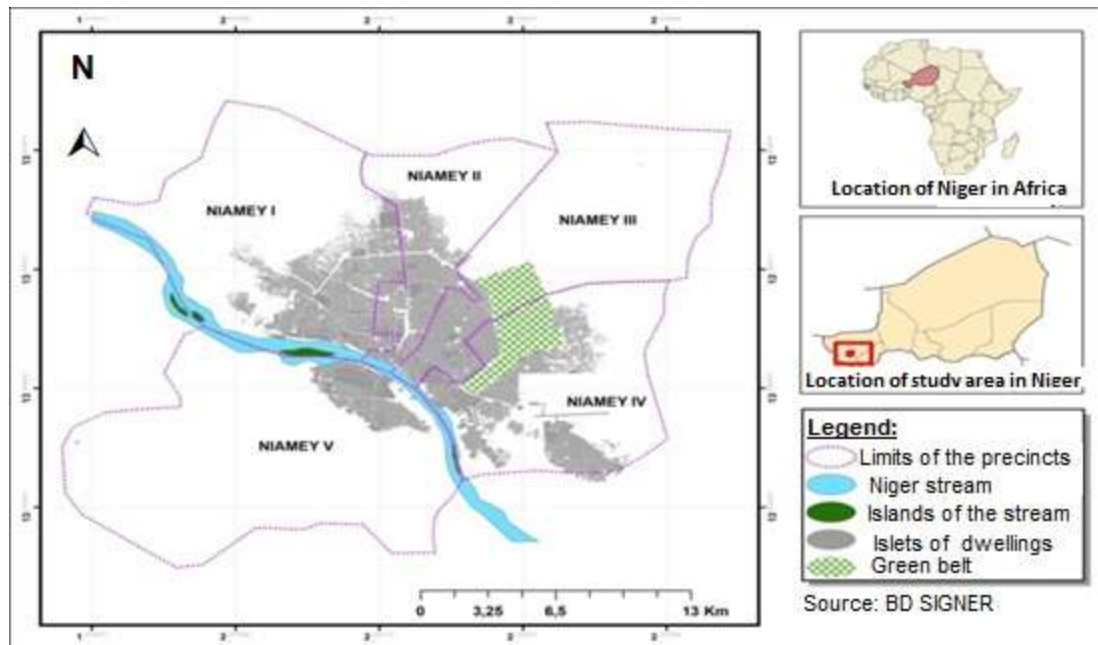


Figure 1:- Geographical localization of the survey zone (Source: BD SIGNER, realized by Waziri Zaneidou (2019), modified by Adamou Marafa).

Methodology:-

The methodology adopted for the realization of this survey, focuses on two strategic axes namely the interview to basis of an investigation grid by the taking parts responsible for the production and the management of the garbage and the observations of the physical environment of the surroundings that have been the subject of investigating.

Interview

The target population of investigation is composed of two constituted groups responsible of the production of the garbage (the households; the health centers and commercial centers, the residential and industrial establishments) and those that are responsible for the management of these urban garbage that mean the townships of all local precincts. However, the investigation has been led on the basis of the investigations namely, the maintenance guide for the townships; the industry; for the hospitals/care and the agricultural hydro amenities.

Structure of the questionnaires:

The formulated questionnaires are constituted by open questions (free answer) and closed (answer by propositions). The fashion of administration of the questionnaires is the face-to-face investigation for the households and the industrial, hospitable establishments, the agricultural exploitations and auto-administration (only investigation) for the townships. To this interview, it was question to discover the different fashions and the places (collectors (gutters, containers), the thalweg " Gounti-yéna " and the banks of the Niger stream) of tipping of the garbage and the availability of the specific works of collection and treatment of the residuary waters and garbage.

Choice and Size of the specimen:

The distinctive criteria for the choice of the investigation sample, has been carried to the authors producers of garbage and the big producers of worn-out water capable to reach in Niger stream. Thus, 70 households have been chosen in an uncertain way according to their proximity to the Niger stream and their immediate locality to a collector. Have been investigated 20 establishments composed by industries, the care center, the hotels, the big market and the University Abdou Moumouni of Niamey (UAM). All townships of the local precincts of Niamey five (5) in numbers have been interviewed by their services of purification.

