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Cartography and prediction of the risk of water erosion in anyama (district of Abidjan): contribution of RUSLE and markov models

Abstract

Water erosion is a major process by which the surface of the earth's crust is continually subjected to abrasion and corrosion. This has consequences for the degradation of communication, sanitation works, stripping the foundations of houses, abrasion of Arable lands and the reduction of agricultural output. Therefore, significant research on water erosion has been carried out from the modeling. This study focused on water erosion of the soils of Anyama, a peri-urban community of the District of Abidjan from remote sensing. The study aimed to quantify and spatialize the risk of water erosion through RUSLE model. The analysis of water erosion reveals four sensitivity levels: low, medium, high and very high. The areas with low potential erosion constitute 24.08% and mainly cover the following cities located in the northeast of the study area. The moderate sensitivity occupies 29.19% of the municipal area. Approximately 24.11% of the town of Anyama has a high susceptibility to water erosion. The study area has a very high susceptibility to water erosion up to 22.62% and concerns the localities in the south and southeast of the town of Anyama. The forecast map of water erosion risk in 2045 reveals a very high susceptibility to water erosion and moderate sensitivity to erosion about 33.6%. The low sensitivity will concern 21.73% of the town of territory.

Keywords: water erosion, RUSLE, forecast, markov model, Ivory Coast

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Introduction

Water erosion is one of the natural risk phenomena and one of the main causes of land degradation in the world. Indeed, soil is observed partially or totally degraded because of this phenomenon. In Latin America, water erosion affects 14.3% of the territory of South America and 26% in Central America.[1] In Europe, according to the European Environment Agency (EEA), the problem affects approximately 17% of the surface of the territory.[2] In Africa, water erosion is also very widespread. According to the European Commission (2012). This phenomenon exists on 500 million hectares in Africa. It has been the subject of numerous studies in some countries in the world with the use of some models such as the Universal Equation of Ground Loss (USLE), the Universal Loss Equation floor Revised (RUSLE), the Water Erosion Production Project (WEPP), the Soil and Water Assessment Tool (SWAT). It is in this context that the first works on water erosion in forest region of Ivory Coast were conducted by Rougerie (1958, 1960). These works have analyzed various erosion processes, factors and erosion control methods.[3] After independence, there was a rapid increase of the Ivorian population of 3,474,724 inhabitants in 1960 to 22,671,331 inhabitants in 2014.[4] This has led to increased demand for land without any real control from the authorities in charge of development, especially in Abidjan. The Northern District of Abidjan particularly Anyama is not an exception to this phenomenon. The town of Anyama is marked by high rainfall, with a rugged topography and clearing of drainage for agricultural purposes which are factors of accelerated erosion. This has consequences for the degradation of communication, sanitation works, stripping the foundations of houses, abrasion of arable lands and reduction of agricultural output. The aim of this study is to map and predict the risk of water erosion in order to inform the population as to the arrangements and the measures to be taken as the anticipatory.

Presentation of the study area

Located between longitudes 4°1'0 "and 5°26'5" West and latitudes 4°16'15 "and 3°58'45" north, the study area is bounded to the north by the cities of Agboville and Bingerville and Abobo and Yopougon and west by Songon (Figure 1). The town of Anyama is located about 10 km from the commercial capital Abidjan. The climate of the study area is wet subequatorial with two rainy seasons. The short rainy season beguins from October to November and the long starts in May and ends in July. They alternate with a long and a short dry season from December to April respectively and from July to September. The average of annual rainfall in Anyama is about 1706mm with a temperature varying between 25°C and 30°C.

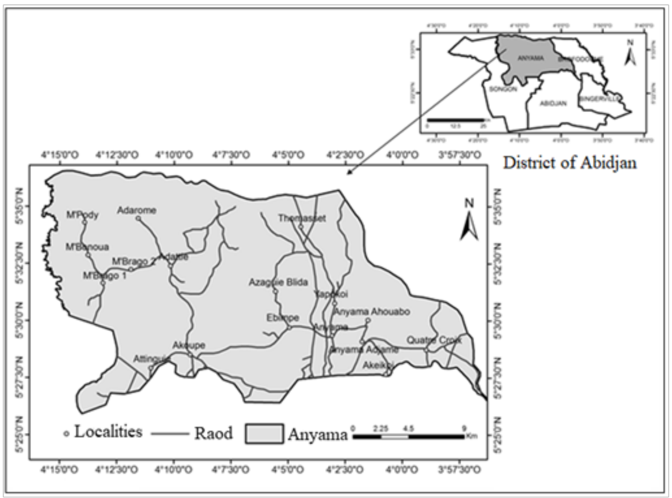

Figure 1 Location of the study area.

