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ASSESSMENT OF EUTROPHOGENIC NUTRIENTS FLUX IN THE URBAN VERSANT OF PORTO-NOVO LAGOON BY THE SCS-CN MODEL

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Abstract: The urban versant of Porto-Novo lagoon is located to the Northern part and covers an average surface of 70 km^2; made of plate essentially covered by bar land with possible altitude 40m, it includes many important depressions. This urban versant contributes to the eutrophication of Porto-Novo lagoon with as consequence a reduction of the specific biodiversity. This study aims to estimate the eutrophogenic nutrients flux to enable municipal authorities to take into consideration during the making up of eventual strategies of eutrophication reduction and restoration of this water plan. The flowing method of evaluation SCS-CN (soil conservation service-curve number method) of the United States Department of Agricultural (USDA) was used; it's improved by nutrients loads estimation tied to domestic activities. Results show that average 543 tons of TP and 108 tons of TN come to Porto-Novo lagoon through its urban versant opposite to what is observed in the water of most municipalities where TN rate is higher than TP. A diffuse source of TP on this basin or in its surrounding environment could be the origin. The analysis of physico-chemical parameters of these waters showed their quality degradation, affecting the biodiversity of their media. A coherent and integrate mechanism on behalf of politics, the contribution of people benefiting from the ecosystem existence and the preservation of the ecological interest of media is most important for sustainable of restoration acts.

Keywords: SCS-CN, eutrophication, TP, TN, basin versant, flow.

Introduction

Water plans and environmental pollution is a targeted subject since many time and has great interest in the current model (Twagirimana, S., 2013); humans and aquatic species interact many with it and are consequently more exposed to pollutants (Falconer *et al.,* 2012). Nutrients inflowing the water plan can come from domestic and urban rejections in the versant, industrial rejections and rejections tied to fishery activities. Domestic rejections and farming activities are the main nitrogen and sediments sources that we find in surface water

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(Hébert and Ouellet, 2005) and the farming genuine diffuse pollution is the main cause of the current bad quality of water (Gangbazo and Painchau D, 1999). The evaluation of the different nitrogen sources contributions to surface water is very important for the application of pollution control measures in order to forecast or prevent eutrophication (Mama, 2010). Porto-Novo lagoon is a water plan which, by its geographical situation constitutes the receptacle of pollution of a major part of Porto-Novo town and surrounding commons; the erosion of versant soil following by transport drains pollution due to incorrect wastes management. Eutrophication of Porto-Novo lagoon has been reported by several authors such as Chitou *et al.,* (2010), Akogbeto *et al.*, (2017) without taking any appropriate measure to abolish it. But a good conscience of users, residing population surrounding the water plan and enterprises benefiting from the outlets of the ecosystem through a balance between economic advantages in relation to social and ecological objectives, has a certain utility for improvement of the mechanism of management (XiaoLi Zhang, 2014). The knowledge of large scale nutrients flux is important to determine the elements of ecosystems susceptible to produce or eliminate these nutritive elements. The real pollutants load of a versant for a given period can never be known exactly but can be precisely estimated (Zamyadi, A., 2006).

The current study aims to estimate the exogenous nutrients fluxes of especially that of urban versant by the SCS-CN model (Soil Conservation Service Curve-Number model) in order to enable governors to consider it during the elaboration of eventual strategies of eutrophication reduction, water plan restoration or sustainable management of Porto-Novo lagoon.

I- Material and methods

Presentation of the study medium and sampling sites

Our study is based on the two Northern sub-versants of the lagoon especially the urban sub-versant sheltering Porto-Novo town (Figure 1). The versant of Porto-Novo lagoon occupies a global surface of 108.7 km^2 (Dorier-Apprill, 2002) though its receptacle, the lagoon located in the South-East of Benin between parallels 6^o 25 and 6^{o}30 N and meridians 2^{o}30 and 2^{o}38 E is average wide 35 km^2. The lagoon communicates in Northern with Ouémé River on the one hand by many diffluent where it receives fresh water and alluvial parts during the flood and on the other hand with Lake Nokoué by the channel of Totché and more at East with Atlantic Ocean.