Treatment of the data:

To assure the credibility of information, the treatment of the data has been driven in such a way that the analysis reflects the present situation of the milieu. While taking this into account, only the establishments connected to the networks of municipal sewers clearing at the stream and/or directly connected to the stream will be taken in to

account (identified and localized) to follow up on the perception of the present situation of evacuation of the urban garbage in the Niger stream in Niamey.

Observation of the physical state of the land

During this stage, have been visited, the urban valley " Gounti-yéna "; the urban infrastructures of collection of the garbage (the gutters and the containers); the specific works of treatments of the urban sewages and some establishments (industries, hospitals, hotels, of the school cities). some direct observations have also been carried on the banks of two strands of the Niger stream in the city of Niamey to note the different exploitations of the strands and those of water, the relative distances of the stream in relation to the dwellings and to the wild garbage dumps of garbage, the outlets of the emissaries of the urban sewages, the presence of the potential pollution indications. The assigned objective by this one is to learn about the reality of the land in order to verify, to complete and to confirm some information collected at the time of the investigation.

Results and Discussion:-

Direct sources of the pollution of the stream: exhibition of the surroundings of the Niger stream in Niamey, to the anthropic pollution,

The occupations of the edges of the stream by habitats, accompanied by the operation of several other anthropic activities likely to generate some pollutants, constitute the direct sources of the pollution of the Niger stream.

Occupations of the edges of the Niger stream and purification of the garbage

The excessive extension of the urban space of the city of Niamey, led to an anarchical urbanization along the Niger stream, of which the maximal distance between the dwellings and the stream, is less a meter (1m) to zero (0 m) for the periods of rise of in the water (local flood and Guinean flood of water climb) and of hundred meters (100 m) to fifty meters (50 m) for the period of subsidence. These dwellings include a part of the districts GamkaléGoudel, Saga, Gamkalé ledge, and Yantala ledge localized on the left strand and a part of the Lamordé district on the right strand. The conditions of hygiene and the purification of these dwellings to anarchical occupation of the edges of the Niger stream are very precarious and austere, by continuation, the insufficiency of the infrastructures of autonomous purifications (latrine, septic tanks and cesspools) and the total absence of the collective works (the gutters) of the garbage. However, the domestic garbage produced by the squatters of the edges of the stream which are conditional to the existence of the human life, are rejected pell-mell, anywhere in the vicinity of their camp. About of excreta them generated by the households of these dwellings of immediate proximity of the Niger stream are in more cases collected directly in the dry or outcast latrines (ancestral practice) in the nature on the banks. Frequently, do to the flooding, these latrines and garbage found themselves swallowed entirely by the water of the stream in wintry season or in period of big rises of water. Otherwise, the results of investigation confirmed by the direct observations on the land show that the riparian dwellings of the banks dispose of very few containers of collections of the garbage, what makes that several wild dumps of garbage are created all around on the immediate banks of the Niger stream (figure 7).

The vacant spaces of the banks of the Niger stream in Niamey are taken in possession by the agricultural activities. The systems of agricultural production from the banks of the stream include the market gardening, the fruit arboriculture, the rice farming practiced along the strands of the Niger stream. This agriculture of proximity offers three (3) types of the culture systems namely: the pluvial traditional system; the individual system by motor-pump and the system arranged on big modern amenities hydro-agricultural, notably, the perimeter rizicole of Saga, Kirkissoye, Saguia and Lossa-goungou. Concerning agricultural popularization, all these systems of culture use agrochemical products (manures and pesticides). However, the big agricultural hydro amenities free their sewages directly in the stream through their systems of drainage. Indeed, the sewages freed by all these systems of the cultures in the stream, also constitute important sources of the diffuse pollutions and nourishing enrichment of the water of the stream.

During the period of low level of the Niger stream, due to the shrinkage of meander of the Niger stream, the bed of the stream is transformed in a place of grazing of the animals, therefore receiving enormous quantity of the animal evacuations. All these situations drive more and more to the enrichment of the Niger stream by organic pollutants and the rubbishes of all sorts. It is in this same order of idea that the survey led by Issaka (2010), report that the pejorative occupations of the banks of the Niger stream in the vicinity of Niamey are favourable sources of the circumstantial pollution of the banks, therefore of the pollution of the Niger stream, in spite of the recurrent flooding draining all garbage stored on the strands.

