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RESEARCH ARTICLE

RAINFALL VARIABILITY, LAND PRESSURE AND RICE CULTIVATION IN THE COMMUNE OF RATOMA, CONAKRY, REPUBLIC OF GUINEA

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ABSTRACT

Rice cultivation practiced in the outskirts of Conakry near the sea arms is one of the most vulnerable to climate variations and land pressure. It is in order to contribute to better understanding the effect of urban pressure and climate variation on rice cultivation that this research was carried out. For this work, the survey method, the cartographic method and the collection of climate data were used. As a result, it appears that rice cultivation in the commune of Ratoma is under the influence of land pressure with a built-up area that increased from 999.66 ha in 1986 to 12,662.81 ha in 2020 as shown in the land use maps. The built-up area occupies 42% of the total area of the commune. In addition, the 30-year rainfall averages show a downward trend from 1981 to 2010. Over this period, 1988 recorded more rainfall, with a cumulative total of 4513.69 mm of water falling, while 1984 recorded the lowest rainfall, with a cumulative total of 2403.40 mm. Despite these situations, some rice-growing areas are still resistant to land pressure and climatic variations in the area. To survive, rice farmers use varieties with an average cycle of 4-5 months and which are resistant to salt. This study is of interest because it presents the difficulties associated with peri-urban rice growing and the local solutions developed.

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INTRODUCTION

Rice, a food consumed by more than 3.5 billion people (1), supports submerged cultivation. It is a plant particularly adapted to humid zones (2). As a result, it remains vulnerable to global warming. Several authors are interested in studying this vulnerability of rice cultivation to climate change, this is the case of (3), in Haiti, who worked on the irregularity of rainfall, as a constraint to agriculture, affecting nearly 40% of households, the same observation highlighted by (4), in the coastal regions of Bangladesh. In West Africa, (5) argue that agricultural crops mainly irrigated by rain are dependent on weather conditions. The same trend in Ivory Coast, where (6) show that rainfall variability weakens rainfed rice cultivation by causing the wilting and loss of certains plants. (7), for their part, worked on the perception of rice farmers in Benin. They show in their study that approximately 44.5% of rice farmers surveyed noticed a delay in the start of the rains, followed by flooding noted by 16.7% of producers. Then, 12% of rice farmers noted a poor distribution of rainfall. Nearly 80% of rice farmers noted a pocket of drought and an early start of rains over the last ten years. In addition to the influence of these climatic factors, rice farming is threatened in large cities by the uncontrolled expansion of buildings and infrastructure (8). In Guinea, studies by (9) show that climate change has an impact on the entire coastal zone of Guinea, due to the socio-economic activities taking place there. These effects are likely to cause increased pressure on low-lying coastal areas, which could threaten the viability of rice plains. The 2017 CommodAfrica report highlights that with climate change, rice yields will decline if suitable varieties are not used. https://www.commod africa.com. The capital Conakry, home to the commune of Ratoma with three-quarters of its territory bordered by water, is directly impacted by coastal erosion and its topography does not promote good control and management of climate risks manifested by flooding. A few years ago, Ratoma was made up of only a few districts with large arable areas, there are now 34 susceptible districts, given the galloping demography. Its population is estimated at 780,146 inhabitants and shares an area of 62 km2 (10). It should be noted that the uncontrolled growth of the city, reflected in irregular occupations on non-constructible areas, is one of the factors aggravating the vulnerability of rice growing in Conakry. The strong population growth is also manifested by rapid urbanization. (11). Faced with this situation, it is necessary to make the link between rice growing, climate variations and land pressure, in order to better prepare for the management of this activity. Thus, to approach this study, the question that arises is how is rice growing in the commune of Ratoma influenced by climate variations and urban pressure? To answer this question, we set ourselves the general objective of analyzing the vulnerability of rice growing to climate change and urban pressure in the commune of Ratoma. Specifically, it involves (i) analyzing climate variables, (ii) evaluating the spatio-temporal dynamics of agricultural areas in the commune of Ratoma from 1986 to 2020. This research has achieved the objectives set at the outset.