Materials and methods

Materials

The basic data used to carry out this work, consist in daily rainfall records from the database IRI Colombia. Satellite data are composed of Aster, Landsat TM, ETM + and OLI images. Topographic maps with 1/200000 established by the Center Mapping and Remote Sensing (CCRS) were also used.

For this research work, several software was used namely:

a. INSTAT 3.36+ and Idrisi Selva for statistical calculations and Markov modeling;

b. Idrisi and ArcGIS 10.2.2 for the development of various factors RUSLE model and their combination.

c. Envi 5.1 for radiometric correction of satellite images, classification of satellite images and validqtion of this classification.

This work also need ground point data for the validation process of the classification of satellite images and recoreded with a GPS (Global Positioning System).

Methodology

The RUSLE model is based on the Universal Equation Revised soil loss. It integrates five factors including the erosivity of the rain, the soil erodibility, topography, vegetation cover and erosion control practices. These five factors are then combined to obtain the water erosion map of the town of Anyama.

Cartography of water erosion

Erosivity of rain or the R factor: The erosivity of the rain or the R factor is calculated according to Equation 1:

$$R = 0.0.483 * P^{1.610} \tag{1}$$

P is the amount of annual precipitation divided by the number of years of the study period.

The erosivity of rain or R factor is calculated for nine points that cover the study area. The R values obtained are then interpolated by using the module "interpol" of Idrisi software to have the map of R factor.

Erodibility or K factor: is obtained by extracting the different sort of soil of study area from the Ivorian soil map. Then, each type of soil is assigned a value in the attribute table (Table 1). A rasterization map was performed to obtain the map of K factor.

Table 1 Summary of K factor values

Soil	K factor
Ferralitic soil moderately leached	0.105
organic soil (hydrmorphic)	0.3

Topography or LS factor: The LS factor is calculated according to equation 2:

$$LS = (L/22.13)^{m} * (0.065 + 0.045*S + 0.065*S^{2}) \tag{2}$$

L: slope length in meters

S: the inclination of the slope percentage

M = 0.5 as the inclination of the slope is greater than 5%.

The Aster DEM image (Digital Elevation Model) is used to determine the maps of L factor and S factor using the modules "slopelength" and "slope" of the Idrisi software.

The "image calculator" module was used to calculate LS factor and to get the LS map.

Land cover or C factor: The C factor process is preceded by mapping the land use from Landsat OLI image from 2015. The following stage is to proceed to the allocation of code for different types of Land use. This stage leds to the Lande use map. The process outlining the image processing in order to obtain of the Land use map are reflected in the chart of Figure 2. Each land use class was assigned values based on its resistance to water erosion (Table 2).

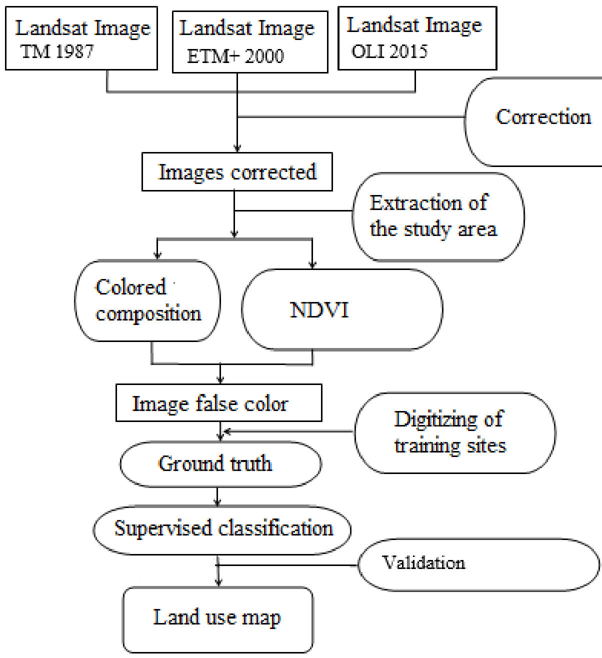

Figure 2 organigramm for the process of the classification of Landsat TM, ETM + and OLI images.

Table 2 Summary of Factor C

Types of land use	C factor
Forest	0.13
Culture/fallow	0.5
Water	0
Home/bare soil	1

Anti-erosive practice or P factor: Farmers in the study area do not use any anti-erosion cultural practices. It was therefore assigned the value 1 on the whole study area according to the table of Wischmeier & Smith[5]

Combination of risk factors of water erosion: The formula of RUSLE model is given by the following equation 3:

$$A = R * K * LS * C * P \tag{3}$$

Maps of erosivity or R factor, erodability or K factor, topography or LS factor and practical management mode or P factor were resampled at 30m resolution. These resampled maps were combined with Land use map or C factor following to above equation (3) to obtain water erosion map of Anyama area.