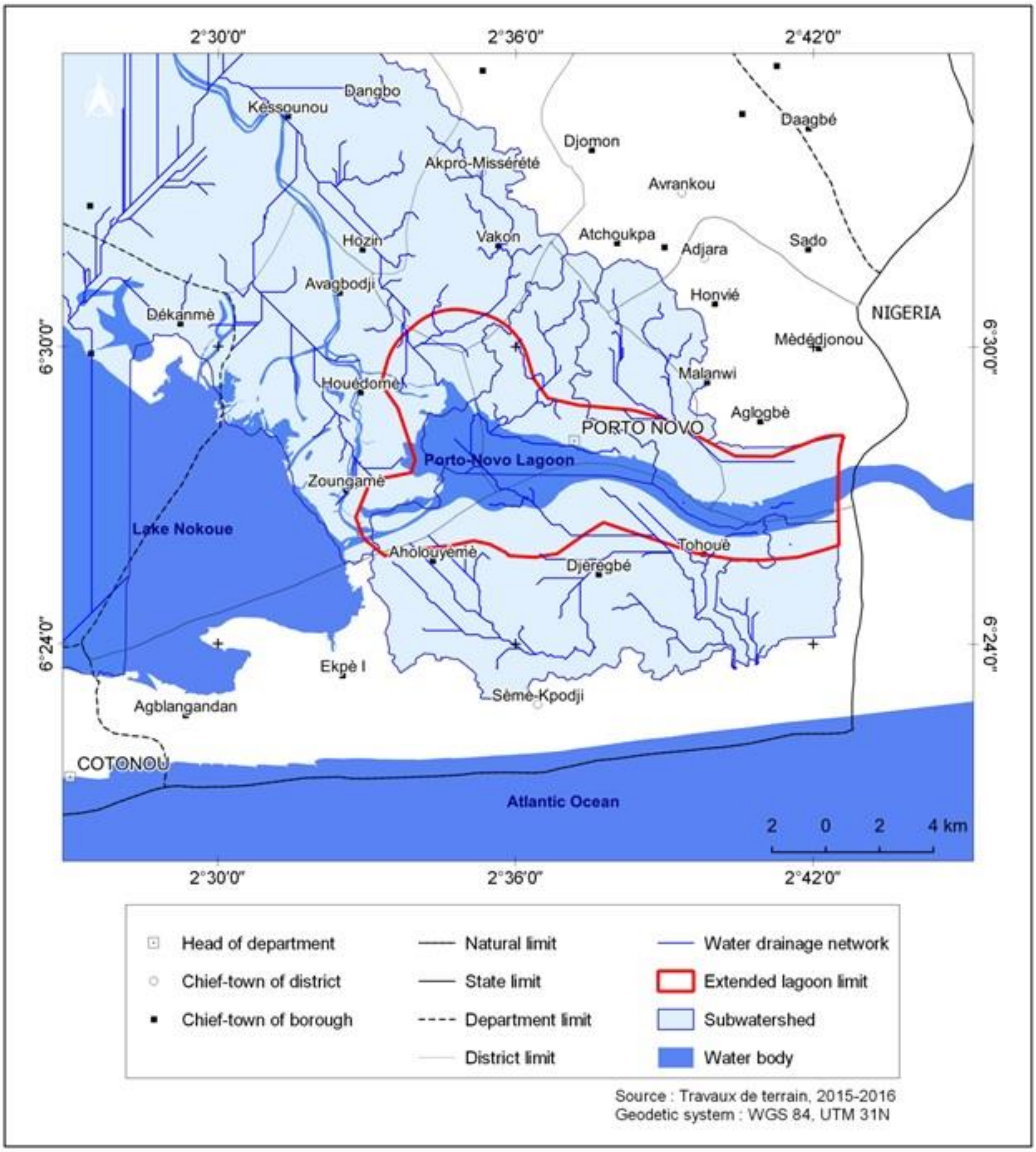

Figure 1: Delimitation of sub-versants by Arc-GIS 10.1

Lagos where it receives salt water during the dry season (Ghabi and Soédé, 1980). The urban sub-versant is covered by eight (08) primary and secondary collectors connected to gutters and these collectors have their outlet either directly in the lagoon or in shallows connected to this lagoon. Two of these collectors were selected for sampling: it concerns collectors I, rectangular, the biggest with 1693.28 linear meters and a dimension 3.00 m over 2.63 m and the smallest, the collector D with rectangle form and 1694.37 linear meters; it presents dimensions 1.20 m over 1.54 m. These two collectors have their outlets in the depression of

Zounvi with GPS generated coordinates (Figure 2). The study sector will be divided in sub-versants for good analysis of water draining system (Figure1). This operation, carried out with *ArcHydro* extension working under ArcGIS, followed the six following steps:

- Determination of the flowing way: the drop of water that flow on each pixel of the corrected MNT has eight (08) flowing possibilities toward surrounding pixels. It concerns East (E), South-East (SE), South (S), South-West (SW), West (W), North-West (NW), North (N) and North-East (NE). To stock these different ways on the pixels, the language of binary coding (0, 1) was used according to the architecture of the computer. Thus, the figures from 0 to 7 were affected as exponent with base 2 ($2^{(0\text{ to }7)}$) for each way from the East in the geodesic way. This will provide the respective values 1, 2, 4, 8, 16, 32, 64 and 128.

  The basic hypothesis of this operation is that the water flows to the pixel with the highest slope.
- Determination of the flowing accumulation: a pixel can receive flowing coming from 0 to n pixels. The number of pixels pouring on any pixel determines its accumulation degree. From the flowing ways, we will determine the number of pixels though flowing was poured on an x pixel. This y number is taken. The space delimited by the whole pixels pouring on the x pixel constitutes a basin and the x pixel is the outlet.
- Definition of the flowing system: the flowing system will be defined based on an accumulation threshold; I mean the minimal pixel number from which a way of the system is defined. To appreciate more the hydrologic resources of the territory, an accumulation threshold of 1111 pixels (either 1 km^2) will be fixed for each way of the system. Otherwise, the ways will be defined so that basins drained are minimum 1 km^2. This threshold allows to get small sub-basins that will be gathered later (at the last step);
- Segmentation of the flowing system: the defined threshold in the previous step served to the segmentation of the study sector into flowing system. The principle is the gathering of adjacent pixels belonging to the same way by affecting to them the same identity;
- Delimitation of sub-basins by portion: based on the segmented flowing system, pixels are gathered to delimit small versants surrounding flowing ways;
- Fusion of portions into sub-basins: the file of the small sub-basins with raster form will be vectored. On the vector product, the objects (features) will be gathered based on the contiguity and the confluence of their outlets.

Sampling and physico-chemical parameters

Sampling was realized in each site after a rain, at a week frequency for a total of three sampling per site. A thirty minutes rhythm separates two consecutive deductions for a total of three deductions per sampling. The physico-chemical parameters such as pH, salinity, EC, temperature, TDS, potential redox (rH) and DO were measured *in situ* with the appropriate material. The flowing water was sampled and kept at each moment for nutrients analyses in laboratory. The Total Phosphorus (TP), Total Nitrogen (TN), Chemical oxygen demand (COD), Biological oxygen demand (BOD) are the dosed parameters.

Estimation of the nutrients flux

The SCS-CN method (soil conservation service-curve number method) though flowing values are estimated in relation to rain quantity, is used to estimate flowing in Porto-Novo town (urban versant) in this lagoon. The SCS-CN is a simple and robust conceptual model made by soil preservation service of the United States (SCS, 1956, Mishra and Singh, 2013) that needs only soil utilization and its texture to model the flowing. It's widely used to estimate the flowing of a versant from small to mean size and urbanized (Mishra and Singh 2013). The rain-flow equation used by the SCS to estimate the direct deep of the rains flowing is as follow:

$$F = \frac{(P - I_a)^2}{P - I_a + S}$$

Where F is the flowing in mm; P is the precipitation in mm; S is the maximal potential retention in mm and Ia is the initial abstraction.

This equation is only valid when P > I, with R= 0. The initial abstraction was considered as equal to I = 0,2S and S = 254 (100 / CN - 1). The CN non-dimensional coefficient called curves number also depends on the field use and is adjusted in relation to the soil permeability. The CN also depends on the soil humidity calculated from the last five days precipitations. The CN doesn't represent physical processes but is empirically deducted from observations in measured basins for soil each and lands utilization; it's a function of soil type and cover (Viji *et al.,* 2015). The CN value ranged between 0 and 100 and the corresponding value to Southern Benin including Porto-Novo and taking into account altitude, land use and pedology (Figures 3, 4,5) and table 2 is CN = 55 (Gerbaux *et al.,* 2009).

