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Rain Erosion and Degradation of Infrastructure in The District of Detohou in The Municipality of Abomey in Benin

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Abstract

Populations outside the innumerable problems they experience in the exercise of their activities are confronted in recent years with the effects of climate extremes. The present study aims to study the impact of rain erosion on infrastructure in the district of Detohou..
The methodological approach used is as follows: desk research, data collection in the field, and the processing and analysis of results. The data were collected through interviews with the populations and observations made in the field. The analysis of the results is done using the PEIR model.
The results obtained show that this erosion is due to precipitation (15.2%), uncontrolled soil occupation (17.2%), lack of canalisation (29.5%) and uncontrolled cutting of trees (4%). Rainfall erosion in the Detohou borough is manifested by soil removal (ablation), transportation of materials and their accumulations. This phenomenon has a significant impact on habitats such as loosening (60.8%), housing collapse (62.6%), and dwellings in a fall position (47%). In addition, the deterioration of streets and alleys (80.3%) is recorded, with the consequent slowdown of economic activities. The inhabitants of the district of Detohou adopt several strategies including filling with sand (60.2%), sack of sand (76.3%), and the belting of houses with bricks (64%). Suggestions have been made to deal adequately with this phenomenon.
Key words: Distric of Détohou, Rain erosion, Heaving, Adaptation strategy

Introduction

West Africa in general and Benin in particular are facing increasingly acute and widespread problems of environmental degradation. The importance and dimensions of environmental problems differ according to the level of development of countries, even within regions of the same country (N. Agoïnon, 2006, p. 08). Among these problems, we can mention pluvial erosion, soil degradation, deforestation, etc.
The dynamics of the geographical environment includes several components, including physical elements. Thus, precipitation appears as the main factor that modifies the substratum (R. Arayè, 2008, p. 11). When it rains, there are three types of movement related to the topography and soil structure: runoff, infiltration or stagnation, with consequent erosion, clogging or leaching. Thus, during thaw or heavy rains, surface water runs off relatively quickly in urban areas because retention and infiltration (characteristics of natural soils and vegetation-covered regions) have been greatly reduced (D. Fox et al., 2008, p. 02). Runoff water threatens living environments, especially urban areas. Benin, like other countries in the world, is facing serious problems related to rainwater. This water, which comes in several forms, is essential for life and whose study today requires great importance because it constitutes a rare source,

distributed irregularly in time and space (T. E. Attolou, 2018, p. 54). In Benin, environmental degradation has reached a worrying level. At the center of this phenomenon is man whose bad practices remain the fundamental causes of the current state of our environment (PAE, 1991 cited by L. Dougnon, 2012, p. 08).

Thus, for several decades certain localities in our country have been subjected to increasingly marked water erosion and a simple observation reveals the extent of these manifestations (M. Alagba, 2010, p. 84). This is explained by the inadequacy, dysfunction and sometimes non-existence of rainwater drainage structures (B. S. Dansou, 2011, p. 14). The damage caused by this phenomenon is visible through the loss of housing, the stripping of tree roots, and gullies and ravines dug by runoff (E. B. Agbahungba, 2012, p. 65). Despite the efforts made by the authorities of the city of Abomey to initiate sanitation actions as part of the construction of gutters, the waste collectors immediately note that the problem of land erosion persists in the city of Abomey. Thus, the research entitled 'pluvial erosion and infrastructure degradation in the district of Détohou' is timely, to allow the authorities and scientists to react a little bit to the phenomenon studied. The general objective of this work is to study the impact of pluvial erosion on infrastructures in the district of Détohou in the Commune of Abomey.

1. Area of study

The district of Détohou in the commune of Abomey constitutes the geographical framework of the present study. It is located between 1°55'00" and 2°00' east longitude and 7°10' and 7°15' north latitude. The district of Détohou is limited to the north and west by the commune of Djidja, to the south by the district of Vidolé and then to the east by the district of Agbokpa. Figure 1 presents the geographical location of the district of Détohou.

