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ANALYSIS OF THE DYNAMICS OF LAND USE AND COVER IN THE DISTRICT OF INHARRIME (1980-2020)

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ABSTRACT

The analysis of the dynamic use and land cover in the District of Inharrime in the period 1980-2020 consisted of the interpretation of the images obtained to partir of the sensors on board in satellites of different times. In this work, landsat 5 images were classification for the years 1980, 2000 and 2020, followed by validation (confusion matrix) that shows the quality of the generated model. The methodology used was the bibliographic review, use of Remote Detection techniques and Geographic Information Systems that on the one hand allowed the acquisition and spatial analysis and on the other facilitated the classification of images from the study area, the handling of the existing database (BDCOV250) of the National Center for Mapping and Remote Sensing of the National Directorate of Land and Forests. As a final product, maps of land use and land cover were elaborated for the three years under analysis. Based on these results, it was possible to make the detection of changes that allow verifying the classes that changed over time and those that remained unchanged. The mapping of land use and coverage based on satellite images will allow planners to become aware of the current situation of the district, for actions that allow the creation of means for conservation, rational and conscious use of existing forest resources in the district.

Key Words: Dynamics, use and coverage, Inharrime.

1. INTRODUCTION

Land use and land cover are understood as being a socio-economic interpretation of activities that occur and are observed on the surface of the earth (FISHER, COMBER and WADSWORTH, 2005). The process by which land cover is modified or converted, according to Lambin et al, 1999, includes two or more components among which activities that are used (or restricted) on a portion of the earth's surface with some significant consequence for land cover; the objectives or intentions that motivate such activities, including the expected goods and services and the forces that cause certain uses to occur in a certain way, at a certain time and place. It is urgent to consider the important distinction between land use and land cover. While land use relates the human activities or economic functions that are found in the study area, the coverage refers to the features present there, so that both are highly correlated, but are not synonymous. Numerous categories or classes can be used to describe the different uses and the different land cover, but their use will always depend on the objectives of the work, which in turn define the appropriate scale and the greatest importance that will be given to land uses or roofs (LILLSAND, And CHIPMAN, 2004).

Land use usually produces changes in the physical environment, manifesting itself in the alteration of morphodynamics and morphofognesis, putting at risk the population living in a certain geographical area or its surroundings. Depending on the intensity of appropriation and

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occupation by human activities on systems that maintained their natural characteristics, changes that occur in space and time can be abruptly or slow.

The existing changes in the natural environment can be justified by various causes, from which are distinguished itinerant mechanized agriculture, pastoralism, forest exploitation, industrial development and the spread of cities and towns. According to (FAO, 1985), land use changes are complexly linked to economic development, population growth, technology and environmental changes, which could be changes in area or changes in the intensity of use, reflecting the history and perhaps the future of humanity.

In general, the changes that occur on earth derive from causes far more complex than their simple quantification, localization and categorization. This is because change classes do not necessarily keep a match with causes. They may not be mutually exclusive and classification systems may not be exhaustive. Moreover, not all changes in land use and land cover are detectable, hence its causes are not detectable either and even among detectable ones there are several levels of detection capability, which in turn depend on diverse, perhaps inaccessible time scales (COPPIN *et al.*, 2004 in KIEL, 2008).

The above mentioned changes occurred scattered in time and space over more than 10,000 years of agriculture, during which major changes occurred in Mesoamerica, Europe and parts of Asia and Africa; in some cases accumulating over time and in others declining as empires decline. In recent centuries and even more in recent decades these changes have become global, both in distribution and in their effects (Houghton, 1994).

Throughout the history of humanity the need to feed, dress, shelter and give work to the human being who remains in a population growth, has forced and will force to bring to the agricultural culture huge areas covered with forests, since it has not been possible, unless in restricted cases, to supply the increase in agricultural production that is imposed only at the expense of improving the technique (TEIXEIRA, 2018).