Citation: Hermann N'GBV, Bachir SM, Helene KB, et al. Cartography and prediction of the risk of water erosion in anyama (district of Abidjan): contribution of RUSLE and markov models. *Int J Hydro.* 2018;2(5):643–649. DOI: 10.15406/ijh.2018.02.00137

Validation of RUSLE model: Validation consists in taking measurements of the exposure of the roots to the air, of the mounds of residual soil, of landslide, of the type of vegetation, of the land use, the length and the width of the roots to appreciate the water erosion of soils. The validation of the water erosion risk map obtained concerned 20 selected sites in the territory of anyama. The location of the sites was done using the established map and a satellite positioning system (GPS).

Forecasting and simulation of rain erosivity (R factor) and land use (C factor)) by markov models

Forecasting rainfall data: Prediction of daily precipitation from 2015 to 2045 was performed with the module "Markov modeling" of Instat 3.36+ software from a two order Markov model combined with a gamma function. This process is made through three stages; Data preparation, the conception of the two orders Markov chain and use of the model to analyze and predict daily rainfall.

Forecasting Land use with spatial markov chain: The spatial Markov model is a spatio-temporal model. Markov models fit the number of stochastic models considering the variability of natural phenomena using probability. The spatial Markov model used in this study is a combination of a Markov chain and a cellular automaton.

Validation of the Land use map predicted by markov model: Validation of the predicted Land use map by Markov model for, used in this study is performed througth the Kappa indices.[6] calculated using the module "validate" of Idrisi software. Four Kappa indices are calculated from this module namely KappaLocation, KappaQuantity, KappaNo and KappaStandard.

Forecasting water erosion risk from 2045: Erosivity of rain or R Factor, erodibility of soil or K factor, topography or LS factor, Land use or C factor and practical management factor or P factor were combined through a GIS model to obtain the map of water erosion of the area of Anyama from 2045.

Results and discussion

Spatial distribution of the factors of water erosion of soil in the town of Anyama

Erosivity of rain or R factor: The spatial distribution of rain erosivity shows that the town of Anyama is subjected to rain aggressiveness. The erosive factor increases from East to West and the values vary between 0 and 8223 Megajoul.mm/hectar.hour.year (Figure 3). The lowest values presented respectively by classes 0 to 5870 and 5870 to 6773MJ.mm/ha.hour.year are recorded in the east of the study area. Its values are 1392.75 and 2222.01hectares of the area of the town with 3.17% and 5.05%. The moderately watered areas are located from the South to the North and Northeast with values ranging between 6773 and 7379. Its values represent an area of 19708.47 hectares or 44.83% of the study area. The high rainfall areas are located in the West, Southwest and Central East of the town of Anyama. These values vary between 5870 and 6773 and cover an area of 20641.59 hectares or 46.95% of the study area.

Sol erodibity or K factor: There are two types of soil in the town of Anyama. Ferralitic soil moderately leached and organic soil (hydrmorphic). The values of the K factor show that more than three quarters of the soil of the town of Anyama (99.42%) have low erodibility reaching values t.ha.h 0.105/ha.MJ.mm. Only 0.58% of the study area has a high erodibility with a value of 0.30t.ha.h/ha.MJ.mm (Figure 4). The spatial distribution of K factor indicates that the least erodible soils cover nearly the entire region with 4 350.53hectares. Most erodible are located in South East ends and Northwest of the study area with an area of 255.06hectares.

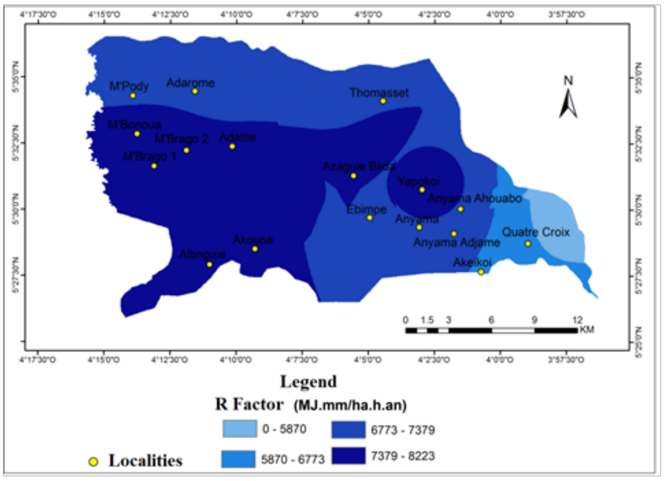

Figure 3 Map of the rain erosivity (R factor).