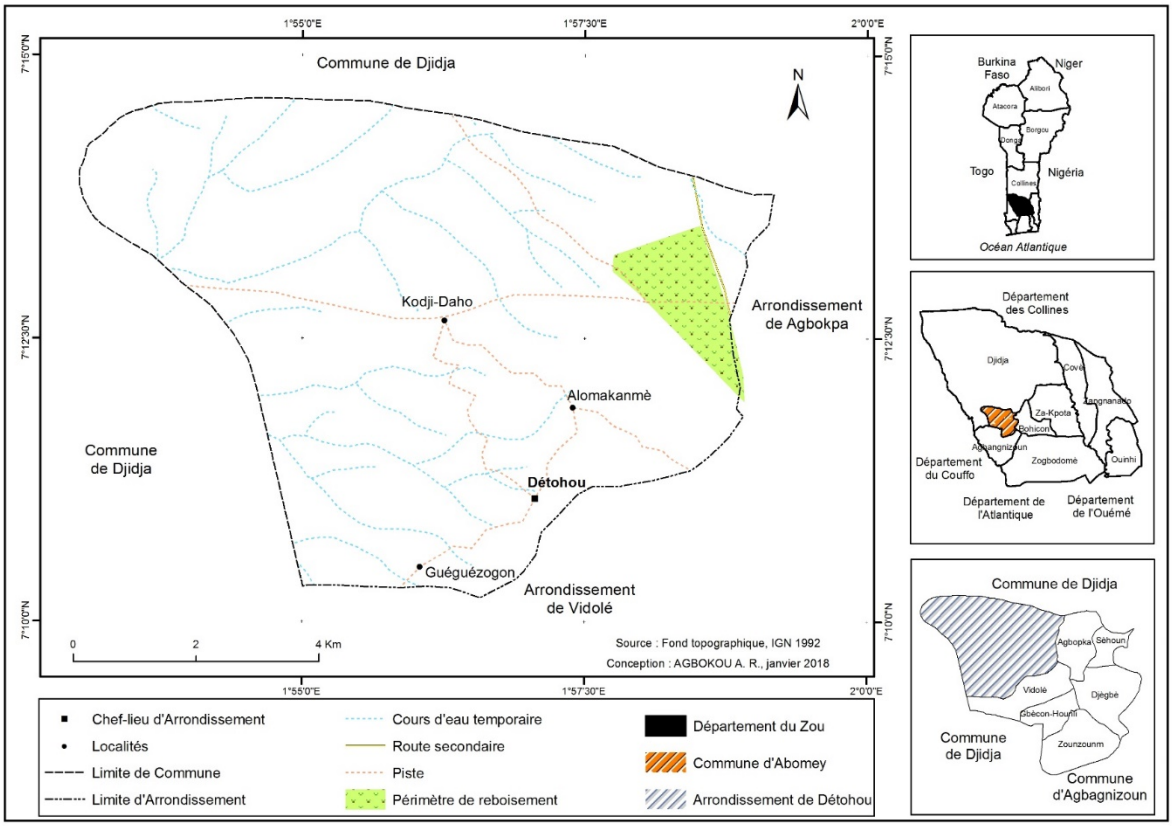


Figure 1: Geographical location of the district of Détohou

2. Data and methods

2.1. Data used

Several data were used in this research. This is data related to the evolution of the population obtained at the National Institute of Statistics and Economic Analysis (INSAE, 2013); climatological data (rainfall, average temperatures over the period 1971 to 2020) obtained at Météo-Benin; field data and information related to the impacts of pluvial erosion and planimetric data obtained at the National Geographical Institute (IGN).

2.2. Methods used

2.2.1. Field work

Direct observations and semi-structured interviews made it possible to identify the neighborhoods affected by rainwater erosion, the characteristics of the infrastructure, and the adaptation techniques developed by the populations; the method of reasoned choice which made it possible to identify the households affected by the phenomena and the target persons who could provide information related to the present research. The collection of this different information was done through questionnaires

To better observe the phenomenon of erosion, the most appropriate period is that of rainy seasons. It is during the rainy seasons that the phenomena of runoff and gullibility are observed. The fieldwork was mainly carried out in the districts of the district of Détohou (Kodji Daho, Gueguezogon, Alomakanme, Détohou) strongly threatened by the phenomenon of pluvial erosion. These neighborhoods were chosen in view of the frequency of the phenomenon, and its magnitude.

2.2.2. Data processing

The processing of data made it possible to distil and analyze the information collected in the field. It was carried out manually (completed questionnaire sheets). The Arc GIS 10.1 software is used for creating the situation map of the study area. Excel and Word software are used to process the data and promote document entry. The creation of graphs and the calculation of certain statistical values are done using software such as Excel and SPSS. They made it possible to characterize the evolution of rainfall and flows in order to establish the link between the two.

3. Results

3.1. Natural and human factors favorable to pluvial erosion in the district of Détohou

The factors that control erosion and condition its impacts are natural and anthropogenic. This part presents these different factors in the district of Detohou

3.1.1. Natural factors

The natural factors that amplify pluvial erosion in the district of Détohou are: precipitation, topography, intrinsic characteristics of the soil and also the rate of vegetation cover.

3.1.1.1. Climatic aspects

Pluvial erosion is characterized by two distinct mechanisms. It is the detachment from the ground under the effect of the impact of drops (battance) and transport by runoff. The study of the inter-monthly evolution of average rainfall in the district of Détohou (figure 2) easily shows the most rainy periods with high erosion activity.

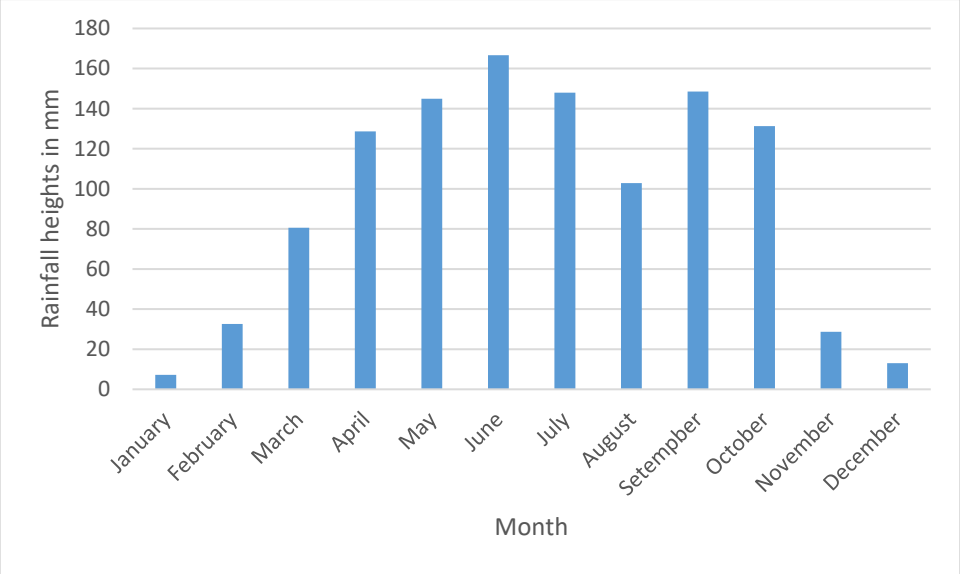


Figure 2: Monthly rainfall regime from 1971 to 2020

Source: Météo-Bénin, 2021

According to the analysis of figure 2, it appears that the rain starts in March and reaches its maximum in June with 159.41mm. The rainiest months are June, July, and September. It is during these months that the battance and runoff, which constitute key elements of pluvial erosion, are important.