On the African continent, where growth and population density are closely related to the increased demand for agricultural land and diversified natural resources, significant changes in the use of tarra are expected, taking into account the UNITED NATIONS projection that points to twice the population in this continent over the next 40 years, exacerbating the problems and impacts on food production, drinking water and other natural resources with an estimated increase of 34 – 40 % of agricultural areas by 2050 (ALCAMO et al., 2011, CLERICI et al., 2013; LINARD et al., 2013).

For Brink & Eva (2009) land covert changes in Africa over the past 25 years have decreased by 21% of natural vegetation, with deforestation rates of five million hectares per year. These deforestation rates are mainly derived from the fact that some 60 million inhabitants live in the African forests south of the Sahara where wood is the main source of energy for 80% of the population (MAYAUX et al, 2013).

In the interest of this study, it should be noted that the UN projections for the 21st century indicate that by 2050 Mozambique will reach about 65.5 million inhabitants, which represents a huge challenge in the management of natural resources to maintain the well-being of these herds

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in the next quarter of a century, bearing in mind that family farming in Mozambique represents 98.7% of agricultural holdings in the country (FRANCISCO, 2016).

For sustainable management of the territory, the knowledge and monitoring of land occupation are paramount for understanding the patterns of space organization, since they allow trends of change to be analyzed. This monitoring consists in seeking knowledge of all its use by humans or, when not used by the human being, the characterization of types of categories of natural vegetation that covers the soil, as well as their respective locations.

The mapping of land use and land cover available in Mozambique was carried out in 1996, and the FAO AFRICOVER classification was used, the results of which were officially published in 1999, on a scale of 1:250 000 from the visual interpretation of satellite images, which met the needs of several local users because, this system allows a specific project or user to be accommodated (Stinger, 2005).

In the aforementioned mapping of land use and land cover of 1999, the methodology used for the "Inventory of Land Use of Mozambique" made by the Institute of Agronomic Research (INIA) in the 1980s, under the aegis of FAO, was followed. This mapping covered the entire country on the scale of 1:500,000 and was done through visual interpretation of Landsat 5 satellite images and small aerial photographs controlled in the field (CENACARTA, 1999).

Although the mapping of information on land occupation is fundamental because it helps territory managers in decision-making, it is, on the one hand, a resource widely used to make more evident the patterns of use and occupation of spaces and the visualization of facts in space and, on the other hand, to improve the understanding of existing interactions and to point out the necessary actions, studies and information of this nature, in Mozambique in general and at district level in particular, are still scarce. In fact, this study aims to contribute to the knowledge of the dynamics of land use and land cover in the District of Inharrime, Inhambane Province, Mozambique.
The general objective of this study is to analyze the dynamics of land use and land cover in the District of Inharrime, using the images of sensors on board landsat 5 series satellites, referring to the years 1980, 2000 and 2020, using the nomenclature of land use and coverage of the AFRICOVER Project, considering that currently, the detection of changes in land use and coverage using satellite images is considered one of the remote sensing functions that add a temporal dimension to the analysis of the information contained in the images, representing a fundamental basis for monitoring actions, the establishment of new environmental policies, including the biodiversity convention, which require detailed information on the dynamics of land use and land cover.

Specific objectives include (i) assessing the agricultural physical environment through data collection; ii) identify the differences in the mode of occupation of the areas and elaborate hypotheses that justify the disparities between the three years analyzed.

2.MATERIAL AND METHODS

2.1 Material

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The study of the change in land use and land cover in the District of Inharrime was done preferably with Landsat 5 images of July 23, 1980, July 7, 2000 and August 23, 2020, with spatial resolution of 30 meters since its acquisition is accessible and because there is an archive of images from previous years for the acquisitions. The images were purchased free of charge on the USGS website (http://www.usgs.gov). Data on land use and cover from 1999, administrative limits as well as images of the Spot 3 and 5 satellite acquired on August 3 and 27 respectively, with spatial resolution of 20 meters were provided by the National Center for Cartography and Teledetection – CENACARTA.