Due to the absence of collective sanitation systems, a part of the waste water pollution is directly rejected in rain water collectors. To estimate TN and TP loads in Porto-Novo lagoon through its versant, some measurements were taken during the rainy season at the collectors flowing points in the lagoon. There is no station for monitoring or measurement of the water volume ejected from collectors. This volume includes rain water and domestic water rejections. We suppose that these latter are constant along the year. Urban versant water is considered as the urban rejections during the rainy season that is a mixture of waste water and rain water flowing strictly through pluvial outlets.

The transported TN and TP mass in the lagoon throughout rain water collectors of Porto-Novo versant was estimated by the following equation:

[Flux(X)] = [X]*Q and [mean flux] = $(\frac{X1+X2+\cdots Xi}{n})(\frac{\sum Qn}{N})$ with [X]= nutrients concentration, n=sample number and N= Number of event.

On the Porto-Novo versant, many “illegal” burying sites were installed and through which the local population eliminates domestic wastes. These discharges constitute punctual sources of TN and TP in the lagoon. The estimation of these charges in lixiviate volume, is based on the size of the discharges and the characterization of solid wastes rejected on the site.

Statistical analysis

The spatio-temporal variability of the different parameters led to a descriptive statistical analysis and the Pearson correlation was also used. All these analyses were carried out by using the Minitab 2014 software. The Excel 2010 software served to data base building for charges estimation.

II- Results and discussion

The SCS-CN method served to estimate nutrient charges of Porto-Novo lagoon versant. It’s a wide spread used method and is accepted in many hydrological studies. The total flow of rain water collectors during the dry season calculated from the daily flow of “potential” population connected to these collectors is estimated to 329880 m^3 /year. It was supposed that water flows constantly throughout the year so that the monthly rejection of waste water is average 82470 m^3 for the whole collectors. During the rainy season, supplementary water joins rain water collectors due to urban water flowing. The monthly calculated flowing based on the SCS-CN method was focused on 70 km^2 corresponding to the two Northern sub-versants (Figure 2). The calculated values indicate that there was practically no flowing in January, February, October, and December 2017 (Table 1). Similar results were observed by Rockstr and Falkenmark (2015) who reported that the mean annual precipitations flowing in Sub-Saharan Africa ranges between 100 and 300 mm.