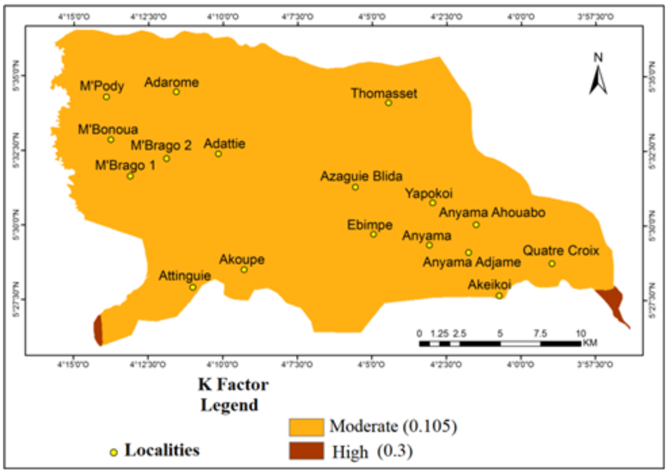

Figure 4 Map of soil erodibility (K factor).

Topography of the site or LS factor: According to the calculation, the values obtained for the LS factor vary between 0 and 1202.304 (Figure 5). The highest values of the topographic factor represent an area of 5 182.2hectares of the study area about 11.83%. These values are distributed over the whole surface of the town; however they are more concentrated in the South. The moderate value is from 3 356.73 about 7.67% of the total area of the municipality and are located throughout the study area. 36.41% of the values are small with an area of 15 943; 59hectares. The lowest values represent 19 306.17hectares or 44.09%. They are located on the plains. Low and very low values are distributed over the whole surface of the town of Anyama.

Land use or C factor: The NDVI value of Landsat OLI from 2015 is between 0.049 and 0.284. The lighter portions represent areas of high chlorophyll activity while the dark parts are areas of low chlorophyll activity.

Spatial distribution map of the C factor of 2015 (Figure 6) shows the sensitivity of different types of Land use to erosive process. The lowest coefficient is located mostly in the north and is withholding water. The moderately vegetated areas and weakly eroded are located in the northwest, southwest and center. The moderately eroded areas are located in the South East, the North and the Center. The highest coefficient is located in the South and dispersed in the northwest. The results show that 1625.51hectares or 40.38% of the area of the town of Anyama has a plant cover rate high with a moderate sensitivity to water erosion and 22131.54hectares or 50.71% are crops/fallow. Crop/fallow area are the localities that are considered highly susceptible to water erosion. 3815.73hectares, which corresponds to 8.74%, are occupied by bare soil and 72.54hectares or 0.17% is occupied by water. Bare floors match the type of the most vulnerable Land cover to erosion. As for water, it concerns the least attacked by water erosion.

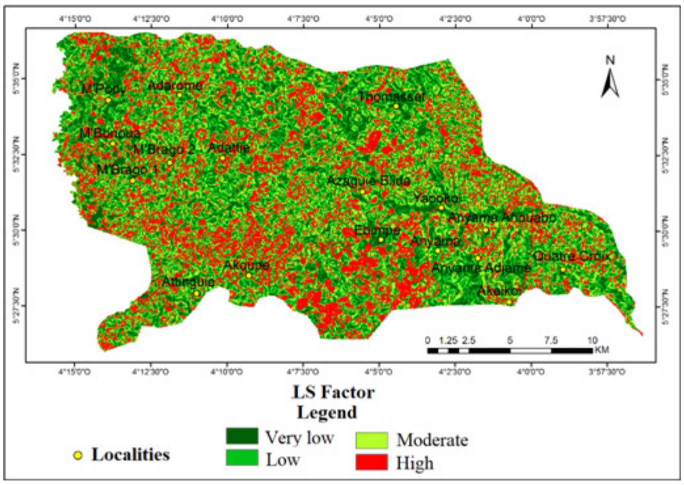

Figure 5 Map of topographic factor (LS factor).

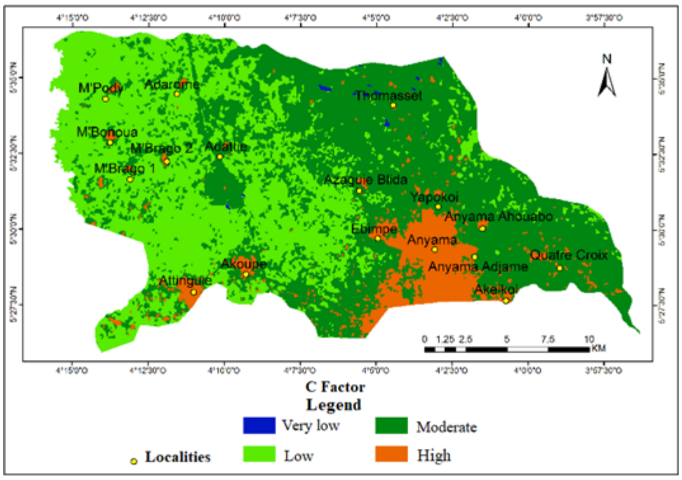

Figure 6 Land use map or C factor from 2015.