2.2 Methods

In order to achieve the proposed objectives, a methodology was adopted that consisted of the visual and supervised classification of satellite images, evaluation of the accuracy of supervised and visual classification and finally the production of thematic maps corresponding to the mapping of land use and land cover for the District of Inharrime.

The study of the change in land use and land cover in the Inharrime district was done with Landsat 5 images. For this purpose, three (3) images with a time period of 20 years (1980, 2000 and 2020) were used.

Since landsat has several information and its use depends on the purpose, for this work it was recommended the use of combination 4(R), 3(G) ,2(B) – falça color because for the study of vegetation, band 3 presents good contrast between different types of vegetation cover (e.g., field, cerrado and forest). It also allows the analysis of lithological variation in areas with little vegetation cover.

Band 4, where the vegetation is green, dense and uniform, reflects a lot of energy in this band, appearing very clear in the images, presenting sensitivity to the roughness of the forest canopy (Tucker, et.al., 2004).

2.3 Satellite Image Classification

In this case study, we used digital images of the Landsat-5 TM sensor, with spatial resolution thirty meters, obtained from the collection of scenes from the USGS (United States Geological Survey) available in an orthorectified way on the GLOVIS platform (www.glovis.usgs.gov).

For the mapping, after previous knowledge of the study area, it was necessary to define classes of land use and land cover of the study area, thus obtaining thirteen classes of land use and land cover referring to the years 1980 and 2000 and ten classes for the year 2020.

The algorithm used for the classification was the maximum likelihood in ArcGIS 10.3, which assumes the normal distribution of the bands for each 32 samples, characterized by the mean vector and covariance. With this assumption, the algorithm calculates the probability of a given pixel belonging to each of the classes defined in the training phase.

2.4 Geographical Location of Inharrime District

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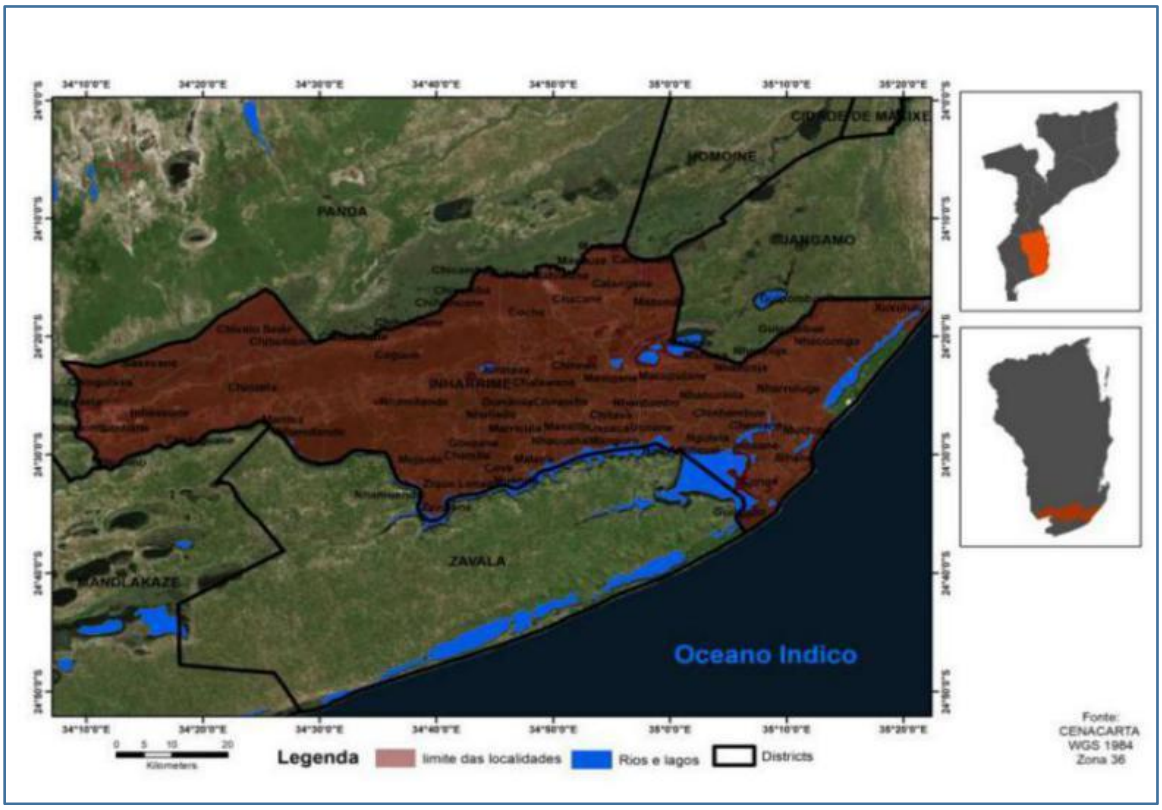