3.1.1.2. Landforms

Topography is an element that intervenes in the erosion process. It is the description and graphic representation of a terrain according to its relief (Djossou, 2009).

The value of the slope determines the flow speed of surface water (Beauchamp, 2006). Its length promotes significant flows and the concentration of water streams. Moreover, the flow becomes more increased as the inclination becomes strong. Figure 3 shows the direction of stormwater runoff in the district of Détohou.

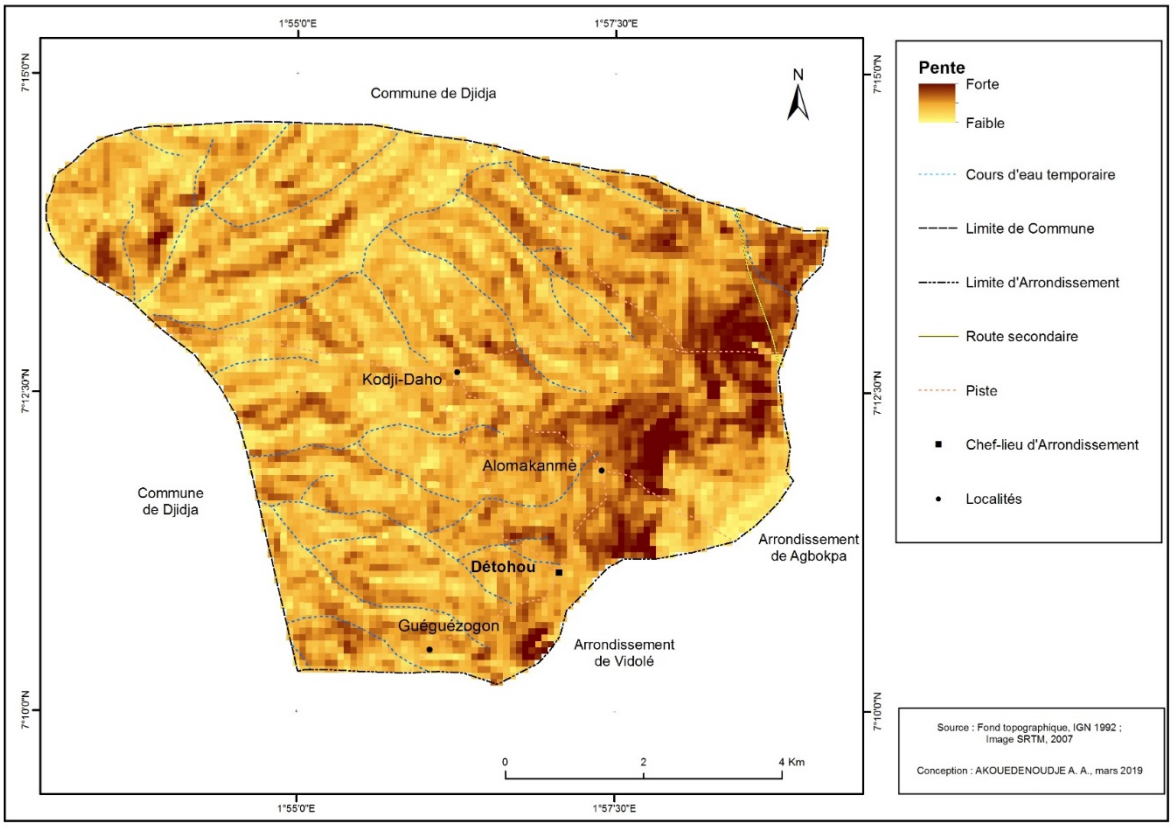


Figure 3: Aspect of the slopes in the district of Détohou

The analysis of figure 3 shows that the different localities are located at the level of the steep slopes, which accentuates pluvial erosion in the district of Detohou.

3.1.2. Human factors

Like the climatic conditions which are decisive in the aggravation of erosion, man by his actions (type of development, density, concentration of dwellings, waterproofing of urban soil) appears as an essential factor in its triggering and in the rhythm of its evolution (Biaou, op. cit.).

Anthropogenic actions result from the anarchic occupation of the soil, poor management of household waste, and the lack of stormwater canalization works in the district of Détohou. Indeed, under the impetus of the strong demographic surge and in the absence of a plan for subdivision and development, the space is poorly occupied and poorly managed. The populations occupy the natural outfalls of stormwater, filling the gutters with piles of garbage automatically preventing the normal flow of water. Also they modify the main circuits of the runoff water flow. These deviate towards inhabited areas and cause the intensification of erosive processes by gradually stripping the foundations, undermining the pathways.

3.1.2.1. Typology of space

Three large areas are identified in the district of Détohou: the residential and administrative area, the dense non-urbanized housing area, and the less dense and non-urbanized housing area.