Anti-erosive practice or P factor: A value of 1 is assigned to the Land cover where there are no anti-erosive practices. According to the sesearch work of Payet et al.[7] In this study the value 1 was attributed to the study area due to lack of erosion control practices. The cultures encountered are not parallel to contour lines. Thus, the entire study area is highly susceptible to erosion (Figure 7).

Spatial distribution of water erosion risk in the town of Anyama: The values of the potential erosion (t/ha/year) obtained in the study area vary from 0 to 879 625 t/ha/year (Figure 7).These values have been grouped into 4 classes of values according to the work of Markhi et al.[8] as follows:

a. The first class contains areas with low potential erosion. It constitutes 24.08% is 10322.28 hectares of the area of the study area and mainly covers areas such as Adaroma, M'Brago 1 M'Pody.

b. The second class includes areas with moderate potential erosion. It occupies 12511.35 hectares therefore 29.19% of the area of the study area.

c. The third class contains areas with high erosion potential. It represents 10332.54 or 24.11% of the study area.

d. The fourth class is areas with very high potential erosion. It includes 9695.43 hectares or 22.62% of the study area. They generally focus in habitats such as Anyama Adjamé Akeikoi, Anyama Ahouabo, Azaguié Bilda, Attinguié, Akoupé. The largest urban stain that is to say the town of Anyama has a sensitivity of 5.52% with an area of 2360.68t/ha/year.

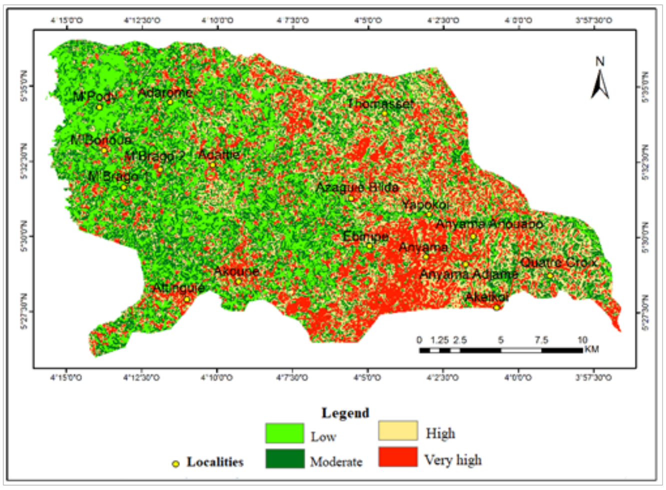

Figure 7 Map of water erosion risk from 2015.

Indeed, the result from RUSLE model reveals the alteration of eroded material and information on the level of risk of water erosion in the town of Anyama. Considering that from the class of moderate erosion risk is significant, the study area is heavily exposed to the risk of water erosion.

Validation of the erosion risk map: 18 out of 30 points match the reality on the ground concerning the sensitivity to erosion identified on the map. This means that the erosion risk map that was established is conform to more than 60% to the reality on the ground.

Results of forecasting of water erosion risk for 2045

Predicted map of rainfall erosivity for 2045: The erosivity map shows that the town of Anyama is subjected to rain aggressiveness. The R factor values ranging from 0 to 7333 Megajoul.mm/hectare.hour.year with an average of 4013.66 Megajoul.mm/hectare.hour.year (Figure 8). The predicted map of rainfall erosivity for 2045 shows variations of rainfall. The highest values vary between 7020 and 7333 Megajoul.mm/hectare.hour.year are recorded to the west and the EST of the study area. These values occupy 1801.26hectares which is equivalent to 4.25% of the town. 16.18% or 6854.31hectares of territory is subject to a correspondingly high climatic aggressiveness to an R factor class between 6835 and 7020MJ.mm/ha.h.y and are located in the West, the Southwest, to the east and north. More than half 65.62% of the study area with an area of 27803.16hectares is subject to erosivity 6667 to 6835 shows a moderate MJ.mm/ha.h.y erosivity. The lowest R values presented by the class 0 to 6666 MJ.mm/ha.h.y focus in the North and East.