Figure 1 Geographic Location of Inharrime District

The District of Inharrime extends on the southeast coast of Inhambane Province, between the latitudes of coordinates [240] and 10' S, northern part and 2400 37'S, southern part and between longitudes 34008' E, western part and 350 22' E, eastern side.

With a surface area of 2,748 km², the District of Inharrime borders the districts of Jangamo to the north, to the south the Inharrime River secedes it from the District of Zavala, the east is bathed by the Indian Ocean, to the west it borders the districts of Panda and Homoíne and the Southwest borders the District of Manjacaze - Gaza Province.

This district is crossed in the North-South direction by the national road (EN1), which facilitates contacts with the different parts of the country. It is bordered by jangamo district to the north and south the Inharrime River secedes it from zavala district. The East is bathed by the Indian Ocean, with a coastline of approximately 50 km. The West borders the districts of Panda and Homoíne and the Southwest borders the District of Manjacaze - Gaza Province.

Taking into account araújo's classification 1997, except for the village-based, the District of Inharrime is rural, since it does not cumulatively gather indicators such as: piped water, electricity network and has less than 50% of the resident population working outside the agrarian sector.

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3 RESULTS

3.1 Mapping the land use and occupation of Inharrime (1980, 2000, 2020)

Thematic mapping of land occupation is an indispensable tool in environmental studies, in decision-making in spatial planning and planning, and in the definition of natural resource management policies.

With this cartography, one can measure the extent and distribution of land occupation classes, analyze the interaction with other classes, identify specific locations for certain activities and plan for the future. At the same time, these data serve as the basis for the production of more complex information on other topics, such as land erosion, waterproofing, among others (Caetano et.al., 2012).

Figures 2, 3 and 4 illustrate the use and occupation of land in Inharrime in the years 1980, 2000 and 2020, respectively.