- **Residential and administrative area**

Field observations revealed that this area in the district of Détohou (Gueguezogon) is characterized by a lack of primary gutters to connect the plots. Some populations who live there still throw their garbage into the few canals that exist. Also the green spaces that are in this area are endangered because of their poor management.

- **Dense non-urbanized residential area**

It is composed of the districts Sotta, Houndjokoue Allomakanme and Détohou north. We note the insufficiency of stormwater canalization works. To this is added the poor management of household waste which results in the discharge of household waste in street corners and uninhabited spaces. Thus, as soon as it rains, this garbage is carried away by runoff water and will block the outfalls.

- **Less dense and non-urbanized residential area**

Composed of the districts Zakanme, Kodji, and Kpetekpa, this area represents the expansion sector of the district of Détohou (according to field surveys). It is characterized by a lack of stormwater channeling, a lack of subdivision which leads to an uncontrolled settlement of populations and a lack of control over the environmental problems that exist there.

In sum, the meticulous examination of the district of Détohou shows that urbanization is still in its infancy. This is evidenced by the almost total absence of infrastructure characteristic of the district, the state of the road and the dwellings mostly in banco (photo 1)

Photo 1: State of the Road in Détohou
Shooting: Ouassa, August 2017

The combination of physical factors (high precipitation, topography) and anthropogenic ones (anarchic land use, poor management of household waste) has made the action of stormwater very important. All this intensifies the erosive activity whose impacts are not negligible in the district of Détohou.

3.1.2.2. Organization of urban space

The mapping of land dynamics in the terroirs of Détohou was analyzed through the land occupation maps of 1995 (a) and 2015 (b). The evolution of the plant formations between these two periods was then evaluated through the variation in the overall rate of evolution. Figure 5 shows the land occupancy maps of the Détohou District from 1995 (a) and 2015 (b)

The physiognomy of the vegetation of the Détohou District in 1995 was dominated by wooded and shrubby savannahs, followed by the thin gallery forests which are located along the various waterways. There are some fragments of light forests and wooded savannas inside the wooded and shrubby savannas. In addition, we note the presence of mosaics of fields and fallows.

In 2015, the vegetation of the study area was still dominated by wooded and shrubby savannas but in a relatively smaller proportion than in 1995. We also note the presence of other plant formations (light forest and wooded savanna, gallery forest) observed in 1995 (Table I).

Table I: Summaries of plant formations and other land use units 1995 and 2015

Land occupancy units	1995		2015	
	S(km²)	P(%)	S(km²)	P(%)
Gallery Drill	0,63	1,24	0,62	1,21
Light forest and wooded savanna	0,13	0,25	0,11	0,22
Wooded and shrubby savannahs	34,61	67,86	30,10	59,02
Planting	0,53	1,03	4,17	8,19
Mosaic of fields and fallows under palm grove	3,77	7,38	3,06	5,99
Mosaic of fields and fallows	11,29	22,13	12,74	24,99
Agglomeration	0,06	0,11	0,20	0,39
Total	51	100	51	100

The analysis of Table I shows that from the year 1995 to 2015, there is a decrease in the area (km2) of gallery forest, clear forest and wooded savannahs, wooded and shrubby savannah and mosaic of fields and fallow under palm grove, which translates into the destruction of vegetation cover in the district of Detohou. In addition, that in 1995 and 2010, the highest conversion rates are observed at the level of mosaics of fields and fallows under palm groves (80.37%) and in light forests and wooded savannas (17.67%). The low conversion rates are observed at the level of gallery forests (1.59%), wooded and shrubby savannas (13.15%), plantations (16.98%) and mosaics of fields and fallows (12.58%).

For the case of this study, the phenomenon of erosion is less visible in 1995 in the district of Détohou. On the other hand, in 2010, the phenomenon of erosion is more apprehended because the vegetation has followed a regression for the benefit of the population by the construction of houses, demand for land for the exploitation of sand, overgrazing, plowing fields, which influence the rain erosion in the district of Détohou. Figure 4 shows the land use map of the Détohou district.