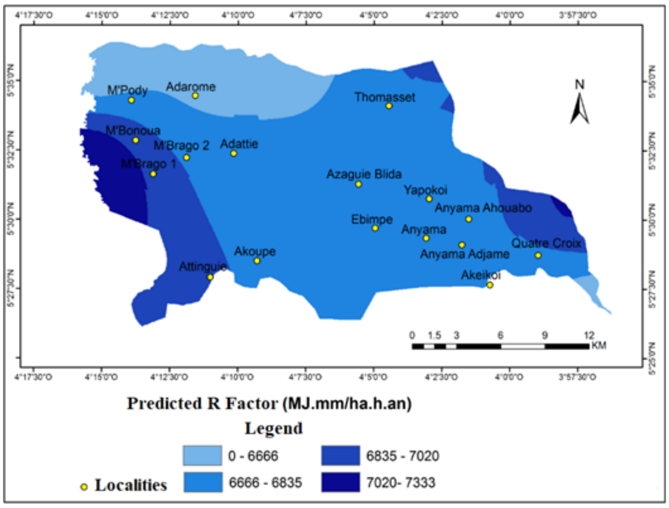

Figure 8 Predicted Map of rainfall erosivity or R factor.

Predicted C factor for 2045

Transition matrices from markov chain: The results in Table 3 show the probability of transition from one land cover class from 1987 to 2015.The transition matrix obtained in Table 3 shows that the class "forest" records the probability of the lower change, ie 0.4460, it thus represents the most unstable class. This class turns into big part in crop/fallow for about 53%, water about 1% and Built/bare soil around 2%. The class "Crops/fallow" has a probability of no change wich is 0.6444. Crops/fallow turn to 21% in forest, 1% water and 14% in habitat. In the matrix, the class "water" represents 0.5110 of not change. This class has changed to 34% forest and 15% in crop/fallow. The class "Built/bare soil" has a probability of no change of 0.5440. The class is transformed to 7% into forest, 38% into culture/fallow and 1% into water.

Table 3 Transition matrix obtained from Land use maps of from 1987 to 2015

	Forest	Culture/fallow	Water	Built/bare soil
Forest	0.4460	0.5294	0.0013	0.0233
Crop/fallow	0.2118	0.6444	0.0023	0.1415
Water	0.3372	0.1519	0.5110	0.0000
Built/bare soil	0.0739	0.3803	0.0019	0.5440

Validation of-spatial markov model: kappa values obtained shows that the forecast made in an existing date (2015) is good and gives four types of Kappa. Indeed, the Kappa standart is 0.64, Kappalocation and Kappa of the location of the localities boundary are 82%. Kappaquantity is 0.68. These values are between 0.61 and 0.80. According to the classification of kappa value made by Landis and Koch's (1977). The occuracy of the classification model is goog and reflects the reality of the study area.

Predicted land use for 2045: The land use map predicted by the Markov model for 2045 (Figure 9) shows that on that there will be changes in the various category of Land use. Forest occupies part of the Northwest and Central West of the study area. The mosaic crop/fallow will be located mainly in the north, northwest, east and south. Bare soil and localities will experience a great change in the increase in their area due to urbanization. These changes will be seen mostly in the localities of Anyama, of Attinguié, Akoupé, of Akeikoi. Water will remain located north of the study area.

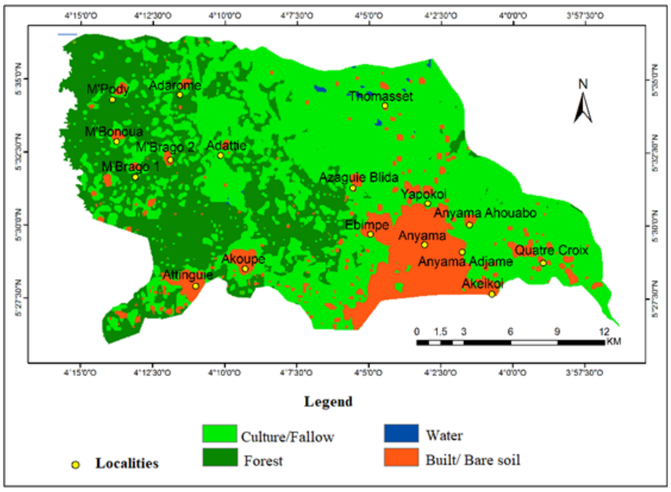

Figure 9 Predicted Land use map for 2045.

Predicted change changes in land use from 1987 to 2045: The analysis of Land use in the town of Anyama shows that in 2045 the forest decline and will cover only 29.46% against 58.38% in 2015. The increase crops and fallows an area of 25705.35 hectares and they represent 30.9% against 13059.21 hectares or 29.92% in 2015. Bare soil and water will also increase and will cover 12.89% and 0.2% respectively against 11.6% and 0.1% of the study area. Table 4 shows the rate of change predicted by the spatial Markov model from on Land use category to another rom 2015 to 2045 in the town of Anyaama.