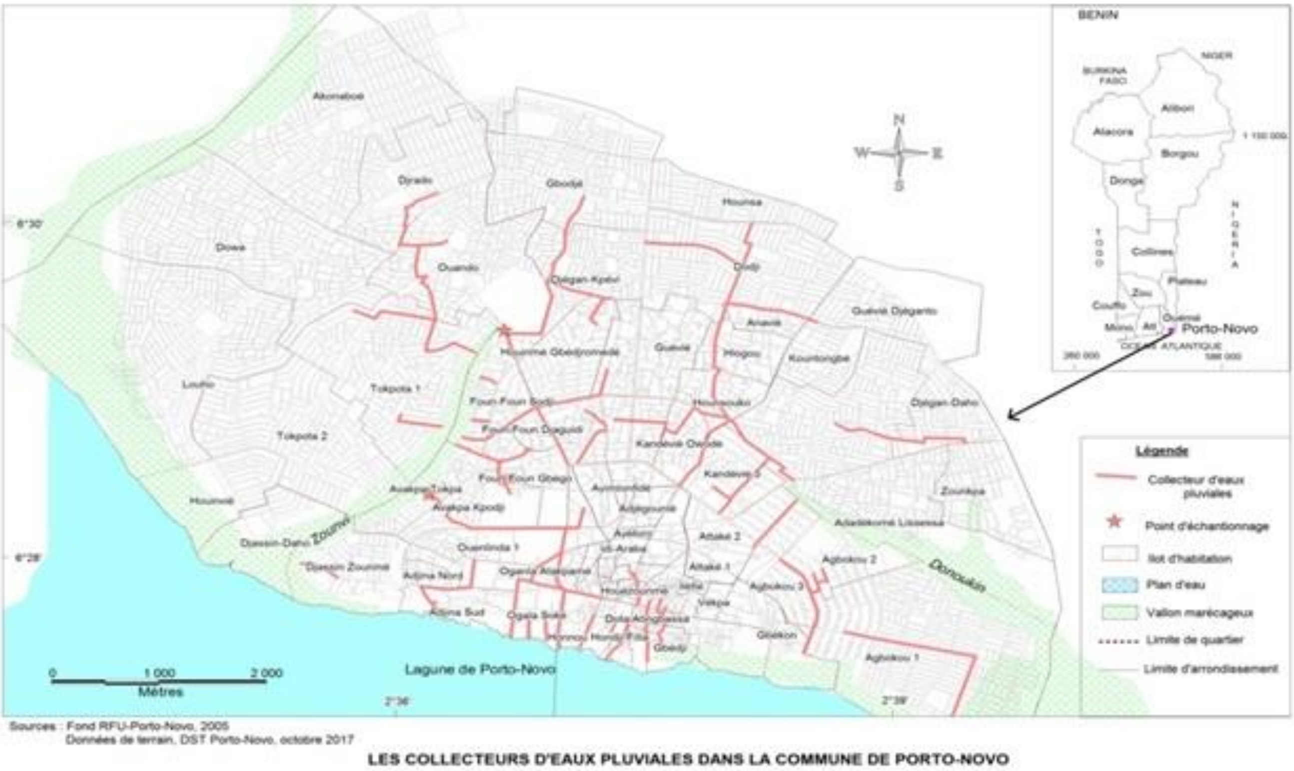

Figure 2: Rainwater collectors and sampling sites

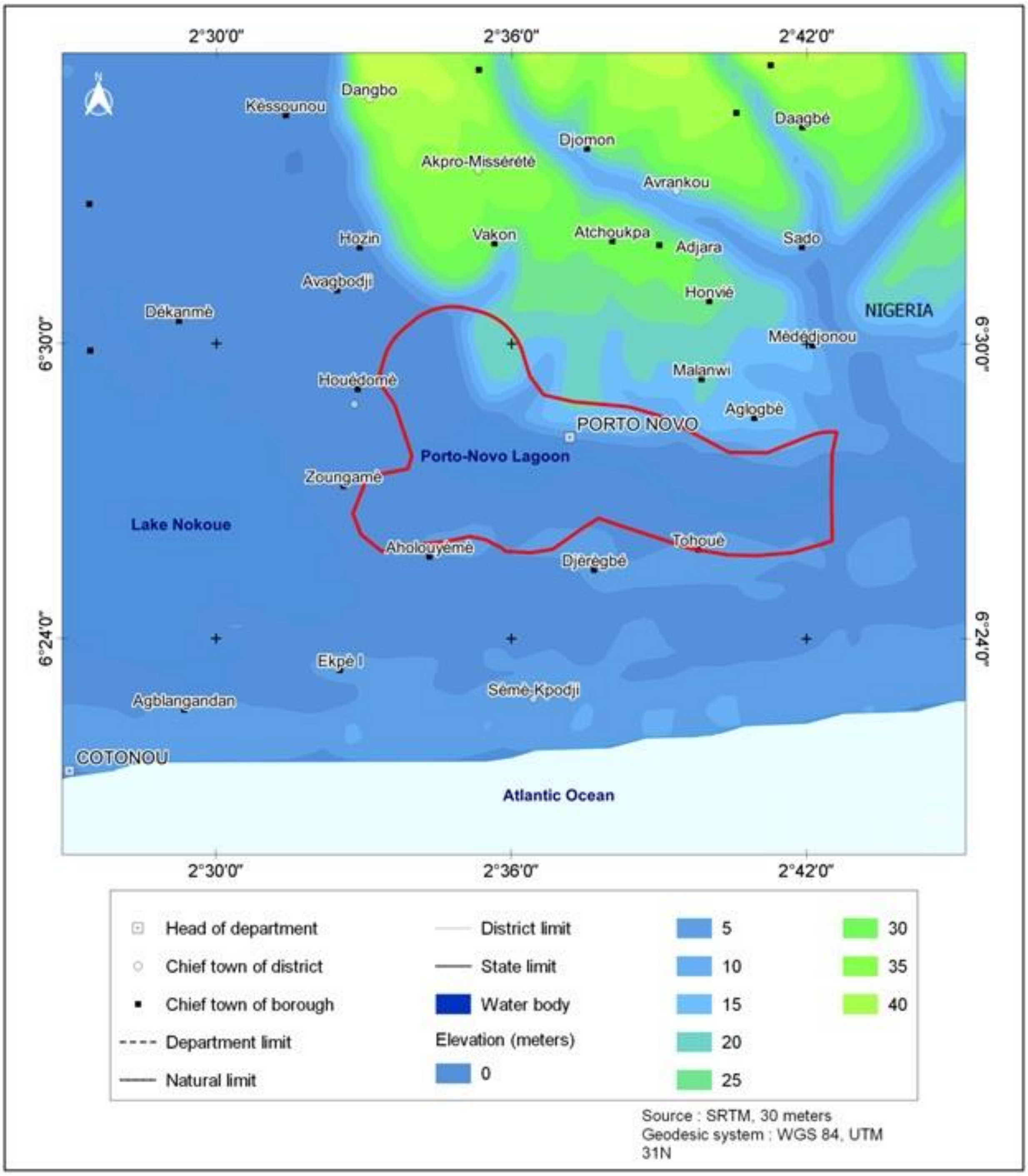

Figure 3: Altitude map of Porto-Novo region

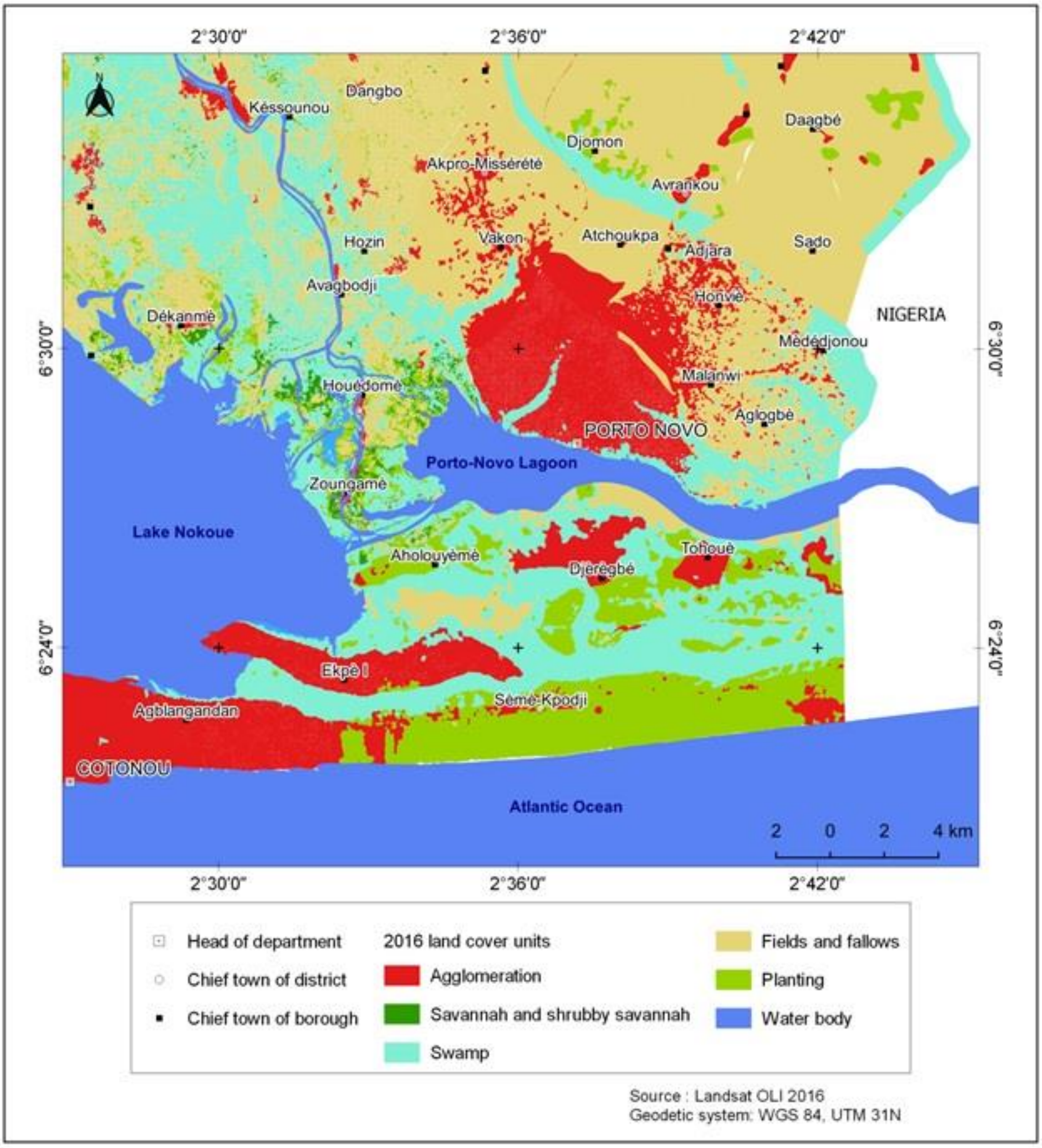

Figure 4: Land use map of Porto-Novo region

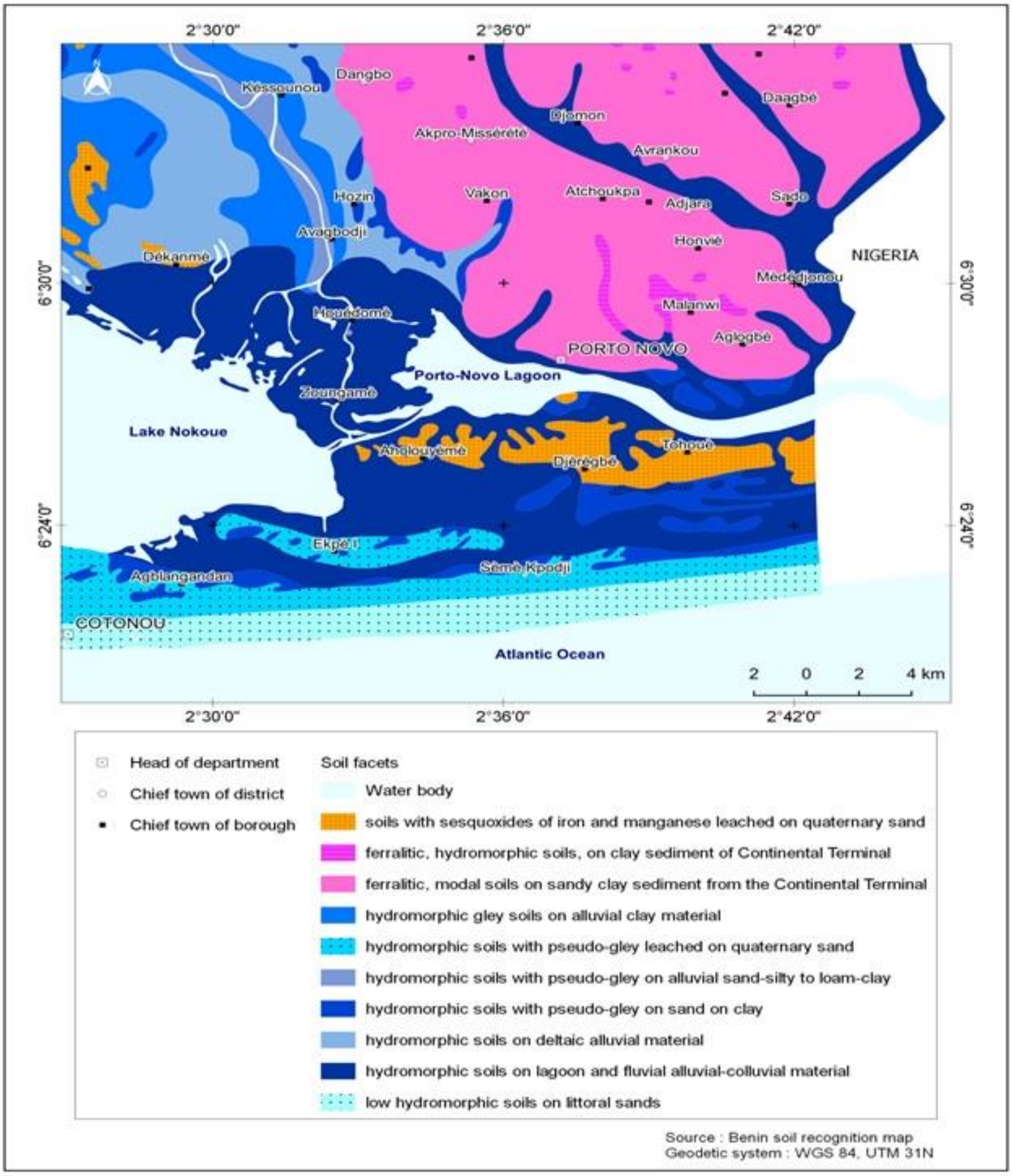

Figure 5: Pedologic map of Porto-Novo region

The maximum flowing happened in June 2017 with average 24 million m^3 of water rejected in the lagoon (Table 1). It's potentially the period where most of solid wastes coming from

Table 2: Classification of hydrologic soil groups

Soil groups	Description	Minimal infiltration (mm/H)
A	Soils of this group have low flowing potential (high infiltration rate) even completely wet. It's made of deep sand, well drained or gravels. These soils have a high water transmission rate.	7.62 – 11.43

B	Soils of this group have moderate infiltration rate when they are well humid and are mainly moderately deep to deep, well drained to moderately well drained with moderately fin textures to moderately rude. These soils have moderate water transmission rate.	3.81 – 7.62
C	Soils have slow infiltration when they are well humid and are a type of soil that prevents water movement to the deep side, or soils with moderately fin and fin texture. These soils have slow water transmission rate.	1.27 – 3.81
D	Soils have strong flowing potential (very slow infiltration rate) humid. These soils are mainly made of clayey soils with high swelling potential, soils on permanent phreatic layer, soils with clay stratum near the surface and less deep, soils on a material almost impermeable. These soils have very slow water transmission rate.	0 – 1.27

(Source: Mc. Cuen, 1982)