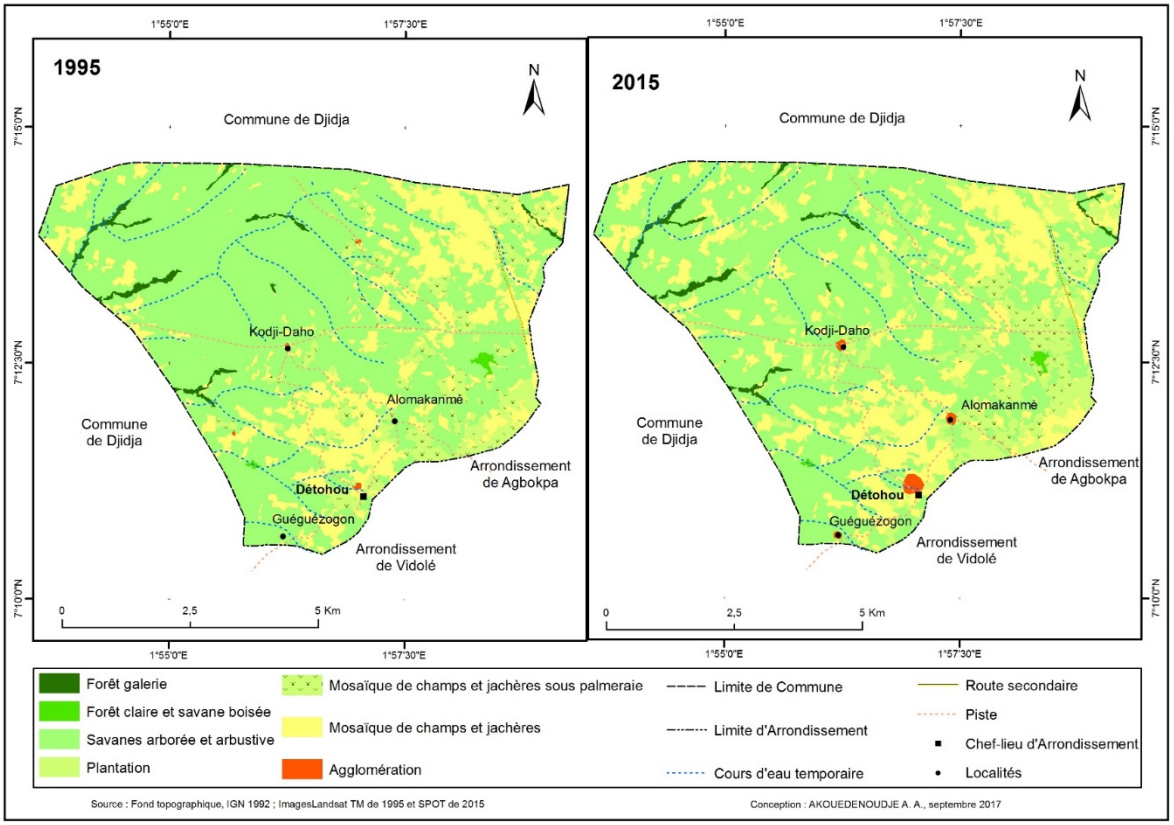
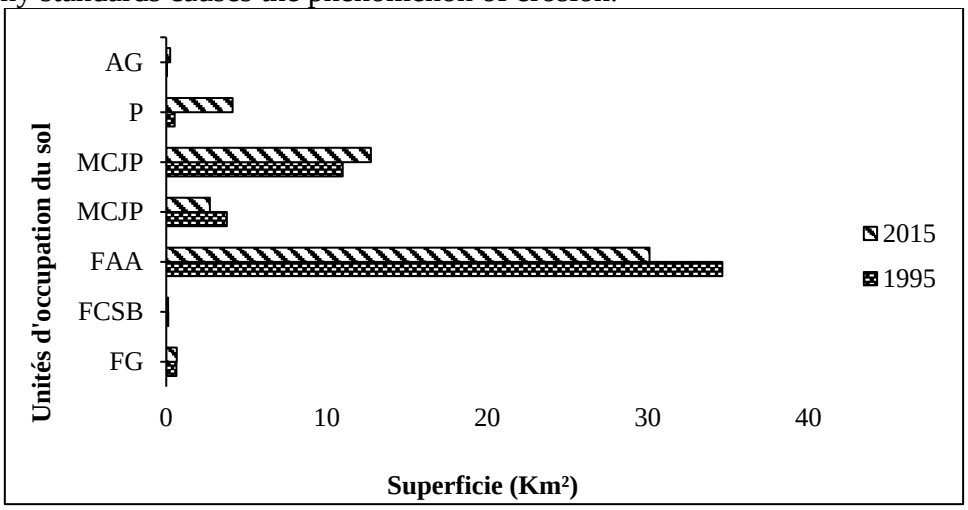


Figure 4: Land use map of the Détohou district

The Détohou district has experienced from 1995 to 2015, profound change. There is an increase in land use units at the expense of the decrease in others.

Figure 5 shows the changes observed at the level of the land use units (agglomerations; bodies of water; Mosaic of fields and fallow areas; shrubby and wooded forests; light forests and wooded savannahs; gallery forests) of the Détohou district from 1995 to 2015. This anarchic occupation of land in the district of Détohou by clearing and construction in disorder and without any standards causes the phenomenon of erosion.



FG: Gallery forest; FCSB: Light forest and wooded savanna; SASA: Wooded and shrubby savannahs; PL: Plantation; CJP: Mosaic of fields and fallows under palm grove; CJ: Mosaic of fields and fallows; AG: Agglomeration; Sup: Area (Km2); Prop: Proportion (%); UOS: Land use unit

Figure 5: Evolution of Detohou's land use units from 1995 to 2015.

Source: survey data, August 2017

It can be seen from the examination of Figure 5 that the changes between the land occupancy units have taken place in the study area in a spatially differential way. In two units, areas of loss, stability and gain were observed and occupy a different proportion of the study area. Thus, the wooded and shrubby savannas are the categories where the changes have been the most significant on approximately 68% of the study area with 9% losses and 59% stability. They are followed by field and fallow mosaics on 28% of the study area with 3% losses against 6% gains and 19% stability. Then come the mosaics of fields and fallows under palm grove on 12% of the sector with 3% losses against 5% gains and 1% stability. In addition, plantations occupy 8% of the sector with 7% gain and 1% stability. Finally, the gallery forests experienced 1% stability, which explains the degradation of the natural environment in the profile of the dwellings. It emerges that this change favors the actions of erosion in the district of Détohou.

3.2. Environmental and socio-economic impacts of rain erosion

This part includes the typology of runoff, the impacts of erosion on the environment.

3.2.1: Types of runoff in the district of Détohou

The pluvial erosion manifests itself according to the topographic slope in the arrondissement of Détohou. Rainwater causes a lot of damage both to the physical environment and to the infrastructure and does not remain without consequences on socio-economic life.
Figure 6 shows the proportion occupied by the different types of runoff according to the testimony of the populations.