Activities anthropic and pollution of the shore

In Niamey, the Niger stream presents the numerous advantages, namely the maintenance of the level of the alluvial tablecloth, the everlastingness of faunistics and piscatorial surroundings, provision of the piscatorial products (pitch), water supply in the city of Niamey and the agricultural exploitations. Besides, are practiced all along the stream several other activities of subsistence for the riparian population of the stream and even urban. According to the results of the investigation, agriculture is the most important socioeconomic activity practiced on the banks of the Niger stream in Niamey. Developed with the use of manures and pesticides, agriculture occupies 74.9% of the riparian population of the stream. Besides the daily delivery of the sewages to the stream, it proved to be that during the wintry season, after washing of the soils of the agricultural hydro amenities, the excess waters charged in water-soluble salts, in fertilizing mineral substances and in vestigial pesticides, by drainage or by streaming in the fields of the cultures are evacuated toward the Niger stream.

Breeding is the second most important activity practiced by 13.2% of people interrogated. The fishing is the tertiary activity of subsistence exercised by 8.2% of the population interrogated. In margin of these activities, the fluvial transportation occupies 3.7% of the investigated sample. During the period of the high waters, the whole urban part of the valley of the Niger stream is an axis of communication through the dugouts between the islands, the surrounding villages and the city of Niamey.

The peripheral districts of Niamey bordering the Niger stream are characterized by a weak cover of the servicing in near and perennial drinking water necessary to the needs of the households. What makes that 91.78% of the riparian population of the investigated sample, use the water of the stream directly for various domestic activities as the bathing, the laundry, the dishes and even often for the food. In addition to these domestic tasks done on the beaches of the stream are noted also, the private laundries, the washings of the cars, as well as the test and the washing of the tanks-cisterns after having contained the oil products. However, the execution of these domestic tasks, require the use of big quantity of detergents freed in the Niger stream and encourage at the sample time the dropping of enormous earthy particles at a time in column of water. In addition to it, the livestock of the riparian population drinks directly to the stream that rejects their evacuations and urines on the banks at the end of this opportunity that will also finish in the Niger stream. The figure 2 visualizes the different anthropic activities practiced at the urban fluvial valley in Niamey.



Figure 2:- Different activities practiced by the riparian population on the Niger stream in Niamey (Source: Adamou Marafa (2021)).

Note:

A :Practice of domestic activities servants on the stream (laundry, dishes and bathing); B: Grazing of the cattles on the minor bed of the stream in period of subsidence; C: Activities of skin tanning; D: Test and washing of the tanks-cisterns after having contained oil products

Besides, the Niger stream constitutes a source of the production and daily restocking in drinking water in the city of Niamey. However, two processing plants of water are installed in Goudel and Yantala upstream of the downtown of Niamey according to the permanent out-flow of the Niger stream. These two stations of water treatment, evacuate in the stream of the enormous quantities of sewages (coming from factory and laboratory) and of the muds rich in chemicals resulting from the decanting basins.

The exploitation of the materials of the bed of the Niger stream to it is added at the height of Niamey, by the enterprises of building construction and public works. This exploitation appears by the clearing of the bed of the stream to extract the sand and gravel (figure 3). What leads at the same time to the salting-out in the column of water, the sediments and pollutants (metallic and organic) that are previously is incorporated in to them. This, leads at the same time to the loading more of advantage of the water of the stream by the solid particles in suspension (elevation of the rate of the solid matters in suspension and the content in silicate).



Figure 3:- Illustrative example of exploitation of the bed of the Niger stream in order to extract the sand(Source: Adamou Marafa M. (2021)).

In short, the interaction between the man and the Niger stream in Niamey, puts in evidence the exhibition of the urban fluvial basin to the risks of the pollution due to the anthropic threats caused by the city-dwellers and the residents through conditional activities to the life of the population of Niamey. So these same reports have been made by Abdoukarim, (1994).

Indirect Sources of the pollution of the Niger stream: Purification of the urban garbage and exhibition of the stream to the pollution

The pollutants generated by the activities in the different socioeconomic sectors of the city of even inconvenient and unsanitary are largely evacuated in the Niger stream through the system of purification of the urban garbage.