collectors are rejected in the lagoon. However, due to the lack of data on the lixiviation of these solid wastes we supposed that pollution by nutrients coming from their charges is constant along the year (Table 1). During the other months of the rainy season, the flowing ranged between 152.470 m^3 and 6.759.766 m^3. These results are majorly due to the estimation method. Indeed, many models are available for estimation of the flowing volume such as the method of cinematic waves (Lighthill and Whitham, 1955) to estimate the flowing of the urban complex zones and for all versants sizes, the method of heard coefficient ratio (Munyaneza, 2014) for smallest versants (less than 25 km^2) and the SCS-CN used in the current study. This latter is frequently used for direct measurement of long term superficial flowing (Muthu and Santhi, 2015; USDA, 1986). This SCS-CN model is practical and reliable for the flowing estimation in tropical regions (Nhamo Luxon, 2013) contrary to others; it combines versants characteristics (soil type, soil cover and soil conditions) and climatic factors in a same entity called curves number. It’s a potential coefficient corresponding to the multiplication of the total precipitations after deduction of losses related to evaporation, absorption, transpiration and surface storage (Soulis and Valiantzas (2012) and Schiariti, P. (2012). The soil of Porto-Novo versant showed the specificities that enabled the of the CN value; they were sand soil or few differentiated sandy-clay; ferruginous and barren land (Figure 3) though characteristics are as follow according to Youssouf *et al.*, (1981): “a pronounced alteration of primary minerals, presence of kaolinite as clayey mineral, high concentration in iron sesquioxydes often accompanied with aluminum sesquioxydes, depth ranging from 2 to 8 m with red color, an absence of spot and concretions, a few developed humus horizon (10 to 15 cm), absence of textural accumulation horizon, highly progressive passage from a structural horizon (B) to the horizon (C), well internal draining favored by a mean polyedric structure few developed and an intensive biological activity, a mean clay washing, few thick soil stratum (40 to 50 cm), appearance of discontinuous bright parts from 50–60 cm, a cation exchange capacity generally low, low or mean saturation rate, acid pH". These soils vegetation is bushy and is often used for forest plantation but especially for cultures such as maize, pineapple, beans, ground nut and market gardening for which some fertilizers are used (Youssouf *et al.,* 1981). These described characteristics are in accordance with the hydraulic classification proposed by Mc.Cuen, 1982 (Table 2) mainly the group D with a normal draining profile and that enabled to assimilate the CN value to 55 after adjustment to the current hydrographic basin (Gerbaux, 2009).

Table 1 : Load calculation model

Date	Precip. (mm)	Area P-N	P-I	SCS-CN (mm)	Real value	Runoff P-N (m3)	ww P-N	Total Q (m3)	TN P-N	TP P-N	TN-SW	TP-SW	TN-Load	TP-Load
jan-17	8	70	-22	4	0	0	82 470	82 470	2,3611	12,185	0,265	0,04	0,46	1,04
fev-17	0	70	-30	7	0	0	82 470	82 470	2,3611	12,185	0,265	0,04	0,46	1,04
mar-17	66	70	36	7	7	490 000	82 470	572 470	2,3611	12,185	0,265	0,04	1,62	7,02
apr-17	69	70	39	8	8	560 000	82 470	642 470	2,3611	12,185	0,265	0,04	1,78	7,87
may-17	180	70	150	75	75	5 250 000	82 470	5 332 470	2,3611	12,185	0,265	0,04	12,86	65,02
jun-17	483	70	453	341	341	23 870 000	82 470	23 952 470	2,3611	12,185	0,265	0,04	56,82	291,90
jul-17	191	70	161	84	84	5 880 000	82 470	5 962 470	2,3611	12,185	0,265	0,04	14,34	72,69
aug-17	76	70	46	11	11	763 721	82 470	846 191	2,3611	12,185	0,265	0,04	2,26	10,35
sept-17	206	70	176	95	95	6 677 296	82 470	6 759 766	2,3611	12,185	0,265	0,04	16,23	82,41
oct-17	19	70	-11	1	0	0	82 470	82 470	2,3611	12,185	0,265	0,04	0,46	1,04
nov-17	43	70	13	1	1	70 000	82 470	152 470	2,3611	12,185	0,265	0,04	0,62	1,90
dec-17	15	70	-15	2	0	0	82 470	82 470	2,3611	12,185	0,265	0,04	0,46	1,04
Total													108,37	543,33

P = precipitation in mm; P-N= Porto-Novo; Qc = the total water discharge from the collectors; TN-C = total nitrogen from collectors, TP = total phosphorus from collectors; TN-SW = total nitrogen from solid waste in tons; TP-SW = total phosphorus from solid waste in tons; TN-Load = total nitrogen loaded from sewage and storm-water in tons; TP-Load = total phosphorus loaded from sewage and storm-water in tons.

As the impact of soil characteristics on the flowing is obvious, the CN is so highly influenced by infiltration rate. The selection of curves number depends on the type of soil and its infiltration capacity (Neelam *et al.,* 2017). Many factors affecting the infiltration rate like water flowing; the infiltration is based on the physico-chemical status of sediments and the chemical and hydraulic characteristics of these sediments water. The infiltration rate depends on the texture and structure of the sediment (soil), the status of sediment surface, the distribution of soil tension, the physical and chemical nature of the water, the depth of the phreatic layer, the biological activity, the water temperature, the sediment air rate and the atmospheric pressure (Nicholas, 2004).

Figure 4 indicates a linear relationship between precipitations and flowing in Porto-Novo versant; precipitations and flowing are strongly correlated with a correlation coefficient (R^2) equals to 0.95 enabling to justify the choice of this method.

The urban rejections during the rainy season is made of wastewater and rain water generally untreated though in the dry season, these rejections are made of wastewater released by population in area deprived from sanitation system. The urban sub-versants covering the Porto-Novo town receive average two hundred sixty six thousand (266,000) of people in 2017 and the population density in this town is average 1000 inhabitants / km^2 (RGHP-4, 2013) that is largely lower than those of surrounding town such as Cotonou and Abomey-calavi. There is no collective sanitation system for wastewater treatment in this town. The survey carried out during the current study reveals that average 58% of houses don't have proper sanitation system and reject waste water in rain water collectors and even on the soil surface. Concentrations in pollutants are very variable, also the physico-chemical parameters. Table 3 and figure 8 illustrate these variations. The TP rate during the study period is variable in all sites. The mean value is 11.24 mg/L with a maximum of 17.48 mg/L and a minimum of 6.61 mg/L. These TP values are very high (largely higher than normal of surface water quality estimated at 0.1mg/L) and can only be explained by versant washing; a permanent addition of other utilization sources and phosphate products rejection could be the reason.