MATERIALS AND METHODS

The Commune of Ratoma is located in the special zone of Conakry. It is bordered: to the North by the prefecture of Dubréka; to the East by the Commune of Matoto; to the West by the Atlantic Ocean; to the South by the commune of Dixinn. As shown in Figure 1 below. The Ratoma site is characterized by a microclimate due to the influence of the sea from which monsoons and sea breezes blow. The average rainfall is 4.2m/year. Due to its geographical position, the Ratoma hydrological basin is well watered. We can mention the rivers of Kakimbo, Démoudoula, Yembeya, Soumanbossia, Wareya, Yattaya Centre, Sonfonia Gare 1 and Sonfonia, the lake of Sonfonia Centre 1, the small lake of Taouyah. These waterways and the vegetation cover above them are threatened with disappearance due to lack of maintenance and deforestation.

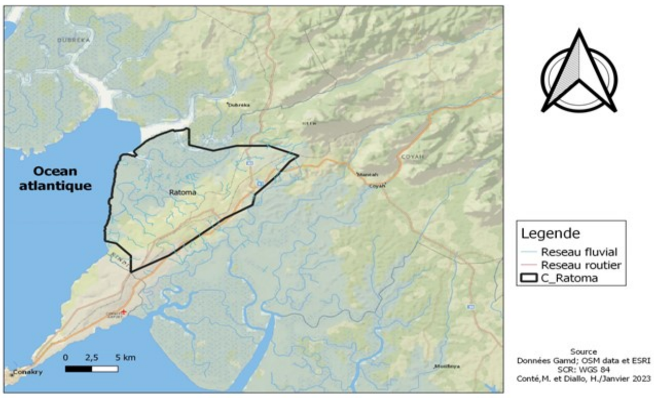

Figure 1. Study area

In this study, the quantitative approach was used. The surveys were conducted by questionnaire in four localities: Kobaya; Tayaki; Kamago and Sofonia-Kamani. The aim was to know the perceptions of the actors on the climatic factors that affect their activities. The people surveyed were rice farmers and executives of the technical services of the municipality and the ministries in charge of Agriculture and the Environment. Sixty (60) people, including forty-five (45) men and fifteen (15) women were surveyed. In addition to the surveys, climate data over a period of 30 years were collected at the National Meteorological Agency (ANM), processed and analyzed.

The cartographic data (Landsat images, over three periods 1986; 2000; 2020), were collected on the earthexplorer.usgs.gov website. The Landsat sensor data were processed on QGis 3.4 following the method used by (12), in his study on the analysis of the dynamics of Senegambian forest landscapes between 1972 and 2016 and by (13), in their study of the evolution of land use in Morocco.

The main results obtained according to the objectives of the study are as follows:

RESULTS AND DISCUSSION

Analysis of climatic variables

Interannual rainfall variability: The interannual evolution of rainfall for a period of 30 years (1981-2010), presented in Figure 2, is characterized by an inequality in rainfall heights during the growing season. This variability impacts the climate of the study area, because it has experienced a disturbance in recent years, with a reduction in the rainy season and an extension of the dry season. The rainfall heights indicate that the years 1982, 1983, 1990, 1997, 1999, 2006 are the least deficient, while the years 1984, 1987, 1993, 2008 are the most deficient. Compared to other years, the trend curve indicates an imbalance in rainfall from one year to another. This variability makes rice growing more vulnerable, especially with ancestral rice growing techniques and late varieties.