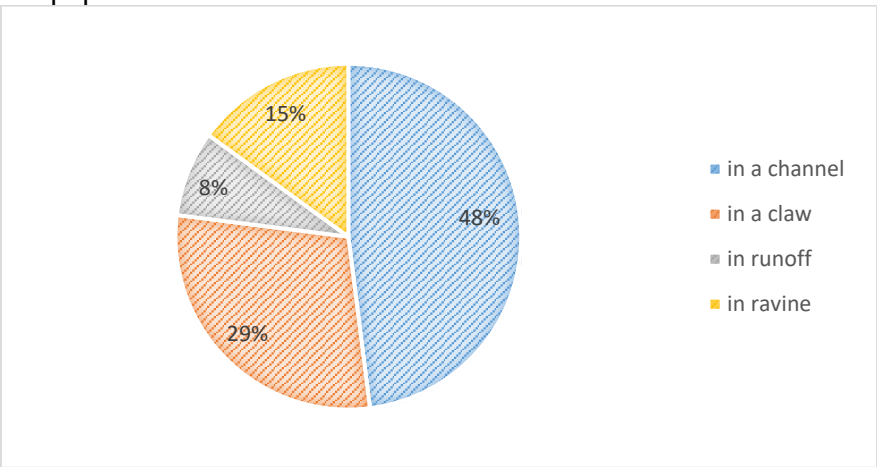


Figure 6: Type of run-off to Detohou
Source: Survey data, August 2017
The examination of Fig. 6 shows that the majority of the water flows in a channel (48%) and in a claw (29%). In addition to these types, groundwater runoff (8%) and ravine (15%) are less perceived by local populations in the Detohou district.
More fundamentally, the runoff in channels and claw are the important factors of rain erosion in the borough of Détohou.

3.2.2. Impacts of erosion on the environment

Rainfall erosion is one of the main phenomena that affects the environment through its degradation. Figure 7 presents the perception of the populations on the impacts of rain erosion on the environment in Detohou.

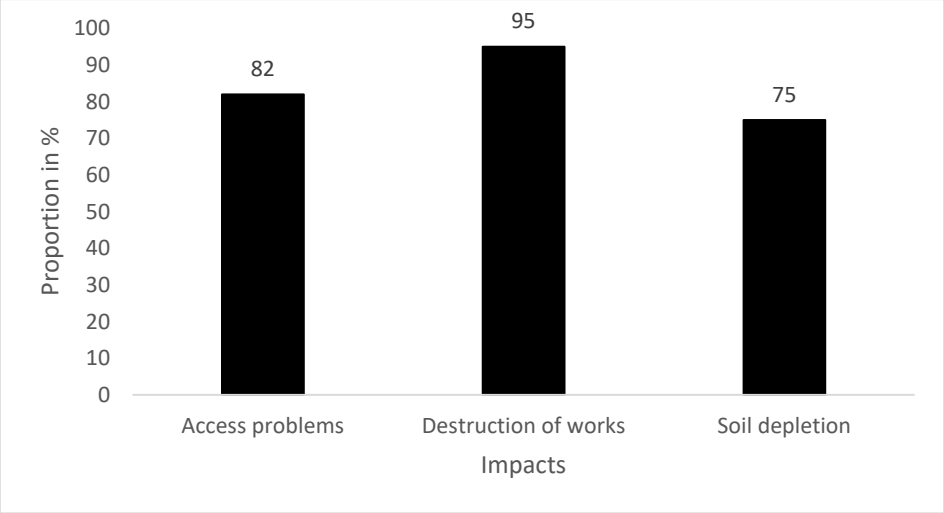


Figure 7: People's perception of the impacts of rain erosion in Detohou
Source: survey data, August 2017

After analyzing Fig. 7, it can be seen that more than 75% of the populations surveyed clearly affirm that the impacts of river erosion on the environment are at the root of access problems, the destruction of public and private works and soil depletion.

3.2.2.1. Degradation of the pathways

The extent of the erosion of road infrastructure, the roads in the district of Détohou are completely degraded. The degradation of the roads is one of the factors that accounts for the impact of rain erosion on the ground in the Détohou district (more than 80% of the roads are degraded). This degradation appears in several forms given the magnitude of the runoff. These are incisions and channels.

Photo 2: Degradation of the tracks
Shooting: Ouassa, August 2017

The analysis of this photo 2 shows that it is especially the streets that are most exposed to the phenomena of erosion in the borough of Détohou.

This degradation appears in various forms given the importance of runoff. These are incisions, channels, and gullies.

3.2.2.2. Incision of the pathways

The falling water from the roofs draw rectilinear traces corresponding to the lines of impact of the drops of water on the ground in the district of Détohou (photo 3).