System of the drainage of the sewages of Niamey in the Niger stream

Niamey is endowed with a network of purification of the residuary water, constituted by main collectors and the secondary and tertiary channels in an open air in their majority that goes against the sewages of the households of the districts of downtown and the industrial zone. According to the diagram of discharge of the urban worn-out waters, the network of collection of the sewages is structured in two parts according to itsworking of discharge structured as follows: a network of collectors, that only transports the waters of urban surface streaming toward the Niger stream and a network of sewers unit that transports a mixture of the domestic worn-out water and the pluvial

waters. The set of the urban sewages, constitute a diffuse pollution, flowed to the Niger stream via the emissaries, in a prompt way along the banks of the Niger stream in the city of Niamey. Otherwise, sewages directly evacuated to the Niger stream without having passed in transit by the network of purification exist however. These direct dismissals are evacuations of the sanitary waters of some households of the edges of the stream, some hospitable centers (National hospital and hospital of Lamordé) and some industrial units. In Niamey, the sewages drained at the stream are various and varied according to their sources and their origins. Notably, have been identified thirty-seven (37) points of dismissals localized along the banks of the Niger stream, of which only three (3) outlets out of the right strand and thirty-four (34) outlets on the left strand. What shows that the left strand is the more exposed to the pollution following the different dismissals of the urban garbage.

Sources and origins of the urban sewages drained in Niger stream

The urban sources of the pollution of the Niger stream by the sewages are essentially the residuary water of all origins resulting from anthropic activities of Niamey and waters of rain coming from streaming of the urban surfaces. Especially, the urban sewages are constituted by the worn-out waters generated by the households, the industrial units and the hospitable centers of Niamey. Especially, used waters of the dwellings, only those of the central districts of the city of Niamey are rejected in the gutters of pluvial waters crossing the urban districts to regain the stream directly or indirectly through the Gounti-yéna valley that itself clears at the stream.



Figure 4:- Adjusting of the sinks collecting used waters of the showers of the households on the gutters (Source: Adamou Marafa M. (2021)).

The worn-out waters generated by the hospitals namely National Hospital and Hospital of Lamordé are collected directly by their units of treatment and evacuated in the Niger stream. The Central motherhood, the powder-keg motherhood and the health Center of Gamkalé evacuate their sewages in the municipal collectors of purification. Being about the dismissals of the hotels (Gaweye Hotel, Big Hotel, Soluxe Hotel and Sahel Hotel), similar to those of the campus of the University Abdou Moumouni (UAM), the Aghrymetcenter, the different faculties including the laboratories of analysis, are evacuated directly to the stream, without any treatment. According to distribution by branch of the generating industrial units of the worn-out water evacuated to the Niger stream, are distinguished the agro-food industries, the industries of leather and skins, the chemical industries, the stations-services and the shops of car washing considering their proximalneighborhood in the industrial zone, some industries namely BRANIGER; ORIBA; Unilever; Labocel; Lanspex; pour their worn-out water in the big collector of the Gamkalé district. Niger-Milk evacuates their sewages in a ravine being in the dressing of the aforesaid society. Other industries installed to the immediate proximity of the stream pour their sewage of worn-out water directly in the stream without any treatment (as not having station of treatment), it is the case of the refrigerated slaughterhouse; the Tannery of Gamkalé; and the SOLANI society.

Garbage drained in Niger stream through the collectors (gutters)

The works of purification of used waters of the city of Niamey are confronted to a notorious reality of failing of their maintenance and the inappropriate behaviours of hygiene of the populations that make that the solid and liquid garbage of the households constitute sources serious of nuisance and insalubrity of these works in an open air in the capital. In the absence of the actual sewer network in the city of Niamey, the manual dustmen evacuate the water of floodgates and the muds of draining of the septic tanks in all gutters of the city including those that are not destined to the evacuation of the worn-out water. The figure 3 indicates the cases of the evacuation practices in the gutters of the contents septic tanks of the households.



Figure 5:- Evacuation of the waters of floodgates and muds of the draining of the septic tanks in the gutters (Source: Adamou Marafa 2021).

Note:

- A: Tipping of the draining of the septic tanks in the gutter
 B: Muds of draining of the septic tanks trickled in the gutter

What makes that these gutters became in the open lodgings potentially favourable to the development of the vectors (flies, mosquito...etc.) of several water illnesses (example of malaria). In addition to it, these gutters are as responsible for clearing of the sickening odors disrupting the quality of air breathed, what hinders the pleasure of the quality of the ambient air of the environment of some alleys of the capital. Thus, to arrive at the end of this clearing of repugnant odors and to the development of the larvas of the mosquitos, some persons responsible of the houses and shops which are at the immediate neighbourhoods of these gutters, pour them worn-out oils of the cars, as the shows the figures 4. At this level, it should be noted, that the Niger stream also receives enormous quantity of used oils of the contraptions, via the gutters through such treacherous practice (in violation of the article 6 of the norm of the Nigerien dismissals).