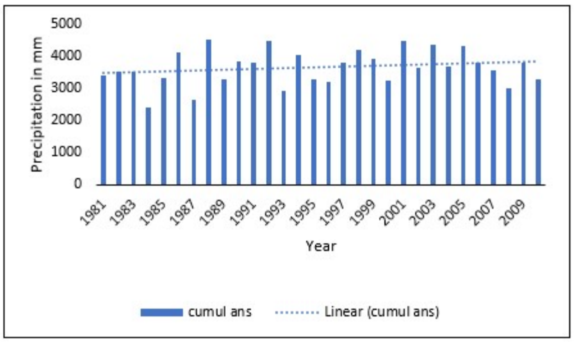

Figure 2. Interannual rainfall in the study area

Monthly rainfall variability 1981-2010: Figure 3 shows that during these thirty years (1981-2010), the seventh and eighth months remain the wettest. The values of the cumulative rainfall for the months of June do not reach half of the cumulative rainfall for the months of July and August as well as the cumulative rainfall for the months of September, this reveals that dry periods are becoming more and more numerous during the growing season.

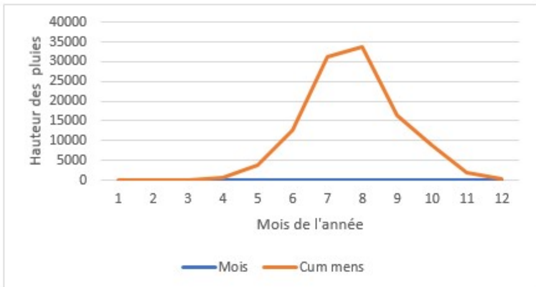

Figure 3. Monthly cumulative rainfall in millimeters and tenths 1981-2010

Evolution of temperatures: Figure 4 below reveals that during these 30 years the maximum temperature in May remained on the rise with a monthly average of 31.6°C and until June with an average of 30.1°C. This increase in temperature not only highlights the delay in rainfall but also contributes to the delay in the rice calendar.

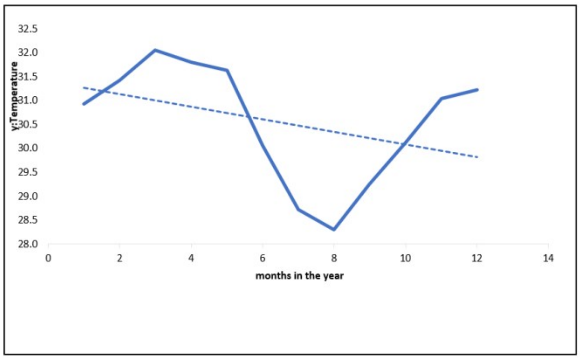

Figure 4. Inter-monthly evolution of maximum temperatures 1981-2010

Rainfall variability relative to temperature: Figure 5 shows that from 1981 to 2010, rainfall remained decreasing with an average of 3687.1 mm in May and 8727.0 mm in October, indicating that dry periods are becoming increasingly long.

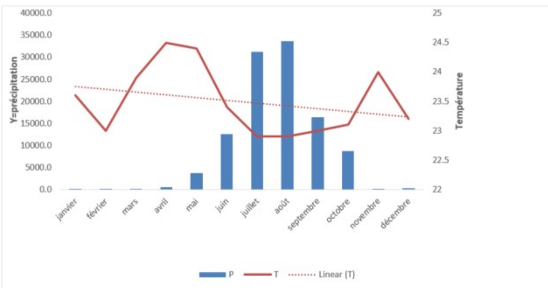

Figure 5. Monthly variation of cumulative rainfall in relation to temperature

In the figures, the interval between 1981 and 2010 is characterized by an inequality in rainfall heights. This variability impacts the climate of the study area, because in recent years it has experienced a disturbance that has resulted in a reduction in the rainy season and a lengthening of the dry season. This variability makes rice growing more vulnerable, especially with ancestral rice growing techniques and late varieties. Our results are similar to those of (14), who state that climate change could lead to a 30% reduction in yields and an acceleration of food insecurity and those of (15), on the shortening of the rainy season in central Côte d'Ivoire and (16) in Casamance, which in addition to the scarcity of rains accuse the rise in salt levels. The situations in the figures evolve in the same direction as the points of view of the actors in relation to these climatic variations, as highlighted in the following lines:
In relation to the effects of climate variability on rice cultivation, the surveys allowed us to characterize and evaluate a certain number of effects of climate change on rice crops in the commune of Ratoma, including:

The delay in the rice calendar: According to 88% of respondents, there is a shift in the sowing date, they are forced to wait for the first rains to start planting the nurseries in kissimoui strips which will last 21 days before transplanting the young plants. Rice farmers are sometimes vulnerable at this stage if this period coincides with heavy rainfall. More than half of the respondents say they have been victims, their crops are destroyed by fish and crabs.

The salt rise: According to the respondents, the salt rise is becoming more and more frequent, sometimes destroying their crops and making them more vulnerable. 53% of respondents testify that they have been victims of rising salt at least two to three times and this has completely destroyed their crops compared to 47% who say they have never been victims of rising salt. The multiplicity and negative reaction of rice varieties grown in the face of rising salt in our area further demonstrates the vulnerability not only of the activity but also of the practitioners.

Analysis of spatio-temporal dynamics from 1986 to 2020: To show that rice cultivation is exposed to various factors that risk leading to its disappearance from these localities, we analyzed the spatio-temporal dynamics to show the anarchic occupation which is one of the factors to which they are exposed. The anarchic occupation of the territory in the commune of Ratoma threatens the expansion of rice cultivation, as evidenced by the occupation maps. The mapping resulting from the processing of diachronic images made it possible to determine the periods of reduction of vegetation, water points and the massive occupation of cultivation areas by buildings. The three land use maps below illustrate land use from 1986 to 2000 and from 2000 to 2020.

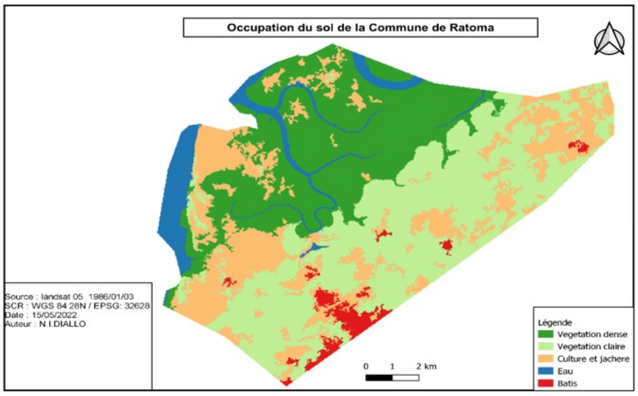

Figure 6. 1986 land use map of Ratoma

State of the land occupation of the municipality of Ratoma (1986): In 1986, the land use of the commune of Ratoma was as follows: Crops and fallow land 969.85 ha or 6% of the surface area; dense vegetation 8332.52 ha or 56%; buildings 999.66 or 7% ha; light vegetation 2899.58 ha or 19% and water 1746.28 or 12% of the total surface area. Figure 6 below shows this occupation. The validation of the land use map is done through a confusion matrix in Appendix A Table A1. The kappa index is 0.75, it shows the reliability of the classification results compared to the reference data. It is between 0 and 1. From 0.75 the result is considered beyond chance (17).

State of the land occupation of the municipality of Ratoma (2000): In 2000, the land use of the commune of Ratoma was as follows: Crops and fallow land 7296.96 ha or 4%; dense vegetation 308.31 ha or 1%; buildings 1077.91 ha or 24% hectares, we note an increase in the number of buildings compared to the previous year; light vegetation 304.01 ha or 10% and water 3238.82 ha or 11% of the total area, as shown in Figure 7 below. The validation of the land use map is done through a confusion matrix in Appendix A Table A2, with a kappa index of 0.80.