Table 4 Predicted rate of change from 2015 to 2045

	Area (ha)		
Years category	2015	2045	Rate of change (%)
Forest	25480.23	12856.05	-28.92
Culture/Fallow	13059.21	25075.35	27.53
Water	44.81	88.29	0.1
Built/Bare soil	5061.2	5625.63	1.29
Total	43645.45	43645.45	

Predicted map of C factor: Predicted C factor value is between 1 for bare soil and 0 for water (Figure 10).

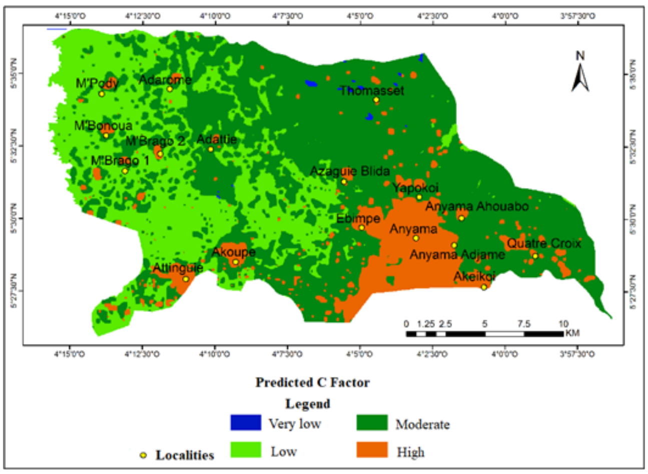

Figure 10 Map of predicted C factor for 2045.

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The results of C factor show that more than half the area 25075.35 hectares or 57.45% is considered to have a moderate tree cover and are occupied by crops/fallow. The highest coefficient (1) corresponding to the Built/bare soil occupies an area of 5625.63 hectares or 12.89%. The lowest coefficient (0) has a Greencover rate wich is 0.21% or a 92.07 hectare. The low value (0.13) relates to the area of forest. They occupy 12856.05 hectare or 29.46% of the town of Anyama.

Predicted map of water erosion for 2045: The combination of erosion factors, R simulated factor, K factor, the LS factor, the C simulated factor and P factor involved in water erosion of soil gave the map of soil loss of the town of Anyama (Figure 11) for 2045.

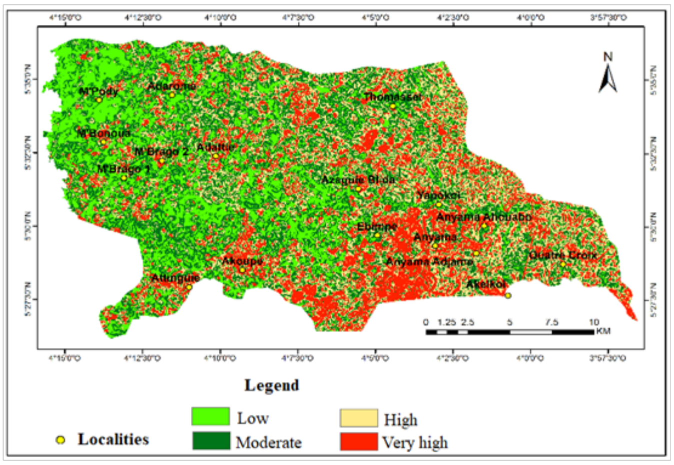

Figure 11 predicted map of water erosion risk for 2045.

Discussion

The erosive phenomenon is due to the aggressiveness of the rains, the rugged topography, and the type of soil, the lack of vegetation cover and the lack of anti-erosion practice. Ivory Coast a developing country does not have sufficient resources to fight effectively against this phenomenon. According to the studies conducted by Brunet-Moret.[9,10] and respectively in Burkina Faso and Ivory Coast, climatic aggressivity is very high in the humid tropics and decreases almost parallel to the isohyets between Abidjan (P=2100mm) and Ouagadougou (P=830 mm). Also for Roose[11] the tropical rains can be, 20 to 100 times more aggressive than those of the temperate regions, twice more erosive than in tropical environment and five times more aggressive than in Mediterranean environment. There are several methods for calculating the R-factor, but some of these use too much detailed data. Due to the lack of detailed data on the study area, we opted for an identical substitution equation as that applied by Payet et al.[7] in this work. This substitution equation has been applied in various studies.[12] Involving RUSLE modeling and showed satisfactory results.[7] This study shows that There are two types of soils (moderately leached ferralitic soil and hydromorphic soil) in the municipality of Anyama. The method used to the assessment of the K factor reveleted 2 values of K factors, 0.105 and 0.30. These values are corresponding with those of Roose[13] whose study area was West Africa even though they do not have detailed data for the calculation of the factor K. This author used more detailed data on the organic matter for each type of soil. The method used to determine the K-factor was based on that of Roose[13]. This methodology was also used in the work of Villemure[14] in West Africa. This author concluded that ferralitic soil is quite resistant to erosion (K=0.01 to 0.2), whereas organic hydromorphic soils have moderate erodibility (0.20-0.30). In a study of erosion in the Senegal basin, Rochette[15] shows that hydromorphic soils are highly sensitive to water erosion. This author explains that this sensitivity is probably related to the excess of water contained in this type of soil.