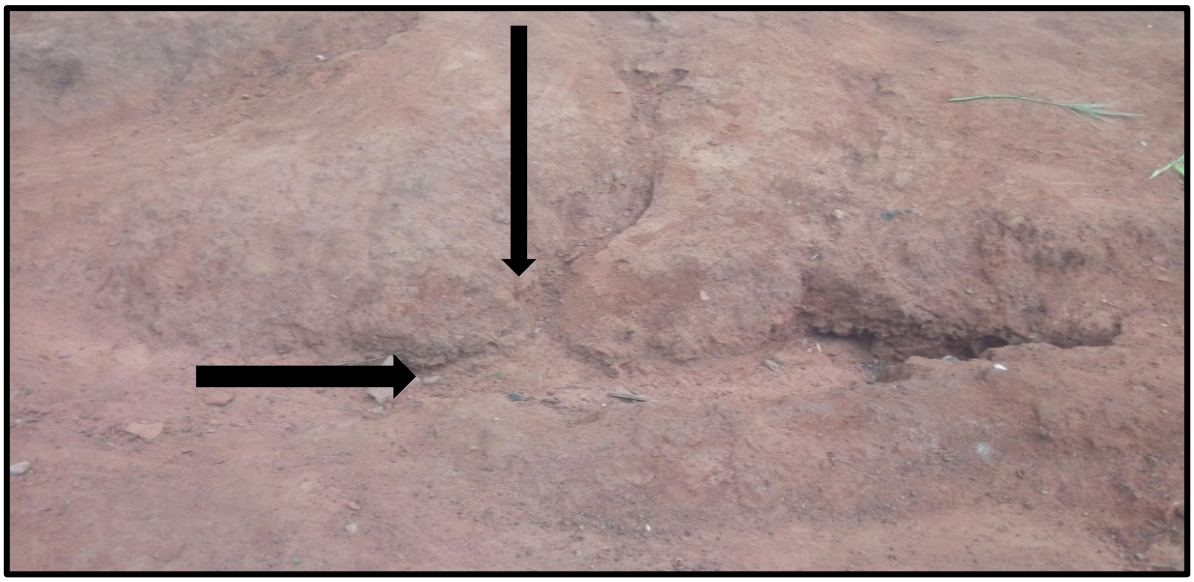


Photo 3: Incision of the road in Detohou
Shooting: Ouassa, August 2017
Photo 3 shows a track sheared by rain erosion in the district of Détohou.
This photo 3 shows an incised track in the district of Détohou. These incisions are observed in almost all the houses in the borough and are sometimes extended by small channels. In addition, they arise from the fall of rainwater coming from the roofs of concessions. Indeed, the water precipitated after recovery by the tin roofs falls a few centimeters from the foundation of the houses because of the reduced width of the awnings. These waters descending from the roofs draw rectilinear traces corresponding to the lines of impact of the drops of water on the ground. This phenomenon shears both the basement of the houses and that of the fences exposed in the borough of Détohou.

3.2.2.3. Giggles

They result from the progressive widening of the incisions left by the traces of the runoff on the bare ground (photo 4). They draw more or less sinuous paths with very irregular transverse profiles. These transverse profiles have a depth that varies between 10 and 20 cm..

Photo 4: Funny to Detohou
Shooting: Ouassa, August 2017

The arrondissement of Détohou is filled with several channels left by runoff, like the one shown in Photo 4.
This ravine is gradually set up by the flowing water. It divides the street in two and makes the houses that are nearby difficult to access.

3.2.2.4. Demolition of houses

Loosening occurs after the layer of earth that protects the foundation of the houses is completely torn off by undermining or ravining. In this case the houses, especially in banco are either partially or totally destroyed (photo 5).

Photo 5: Housing in a fall position in the district of Détohou
Shooting: Ouassa, August 2017
This photo shows the condition of some buildings that have been removed. The building in Photo 5 has half collapsed due to the action of erosion. Through these photos, we realize the difficulties that the populations face in the face of rain erosion in the district of Détohou.

3.2.2.5. Degradation of public infrastructure

Direct observations on the ground have also helped to assess the vulnerability of public service buildings to rain erosion (Photo 6). The infrastructures affected by the effects of erosion are largely the gutters.

Photo 6: Damaged water pipe in Detohou
Shooting: Ouassa, August 2017
Photo 6 shows a primary gutter whose base has been undermined by erosion and which is almost in the ravine. The state of advanced degradation of these infrastructures is explained by their installations in sectors with steep slopes and especially on slopes that serve as flow paths for runoff water.

3.2.3. Socio-economic impacts of erosion

In addition to the physical environment, erosion has also affected the social life of the inhabitants. Among the difficulties encountered we have the various psychological discomforts, the difficulties of movement in the city, the material and financial constraints.

3.2.3.1 Psychological discomfort

The populations of the Détohou arrondissement are sensitive to the severe degradation that their living environment is experiencing. From the surveys carried out on the ground, it emerges that these populations do not completely control the mechanism of erosion. For them, the human factor does not accentuate the process. Faced with the multiple damages caused by erosion and the precarious and unsuitable methods at their disposal, the populations feel disarmed, demoralized and distraught. To this is added the helpless gaze of the authorities whose rare attempts with regard to this phenomenon prove futile. The populations therefore live in renewed fear of one day seeing their wall or their house collapse, they want the public authorities to build water drainage networks and degraded streets without however worrying about the organization and management of the space.
The problem of erosion is not without impacts on the movement of people and goods in the district of Détohou.

3.2.3.2 Traffic difficulties

The degradation of the infrastructures, the presence of claws, gullies or channels on the approaches of the tracks disrupt the circulation of goods and goods through the borough of Détohou. Even pedestrians experience traffic difficulties on certain lanes for fear of falling into channels or gullies. The consequence of all these difficulties is that economic activities are slowed down or sometimes blocked because of the impassability of the roads, thus creating a decrease in their already modest income (Photo 7).

Photo 7: Impassable way to Detohou
Shooting: Ouassa, August 2017
Photo 7 shows a degraded road which the population of the Détohou district is having great difficulty crossing.

3.2.3.3. Material and financial constraints

The fight against rain erosion requires enormous financial resources. Indeed, the measures that the populations take in order to solve the problem of degradation of their environment have considerable financial implications.