Figure 6:- Tipping of the used oils of the contraptions in the gutters (Source: Adamou Marafa M, 2021).

Besides, the municipal works of purification of the worn-out and pluvial waters of the city of Niamey, mainly the gutters in an open air are struggling with a situation of insalubrity resulting from the inappropriate behaviors of hygiene of the populations and to the failing of their maintenance. In a general manner, the vicious behaviors of the population on the gutters amount to the manual tipplings of the draining of the septic tanks, to the draining of the pots (stools) of the children, the dismissals of the solid objects resulting from the dismissals of the individuals, the tipplings of the garbage, and to the illegal adjustings of the latrines to the gutters by some households. In short, the assembly of such heterogeneity (worn-out water, solid and fecal matters) constitutes serious sources of nuisance and insalubrity of these collectors in an open air of the worn-out and pluvial water of the central districts and central of the city, whose outlets clear in Niger stream. However, the evacuation of the garbage contained in all collectors of the worn-out and pluvial water of Niamey was done directly at the stream without having passed in transit by no station of purification. What exposes the Niger stream more too all sort of anthropic pollution around Niamey. This latter, is fundamentally a question of behavior of the citizens, on behalf of both the populations (negative behaviors), and the persons responsible charged of the question of hygiene and the purification of the city to all levels. All these hiatuses of behavioural order both on behalf of the population and of the public institutions in the setting of purification and the urban hygiene of Niamey, have been underlined early by several studies tracks (Tini, 2003; Issaka, 2010).

Diagnoses of the system of treatments of the sewages clearing at the stream

The characteristic common point of the establishments having been the subject of investigating is the production of the residuary water clearing directly or indirectly to the Niger stream. According to the investigation, on twenty-one (21) establishments investigated, only six (6) arrange works of treatment of their sewages. A part from BRANIGER, Niger-Milk, Lamordé Hospital, most stations of purification of some establishments are dysfunctional, the case of the University Abdou Moumouni (UAM), SOLANI and National Hospital.

After field visit confirming the information of the investigation, except Niger-Milk, the infrastructures of control of dismissal of these establishments are in a state of ruined working, therefore fully not filling their function. What proves that the process of the treatment to small scale of these establishments, don't eliminate all polluting substances. Otherwise, the establishments that never had the stations of purification of their sewages, the case of Tannery of Gamkalé, Refrigerated Slaughterhouse, Central Motherhood, care Center of Gamkalé, Lanspex, Labocel, Gaweze Hotel, Sahel Hotel, Grand Hotel, Soluxe Hotel, also exist.

Used waters of the dwellings of the central districts of the city of Niamey are rejected in the gutters of pluvial water crossing the urban districts to regain the stream directly or indirectly through the Gounti-yéna valley.

The network of purification of the city of Niamey is the unit type constituted an open air by main collectors and secondary and tertiary pipelines in their big majority that goes against the sewages of the capital. With regard to the specific works of purification of the worn-out water, that Niamey sheltered, the station of purification of UASB type on the Gounti-yéna and school purification of type " Jyocaso ", are in a state of working stop since more of one decade.

Solid urban garbage evacuated in the Niger stream

The solid garbage generated by the activities of the population of the city of Niamey, constitute a supplementary source of the pollution of the water of the stream.

Tipping of garbage in the collectors of the worn-out and pluvial waters

An important part of solid garbage generated by the activities of the population of the city of Niamey, leads directly in Niger stream via the gutters or indirectly through the urban valley " Gounti-yéna". This solid garbage evacuated to the Niger stream constitutes a supplementary source of the water pollution to this one. The garbage collected by the gutters are resulting from the households of the central districts and urban central of Niamey that are not at all sufficiently covered by the public services of collection of garbage. However, an important part of these garbage is eliminated in an anarchical manner through the gutters. This situation is very shattering when one discovers that the elimination of these garbage in the gutters by the townships of Niamey through the clearing-outs, endure an insufficiency the sight of their state of insalubrity. The famous face 3 the presence of the garbage in the gutters drained until the stream by the current of the worn-out or pluvial water.