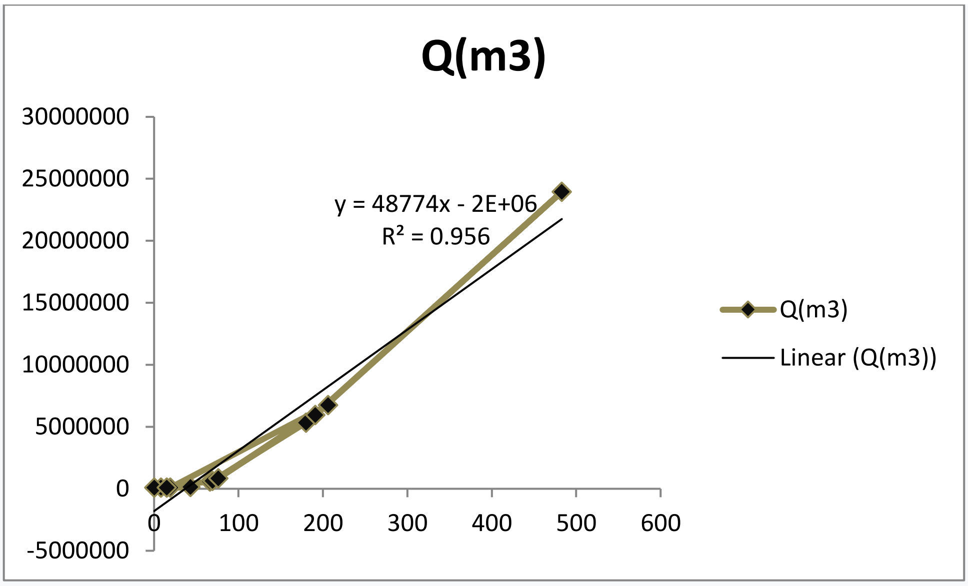

Figure 6: Flowing-precipitation correlation in Porto-Novo versant.

Concerning the TN, the mean value is 2.88 mg/L with a maximum equivalent to 5.19 mg/L and a minimum equals to 0.38 mg/L. These values are lower than those of surface water (TN=6 mg/L) and could be the consequent of progressive versant washing and show a good quality of this water regarding nitrogen ions.

The simultaneous analysis of quality parameters (BOD, TN and TP) according to the Figure 7, show a spatio-temporal variability of the concentration of these parameters, indicating the non-linearity of pollutants fluxes that is consequence of a temporal variation of rains and water flow. This observation is similar to that of Chocat (2014) who reported that pollutants concentration of rain water depends on the rain intensity, flowing extent, nature of surface material, nature of activities on or near the surface. The same trend was confirmed by Dufour (1985) who reported the spatial heterogeneity in nutritive salts concentrations of wastewater is considerable because these waters join the lagoon by multiple ways. A Pearson correlation analysis was carried out between the different pollution parameters (Table 4) showing that pH is significantly tied to rH (r=0.97) confirming that the acidity of these waters is the consequence of the accumulation of oxidant particles. A correlation is also observed between COD and BOD (r=0.72) indicating the relative mixing and biodegradability of the effluent.

Table 3: Variation of the concentration of physico-chemical parameters.

Sites	pH	Temp	DO	MES	TDS	EC	rH	TN	TP	BOD_5	COD
S	5,46	25,25	5,93	13,89	117,3	117,3	88,99	2,36	12,03	27,89	57,11
H	5,42	24,58	6,02	10,11	80,56	80,82	88,60	2,35	12,33	21,56	47,00
Min	4,87	23,00	4,30	2,00	42,00	41,90	18,30	0,38	6,61	8,00	17,00
Max	6,50	25,60	8,30	41,00	154,00	151,50	126,90	5,19	17,48	44,00	79,00
StD	0,08	0,14	0,35	2,84	7,91	7,89	5,31	0,37	0,72	2,55	4,39
Mean	5,44	24,92	5,97	12,00	98,94	99,05	88,80	2,36	12,18	24,72	52,06
Surface water Standards	6<x<9	< 25°C	> 5 mg/L	< 50 mg/l		800 µS/cm		< 12 mg/l N	< 1 mg/l P	< 8 mg/l	< 40 mg/l

*value±SE SE: Standard Error Summury descriptive statistic

Table 4: Pearson correlation coefficient between the different physico-chemical parameters

	pH	Temp	EC	TDS	rH	BOD_5	TP	TN	MES	COD	DO
pH	1										
Temp	-0,132	1									
EC	0,093	0,285	1								
TDS	0,099	0,285	1,000	1							
rH	-0,970*****	0,318	-0,075	-0,082	1						
BOD_5	0,008	0,439	0,474	0,468	0,057	1					
TP	-0 ,051	0,164	-0,344	-0,344	0,101	0,127	1				
TN	-0,222	-0,125	0,177	0,158	0,210	0,189	-0,221	1			
MES	0,033	0,287	0,159	0,159	0,063	0,082	-0,048	-0,165	1		
COD	-0,137	0,448	0,074	0,066	0,220	**0,721***	0,130	0,135	-0,033	**1**	
DO	-0,251	0,421	0,034	0,028	0,338	0,154	0,325	-0,082	-0,112	0,107	**1**