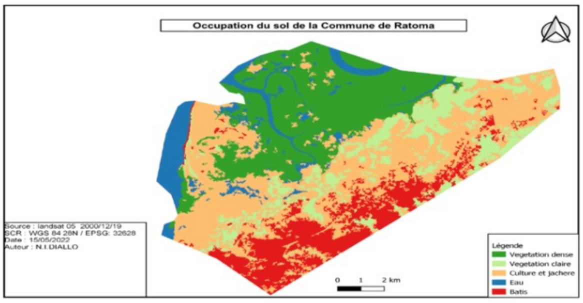

Figure 7. Land use map for the year 2000

State of the land occupation of the municipality of Ratoma (2020): Figure 8 below shows the land use of the commune of Ratoma in 2020. The areas occupied by the different classes are as follows: Crops and fallow land 399.01 ha or 1%; dense vegetation 109.001 ha or 1%; buildings 12,662.01 ha or 42%; light vegetation 328.001 hectares or 1% and water 1,471.002 or 5% of the total area. This analysis shows that the area occupied by buildings in 2020 is much more than in 1986. This strong advance of buildings in the commune of Ratoma clearly highlights the occupation of rice-growing areas which are sources of abandonment of the activity. The kappa index for this 2020 map is 0.83. The confusion matrix is attached as Appendix A, Table A3.

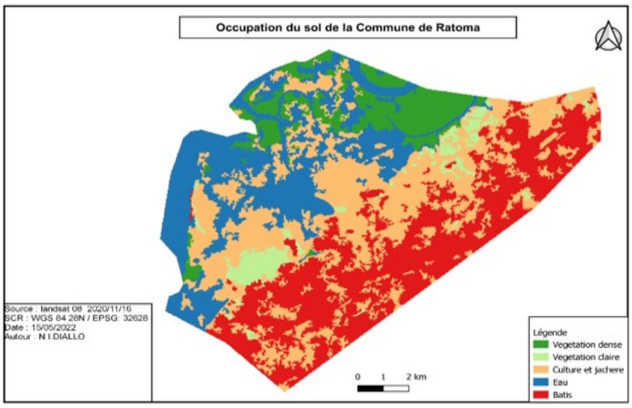

Figure 8. Land use map for the year 2020

The results of our research show a strong advance of the city, i.e. a percentage of 7% of buildings in 1986 and 24% in 2000 towards places of cultivation, reducing not only the cultivable areas and causing the abandonment of the activity. The cultivable spaces that were far from the inlets are now occupied by houses, rice farmers are forced to approach the sea. This occupation of rice fields also contributes to the disappearance of rice farming and increases the unemployment rate.

This result is identical to that of Cavailhès and Waves (2002), who indicate that the valorization of agricultural land is not comparable with that of alternative uses. This results in pressure for urbanization and artificialization, which lead to the decline of agricultural land near urban areas for which agricultural land constitutes a land reserve, and therefore real difficulties in making agriculture live on the outskirts of cities, due to the never-ending progression of buildings.

CONCLUSION

In short, it emerges from this study that the vulnerability of rice cultivation in the commune of Ratoma is related to the rise in temperature and the lack of rain, which affect the rice calendar; but also the inequality of rainfall heights which is manifested by the excess and deficit of water during the growing period causing flooding at times as well as the destruction of crops by crabs and fish on the one hand. Also, the dynamics of land occupation, reduces the cultivable areas, causes the saline rise. This advance of the city in the rice fields also contributes to the abandonment of rice farming activity and increases the unemployment rate in the city.

In perspective, the study recommends

- The improvement of adaptation capacities by the establishment of protective dikes which can resist effects such as the saline rise and flooding;
- The use of early varieties (100 days), to be able to carry out two production cycles in the year instead of a single production cycle or to adapt to the shrinking rainy season and the carrying out of research on climate-friendly rainfed rice cultivation capable of effectively combating food insecurity.

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