Figure 7:- Garbage evacuated in the gutters and drained until the stream (Source: Adamou Marafa M. 2021).

Note:

A: Solid objects rejected in the gutters

B & C: Evacuation of the garbage in the gutters

It is especially during the wintry season, by auto-clearing-out resulting from the repression of garbage by establishment of a turbulent regime of the pluvial water that all garbage contained in the gutters reach at the stream. Indeed, the Niger stream constitutes the spillway of the solid garbage resulting from the various urban activities of Niamey.

Direct stripping of garbage on the banks of the stream

The households of the riparian peripheral districts of the stream (along the Yantala ledge, the Gamkalé ledge, the vicinity of the districts Saga and Goudels) are injured very by the public services of collection of the garbage. According to the investigation, 58 households out of 73 evacuate their garbage to the immediate proximity of the beaches of the Niger stream. Only, seven (7) containers of collection of garbage are put at the disposal of this part of the agglomeration of Niamey besides classified urbane. However, the solid garbage generated by these households are rejected in an anarchical way on the banks of the stream and its vicinity with the creation of about thirty dumps the wild garbage. The rain water carries every year of the enormous quantities of the garbage until the Niger stream. The figure 7 shows the different storages of the garbage on the surroundings of the Niger stream at the height of Niamey.



Figure 8:- Storage of the solid garbage on the banks of the Niger stream at the level of Niamey (Source: Adamou Marafa M. 2021).

Note:

A and C: Wild dumping ground for house hold waste on the bed of the Niger river

B: Wild stripping of the rubbishes of skin tanning on edge of bed of the Niger stream

Of these urban solid dismissals, are observed the rebuses resulting from the processes of manufacture of goods by some industrial and artisanal units. It is the case of the refrigerated slaughterhouse and the Tannery of Gamkalé in Niamey. Considering the analysis of this situation, the Niger stream acts at the same time as garbage dump and

spillway of the solid garbage of all sorts. Especially, have been identified thirty (30) points of stripping of the garbage (8 official garbage dumps and 22 wild garbage dumps) near to the Niger stream, of which twenty-three (23) on the left strand and seven (7) on the right strand. What shows that the left strand is the more exposed to the pollution resulting from the stripping of the urban garbage.

Indices of the anthropic pollution on the bed of the Niger river in Niamey

In Niamey, the valley of the Niger stream, seen from the Yantala ledge and Gamkalé, constitutes a potential picturesque landscape based on the potentiality in water and in greenery. The advantage of this amenity potentiality has been pulled through the realization of several amenities namely the private gardens, the small public spaces, the bars and the restaurants often installed on the strands adjoining to the stream. More and more, the amenity of this landscape sees itself discount in reason by the behaviors of inappropriate hygiene of the riparian populations resulting from the direct tipping of the liquid sewages, the solid garbage and the defecation to the free air on this heritage. This ancestral practice of defecation to the free air, is perpetrated by the members of twenty-four (24) on seventy-three (73) riparian households of the stream that don't have some of the autonomous ease places in their home. However, the banks of the stream especially to its left strand are subject in an alarming insalubrity state. In some places of banks, these garbage are stored anywhere in anarchical manner near the current of the stream. Very often these garbage are also burnt to the free air letting the blackish stains constituting serious sources of insalubrities and spots for these natural resources in part. Indeed, this audible pollution affecting the integrity of this natural heritage, restricted their values of cultural and tourist uses. However, the management of such a spot imposes itself to limit the negative impacts before the deterioration of the quality of this natural landscape becomes terrible. Otherwise, the banks of the Niger stream in Niamey, are the homes sheltering the outlets of the collectors of the worn-out and pluvial water of the city (figure 9 A). However, around Niamey, the bed of Niger stream is seen like being a potential lodging of accumulation of strong garbage composed of the objects of all sizes. It is necessary to note that, it is during the rainy season that all strong garbage poured in the gutters, in the Gounti-yéna valley and on the outskirts of the stream, are evacuated truly to the stream and are drained by the current of this one. Notably, more than 35% of the garbage produced in the city of Niamey, are drained at the stream every year. The pluvial water that carry all these solid garbages in the stream are composed of the dissolved matters (very fine and light solids), the colloidal matters (solids with very small particles), matters in suspension (solid in menus fragments) and the floating matters (fluid sleek). According to the size of the particles or the solid objects considered in the pluvial sewages evacuated to the stream, one distinguishes the very rude and rude matters that deposit themselves to the low bottom of bed of the stream and the very light matters that leave in suspension. The figure 9-B shows the deposits of the solid objects of small size (plastic (sachets and cans), rags...etc.) and of large size (tires, carcass of electronic machines...etc.) on the floodplain of the Niger stream coming from the dismissals of the solid garbage of the city of Niamey carried by the streaming of the rain water since the first rain.