From the surveys carried out on the ground, 75% of the inhabitants of the district of Détohou are grouped by area and it is through the grouping that they make the tontines intended for road repairs, backfilling of eroded spaces, With regard to the small wooden bridges, the unit is estimated at 1800 FCFA (purchase of materials and labor). However, the monthly income of many of these inhabitants is less than 34,000 CFA francs because most of them are farmers, and it is in this income that they manage to pay their expenses. So the phenomenon of rain erosion significantly affects the inhabitants of the district of Détohou.

3.3. Strategies to combat rain erosion

Some practices aim to reduce the amounts of runoff water. The populations organize themselves either at the concession level or at the neighborhood level to protect the infrastructures against rain erosion. Thus, each household is content to protect its storefront, or the street that surrounds its immediate environment without thinking about community infrastructure. The most frequent practices used to actively fight are:

- **The Laying of a stone block**

This method aims to lay blocks of large stones at the level of the over-digging of the ground to slow down the passage of water and retain all the other elements drained by the water during its passage. It plays the same role as the bags filled with sand or pebbles deposited on the rainwater route. These stone blocks are also deposited along the foundations to prevent the collapse of the houses (Photo 8).

Photo 8: Deposit of pebbles for the endogenous protection of houses in Detohou
Shooting: Ouassa, August 2017

Photo 8 shows the embankments by the bricks at the front of a house to stop the phenomenon of erosion. This practice is less effective in limiting the damage caused by rain erosion which erodes the walls of houses. The population sometimes, for lack of modern means, uses stone blocks, terraces to girdle the foundation of their habitat.

- **Protection of foundations**

To protect the foundations, the populations are developing techniques such as: filling or earthmoving and crossing structures. Photo 9 shows a device for protecting the foundations of houses in the district of Détohou.

Photo 9: Device for protecting the foundations of houses in Detohou
Shooting: Ouassa, August 2017
Photo 9 shows a house whose foundation is supported by stones and bricks interlocked one after the other.
This method is used to protect banco houses with a loose foundation.

- **The Filling of household waste**

These methods are more widely used and are less expensive, because they consist in dumping household waste at the level of over-digging of the ground. However, they have very serious health consequences. They favor the multiplication of the filth of the wetlands, the proliferation of pathogens and worse, the pollution of the environment.

- **A Dam made using wood**

This practice consists of simply planting stakes or stakes crossed with woods. It allows the rainwater to run off, but the device retains the sand and debris drained by this water. The limitations of this device is, that it is easily destroyed by the combined action of water and termites (photo 10).

Photo 10: Wood dam technique in Detohou
Shooting: Ouassa, August 2017
The analysis of Photo 10 shows the damming technique made using wood.
This technique is used to make circulation easier.

- **The Dam is made using the bags**

The populations deposit bags filled with sand in the rainwater flow corridors perpendicular to the direction of flow. The duration of the resistance of these sandbags is low and varies between about 4 to 8 months. They are exposed to variable atmospheric conditions. It is about the sunshine and the rain (acid runoff water). Also, unconscious men especially children and animals (pigs, chickens, rooster, etc.) exert negative influences on the bags filled with sand. Under these conditions, they tear and the contents are drained by runoff water. This method consists in aligning bags previously filled with sand in the ravines (photo 11). This technique is easier and less expensive.

Photo 11: Sandbag dam in Detohou
Shooting: Ouassa, August 2017
This photo 11 shows bags filled with sand arranged to stabilize the particles torn off upstream and to channel the water. This practice is easier and less expensive.

Conclusion

Rain erosion causes the displacement of soil materials by water. This is the loss of the upper part of the soil. Uniform loss by surface runoff or sheet erosion. In the final exercise, investigations on the state of soil and infrastructure degradation in the Detohou district subjected to severe erosive activity due to rainwater were conducted.
Of all these works, the rain erosion of soils and infrastructures results from the interaction between statistical factors and dynamic factors. The statics are related to the vulnerability of the land. This represents a specific characteristic of the environment, dependent on the nature of the terrain and independent of dynamic factors. The dynamic factors are the agents of pressures which can be either natural (climate, and vegetation cover) or human. Pluvial erosion therefore derives from the interaction of climate, soil properties, the relief of cultural practices and vegetation cover. The spatial and temporal modification of interaction can induce an amplification of erosion. The rain is obviously the essential agent of rain erosion (serosity of the rains). During the rainy seasons, the degradation of the Detohou district intensifies under the helpless gaze of the populations and the authorities. The inadequacy of the rainwater drainage works and the cramped nature of the existing ones are not without consequences for the borough.
However, erosion has essentially become a direct consequence of human activity which now represents the main factor in soil degradation. To these are added the demographic surge which has generated a corollary of negative human interventions on the environment. Thus, under this strong human pressure, the vegetation, the main limiting factor of runoff, is gradually destroyed in favor of the installation of dwellings. These are the elements that favor runoff, a determining factor in the erosion process in urban areas. Man can be at the origin of the triggering and acceleration of erosion by his actions of clearing forests of vegetation fires, overgrazing, cultural practices of mining, the abusive cutting of firewood, lumber and urbanization, making the soils erodible.
Faced with this situation, the populations and the activities are not impulsive but their mitigation strategies prove to be temporary. Thus, efforts must be made to protect fragile natural environments. Failing to focus on the State's endowments, as 80% of those surveyed wish, it will be imperative that much more committed initiatives be taken at the local level for the improvement and maintenance of existing infrastructure.

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