*p<0,01 **p<0,001

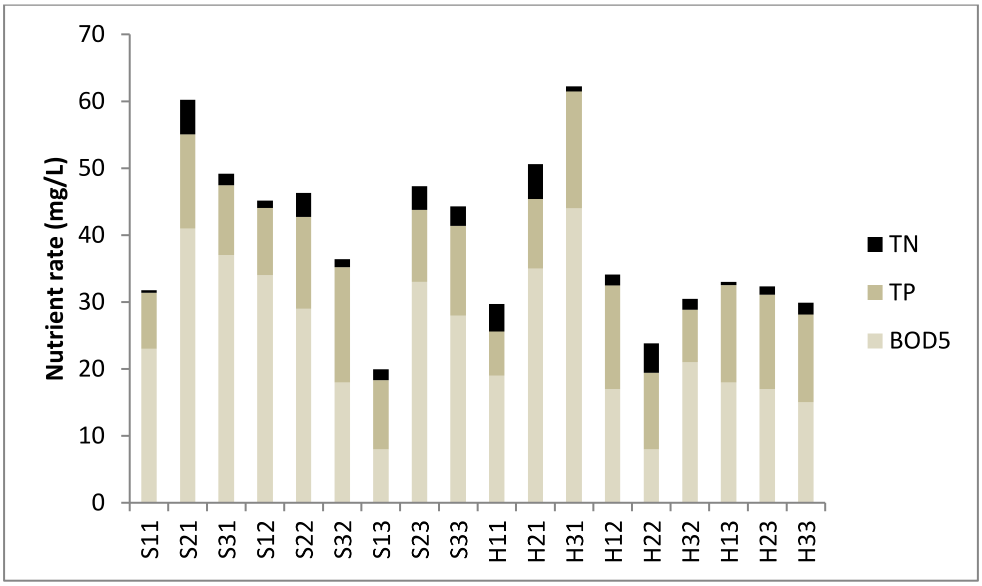

Figure 7: Relationship among the pollution parameters

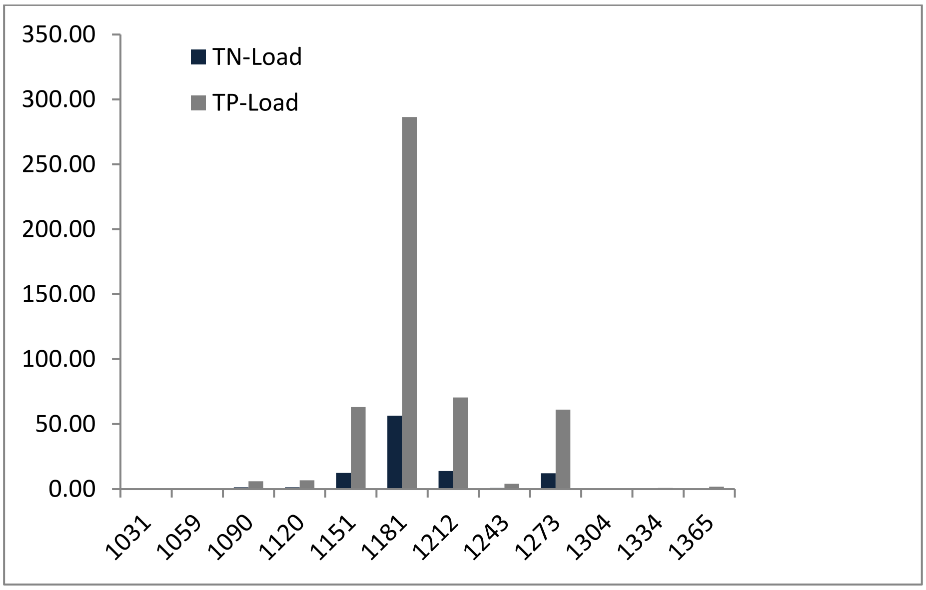

Figure 8: Relative change in TN and TP rates

The estimation of pollutants flux especially TN and TP concentrations during the rainy season are higher than those in dry season with fluctuations of each season. A rain washing of the versant could explain this increase in relation to dry seasons and especially that sampling was carried out after rain fall. The TN and TP load is not only the consequence of waste and rain waters. Indeed, the field observations indicated that most of rain water collectors contained important solid wastes released by the local population. This non-civism situation of the population could also be tied to the fact most of collectors are open. Besides, many discharges (made of domestic wastes) were found. These solid wastes influence the quality of water coming from these collectors and are evacuated to the lagoon after intensive rain fall. The quantity of these solid domestic wastes is estimated to 159 tons per year by referring to the number of mixture in a 200 m ray of these collectors. The application of a ratio of 2% TN and 0.3% of TP (Biernaux, 1978) enables to have the total supply of nutritive elements coming from these solid wastes estimated to 3.18 tons of TN and 0.48 tons of TP per year. The TP charge previously mentioned is higher than that of TN in the water rejections. It reaches 543 tons of TP for average 108 tons of TN per year (Table 1) suggesting a diffuse source of phosphorus coming from this versant. The SONGHAI center that reject directly to the environment the over flow of its fish farming ponds and the numerous market gardeners surrounding this versant could be the suppliers in phosphate molecules. Indeed, fertilizers supplied to producers in this area by agricultural, fishery and rearing structures during the 2015 to 2017 period are estimated to 250 tons of NPK and 170 tons of urea each year (statistic service-DDAEP, personal communication). The nutrients load is higher than the municipal genuine pollution load observed in the versant of Chaudière River that was 990 tons of TN and 110 tons of TP per year (Simoneau, 1991) despite the spread of this basin compared to that of Porto-Novo lagoon (240.55km^2). It's also higher to the observations of Mama in rain waters of Cotonou (Mama, 2010) and Djihouessi from his studies based on Cotonou and Calavi towns (Djhouessi, 2018). The estimation method used considering possible sources of pollutants could explain these results. The origin of pollutants contained in urban rejections during the rainy season is multiple such as atmospheric pollution, washing of dry season depositing accumulated on the versants, erosion of urban materials, suspension of pollutants present in sanitation systems (Chocat (2007). These rejections can eventually be mixed to waste waters before joining the natural environment (Kanso *et al.,* 2007). It's especially the reason of the high rate of these pollutants compared to the normal of surface waters. These waters are polluted and worth to be purified by abatement treatments (Selghi, 2001) or collective or individual pollutants elimination before reuse or rejection to the natural environment (Paulsrud and Haraldsen, 1993). They could provoke an increase in nutritive salts of receptive water that is Porto-Novo lagoon. These urban effluents modify the relative composition of lagoon waters that enrich them in phosphorus than nitrogen (Dufour, 1985), presenting bad consequences on the aquatic fauna of the receiving medium. This situation poses the problem of pollutant reduction strategies in the versant or upstream of this latter by the installation of wastewater purification or treatment systems before their rejection to the receiving medium. Mama, (2010) reported that the use of fertilizers must be moderate to reduce their washing by rain. The alternative solutions to the direct evacuation of rain water from the versant to the associated ecosystem will enable to solve certain sanitation problems.

Zheng and Shou Ren, (2014) by recognizing the rejection of wastewater in the aquatic media as responsible factors of degradation of these media, proposed multiple dimension mechanisms to solve it. Zhou Hai Wei and Zang Shen (2013) agreed for the settling of victims' indemnification that passes through prior evaluation of economic losses (Hou Yu, 2012). Such an approach in the lagoon environment as Porto-Novo lagoon necessitates not only a definition of ecosystems service scales and an adequate mechanism of their use but also a coherent governance and institutional arrangements for orientation and monitoring. Le Jallé *et al.*, (2009) prefer in contrary an integrate rain water management due to interdependence of the different urban services especially wastewater sanitation and solid wastes management.

Conclusion

Carried out during the bid rainy season, the current study based on the assessment of eutrophogenic nutrients flux of Porto-Novo lagoon versant enabled to understand the important nutrients flux drained to this lagoon. Average 543 tons TP and 108 tons of TN come to Porto-Novo lagoon through its urban versant. The analysis of physico-chemical parameters of this water showed their bad quality that is dangerous to the biodiversity of the medium. The estimation method used (SCS-CN) is a first on the versant. It indicates a correlation between precipitations and flowing and enables to evaluate easily the load of these nutrients. Although it worth to be reviewed over several years to determine the most adapted curve number (CN) to this versant. If Beninese authorities defined sanitation strategies of wastewater in urban medium, nothing was forecast concerning rain waters; a coherent and integrate mechanism on behalf of politics, the contribution of people benefiting from the ecosystem existence and the preservation of the ecological interest of media is most important for sustainable of restoration acts.

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