Figure 9:- Impacts of the dismissals of the garbage on the bed of the Niger stream in Niamey (Source: Adamou Marafa M. 2021)).

Note:

A : Intrusion of the urban sewages of Niamey in the Niger stream (evacuation of Gounti-yéna)

B : Deposit of the strong garbage on the floodplain of the Niger stream after the first rain corresponding to the period of lowering (behind the palace of convention and Gaweye hotel)

Curiously, even the minor bed of the Niger stream around Niamey, also conceals enormous quantity of the solid garbage undermining the activities of the fishing of fish practiced to the net in stitch, especially during the period of local rise in the water level (wintry season). These possible prejudices are due to the sowing on the major part of minor bed of the Niger stream by garbage of all sizes. The most irrefragable sectors of the stream to the deposits of garbage, are the fluvial urban zones corresponding around Goudel to Saga on a length of more than 15 km. Obviously, gone the rize of the mesh net by the fishers always revealed the presence of the garbage on the minor bed of the stream through their content in objects of all sort seized for lack of fish. In addition, the mutilation of the net by cutting solid objects, confirm the existence of the garbage notoriously also on the minor bed of the fluvial valley in urban zone of Niamey, according to the subjects collected by the fishermen. Eventually most of this garbage will be buried inevitably, in the bed of the stream by the sediments. Indeed, the more pronounced impact of the progressive accumulation of the solid garbage on the bed of the stream, is the excessive reduction of the depth of the minor bed of its meander.

In short, all these environmental disasters caused by the man on the Niger stream in Niamey, find their origin in the carelessness of the surveillance and the control of the dismissals of the urban garbage leading in Niger stream.

General discussion

The geomorphological subunits of the agglomeration of Niamey regroup, the T1 and T2 terraces where shelter the big part of the city of Niamey, the T3 and T4 terraces where are the gardens, the fields of pluvial and irrigated cultures all along the strands at the height of the city of Niamey. These terraces that overhang the populous trays, with slopes in steepness emerging the plain, accelerate the streaming of the pluvial water toward the Niger stream. However, the first big showers in wintry season, drain in Niger stream by streaming of water crossing the districts, the litters of garbage, the excrements of the humans and animals, the soot, the paintings and the oils of draining of the cars poured on the floor, the cardboards and the plastic garbage thrown on the floor... etc. Solely, during the wintry season, during heavy rain, the importance of the debit of the pluvial water drained by the gutters toward the Niger stream, exercises to them a turbulent regime and carries away all garbage introduced by the populations. Finally, around Niamey all urban rubbishes, the fields of the cultures (in which are stored garbage and the muds of draining of the septic tanks) and the gardens, finding at the stream. Otherwise used water of all activities of the city of Niamey, evacuated to the Niger stream, constitute the prompt sources of the pollution. Other sources that are of diffuse nature are also added to that one, notably, the waters of resulting streaming of the lands of cultures (waters of washing of manures and the vestigial pesticides) or grazing of the animals (the excrements). These human impacts are well illustrated by works of Bah et al. (2020) in Faranah in Guinean, the superior part of the Niger stream. Besides, the sewages of used water of the city of Niamey, coming from the urban activities, notably, the households, the hotels, the public and private services, the cities, the barracks, the stations-services, the laboratories, the medical centers, the agro-alimentary industries, the industry of leather and skin, red meat slaughterhouse, regain the Niger stream without any treatment. What constitutes a proven threat of the flagrant pollution of the water of the Niger stream in Niamey, whose current situation always reflects the same previous situation, illustrated in the survey led by Alhou (2007) and by Tinder et al. (2011). All these factors of the pollution of the stream of Niger impacts seriously on the quality of its resources in water, especially during the period of lowering, when the debit of this one is extremely low (due to heavy evapotranspiration and to the multiple withdrawals of water for agriculture and urban activities) to assure the dilution of the pollutants.