The results of our work show that the value of LS factor varies from 0 to 1202. Very low and low values are respectively 0-60 and 60.3655-120.731. As for the moderate and higth values, they are respectively 120.732-181.0965 and 181.0966-1202.3. Zones with high LS values are practically located in areas with high risk of water erosion. As a result, the LS factor contributes as a major criterion in quantifying soil water erosion. The results of the present study are different from those obtained by Yjjou[16] from the Oum Er-Rbia watershed, which shows that 62% of the area is in class 5 to 30. In Morocco, and more specifically at the watershed of the Boussouab wadi in the eastern Rif, Sadiki et al.[17] found that the LS factor varies from 0.48 to 87.9 and that the average losses in soil increases linearly with inclination of slopes. According to these authors, inclination of slopes has an importance in the process of sheet erosion at this basin. Indeed, 55% of the watershed area of Wadi Boussouab has slopes greater than 15%.

The LS factor was calculated from the equation of Wischmeier & Smith.[5] According to Payet et al.[7] this equation gives satisfactory results with respect to the topography of a study area. For them, the value of LS factor is calculated shows Aster/Srtm gives an overestimation of the values larger than those measured in the field. The C factor was determined from the land cover map. According to Payet et al.[7] the approach developed for the calculation of C factor provides an overall estimate of the sensitivity of land cover. Based on available data, it is a reliable means of accounting for factor C. Factor C results show that 40.38% of the area of the study area has a high plant cover rate, 50.71% is considered to have average vegetation cover, and 8.74% have no vegetation cover and are highly exposed to erosion. Similarly, a study of the Oum Er-Rbia watershed revealed that 64% of its area has a very low coverage rate and only 12% of the catchment area of this area is well protected Yjjou et al.[16] Thus, it is concluded that the potential erosion in this watershed is greatly accelerated. According to them, tillage influences the sensitivity of the soil to erosion. Generally, the crops require a refinement of the surface layer of the soil, which can lead to the formation of a crust that in case of heavy rain reduces infiltration and therefore accelerates the runoff. In this work, we used remote sensing to map land use of the study area. This method was also used by Payet et al.[7] to estimate their vegetation cover with satisfactory results. Several authors including[8,12,16] used Geographic Information Systems (GIS) to maps water erosion. These authors showed the relevance of RUSLE results in a GIS.

The methodology used to map the risk of water erosion in this work is that used by Wischmeier & Smith[5] adapted to the use of GIS and remote sensing. In their study, they developed the water erosion map by combining the five factors (erosivity, erodibility, topography, vegetation cover, and anti-erosion practices). Several studies performed using this methodology and have yielded satisfactory results.[12,18] The results in this work vary between 6899 to 879625. The higth and very higth sensivities zones represent respectively 24.11% and 22.62% of the surface of the study area. The weak and moderate areas sensivities occupy respectively 24.08% and 29.19%. These results are these results are substantially identical to those of Yjjou et al.[16] where the risk of water erosion in the Oum Er-Rbia watershed is greater than 2000 t/ha/year. Markhi et al.[8] score above 1221 t /ha/yr in the N'Fis watershed. For them, the basin is subject to a higth erosive sensitivity.[19–21]

Conclusion

The present study takes place in the town of Anyama located in the north of the District of Abidjan. Remote sensing is the tool that has enabled the assessment of water erosion. The quantification of soil losses in the study area was performed using the Revised Universal Soil Loss Equation (RUSLE) integrated into a Geographic Information System (GIS). The method provides significant assistance to decision makers to simulate scenarios for the evolution of the region and plan interventions against erosion. The results obtained show that the town of Anyama is impacted by water erosion soil. This serious situation is favored by erosion factors combined to accelerate erosion. These results also indicate that the study area was strongly eroded in 2015 and affected 46.73% of the area of the town. The small losses concern 24.08% of the study area and the areas with moderate sensitivity occupy 29.19% of the area of interest. The forecast map indicates that the level of erosion will increase by 2045 in the study area. The traditional Kappa is about 0.6 4 and Kappa location is 82% as well as Kappa of localization of limit of the localities and the Kappa quantity is 0.68 and show that the forecast is good.

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Conflict of interest

The author declares that there is no conflict of interest.

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