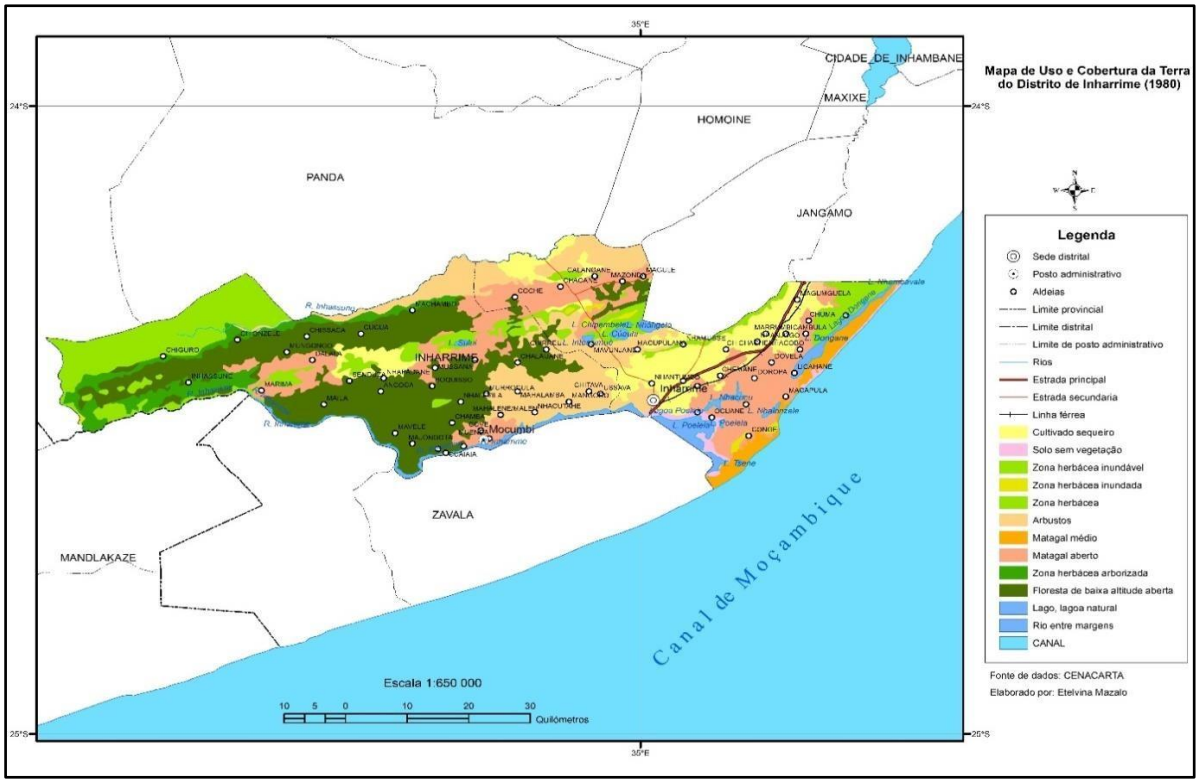

Fig.2 Map of land use and occupation of Inharrime district (1980)

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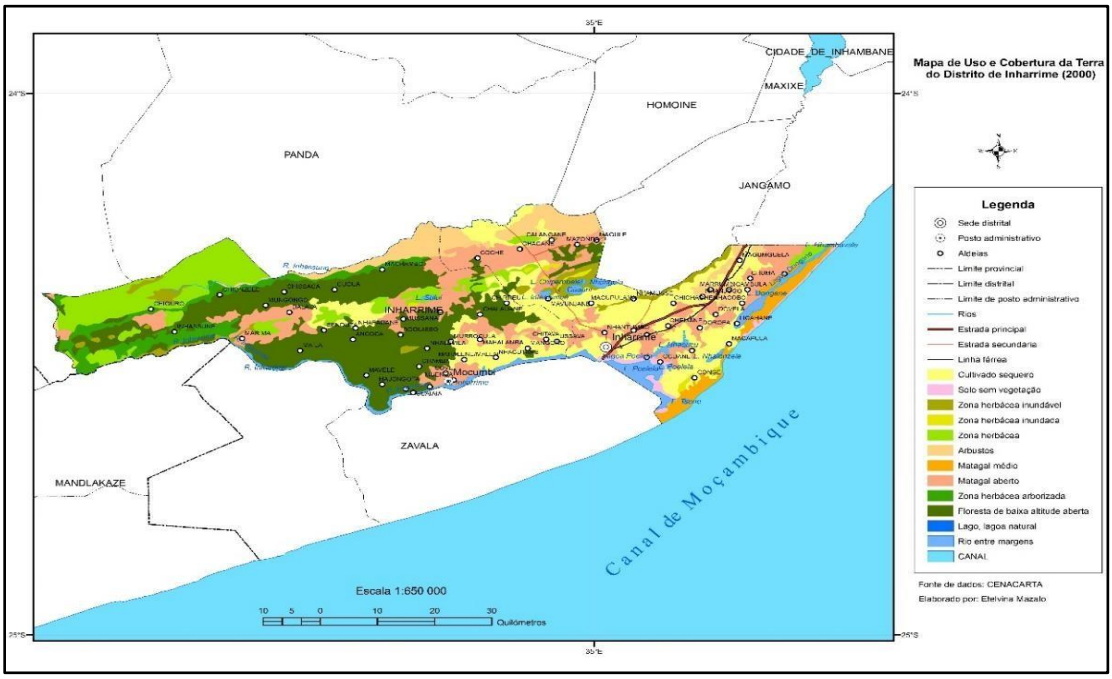