So that, the contributions in garbage in the basin pouring from the Niger stream in Niamey are at the origin of the deterioration of the quality of its water on a local scale, they will also be at the origin at sea level of the pollution in plastic garbage to the scale of all extent of the basin of Niger. However, the more the Niger stream receives garbage of the riparian agglomerations, the more its yearly contribution to pours it oceanic in plastic garbage of all sizes, is big. According to a survey led by Schmidt (2017), shows that Niger is one of ten streams in the world that would be responsible for 88 to 95% of oceanic world discharge of plastic garbage.

The uphill part of the Niger stream in relation to the city of Niamey, knows facilities of several cities, notably, in Guinea (Faranah, Kankan and Kouroussa), as well as in Mali (Bamako, Koulikoro, Ségou, Mopti, Toumbouktou and

Gao) and in Niger (Ayorou and Tillabéri). The swallowing part Niamey in relation to the record of the Niger stream, are implanted several cities, on the Nigerien territory: Kollo, Say, Gaya, in the Benin Malanville; and finally in Nigeria are counted the cities as, Zaria, Kainji, Lokoja, Onitsha. The activities anthropic likely to generate the pollutants increase in these cities and riparian villages of Niger. Given that since, its existence, the Niger stream always constitutes a vital setting privileged for the riparian populations who always centered their main activities (fishing, agriculture, breeding transportation, laundries, bathings...) on these resources in natural water in spite of all incurred ominous consequences. It is so true that the man's impact on the Niger stream to the level of the agglomerations to the extreme is the most alarming. Nevertheless, this impact well exists to the riparian villages and had begun since the first attempts of the man's sedentarization to its surroundings, therefore dating from a very long time. However, the main sources of the pollution of the water of the Niger stream in these cities are similar to those discovered in Niamey, according to the studies led by Sow (2017) and Bah and al. (2016) on the Guinean part of Niger; by Sidibé (1992); Cissé (1997); Koné and Kotschoubey (2005) on the Malian part of Niger. What shows that in the big riparian urban centers, the protection of the Niger stream is not on the agenda. What attests that, the polluting substances generated in the Niger stream by the man in Niamey, constitute supplementary sources to those already generated by the other cities situated to its uphill. Globally, the situation is very troubling, especially if one notices that, all main sources of the anthropic pollution of the water of the Niger stream, are similar to those of the other cities of the basin of the Niger residents of the stream.

Conclusion:-

The urban residuary water of Niamey collected by the network of purification is evacuated to the stream without any treatment, therefore in violation of the Nigerien norm of dismissals. Correlatively, the solid garbage is also evacuated in an anarchical manner in flagrant violation of the ruling texts in vigour. However, the main sources of the pollution of the water of the Niger stream in Niamey result so much from dismissals of both solid garbage that liquid garbage of all origins (residential, hospitable, agricultural and industrial) without no treatment, essentially bound to the activities of the population.

Yet the management of the purification works and the elimination of the garbage out of the capital are assured by the benefit of the public services mainly conducted in municipal state control. However, the results of the management of the garbage (control of the dismissals, elimination of the garbage) discounted by the services of purification are much more mediocre on the land by the rate of intervention that is always in permanent reduction and reaching catastrophic levels, in view of all urban garbage (solid and liquid) that succeed constantly at the stream. The anthropic pollution of proximity water of surface of an urban center, as Niamey with the Niger stream, is generated by the contribution of garbage and the intrusion of the exogenous water (worn-out and pluvial water) greatly loaded in: organic matter; in manure; in pesticides; in detergents; in acidic chemicals; in stains; in plastic; in toxic derivatives; in heavy metals; in fibers; in bacteria; virus; proteins...etc.

Within the results brought by this survey, strategic actions of management of the different sources of the pollution of the water of the Niger stream impose themselves to assure the protection of the integrity and the everlastingness of the natural quality of these vital resources. However, the preservation of resources in water of the stream Niger generous or a lasting development must be fundamentally a preoccupation of all member states of basin of Niger. In this present context, the actions of management must be clinched on the setting in consistency of the legal instruments to the present realities and to their setting in applications. Again to the setting up of the elements of orientation policies of reduction sources of pollution, namely the management of the garbage, the setting up of a surveillance system, the mobilization of all taking parts, to endow the city of Niamey by necessary infrastructures with purification of the garbage namely the works of collection (garbage and worn-out waters) and the stations of purifications of the worn-out water.

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