Fig.3 - Map of land use and occupation of inharrime district (2000)

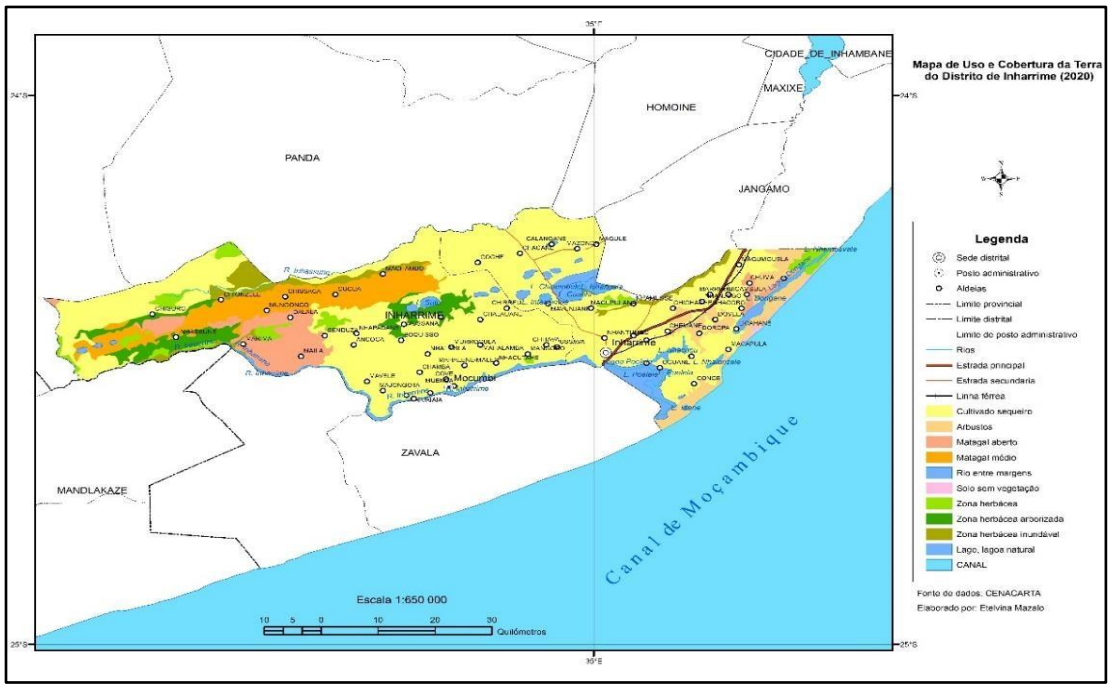

Fig.4 - Map of land use and occupation of Inharrime district (2020)

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3.2 The dynamics of land use and occupation in the District of Inharrime

The land use and land cover of the District of Inharrime extends over an area of 2,748 km² of which 281 ^{km2} correspond to the cultivation area and 1 km2 to population settlements. The cultivation areas extend along the wetlands of the Inharrime Administrative Post and in some areas of the Mocumbi Administrative Post where large watercourses (rivers and lagoons) are concentrated. These cultivated areas usually appear as an extension of population clusters.
Most regional vegetation types differ from each other in height and the density of their main forms of growth, but there are often atypical variants in these aspects, which, however, are typical in most other characteristics. This means that although height and density have considerable diagnostic value, their application must be flexible, and sometimes they need to be subordinated to other physiognomic characteristics.

Much of the district area, corresponding to 89.7%, is occupied by different land cover that are mainly exploited by the family sector. In digitising the data, the actual use of land was taken into account from the analysis of other types of cover, namely "natural" and "anthropogenic" vegetation cover. From the mapping under analysis it can be seen that in the District of Inharrime, the agriculture of the land, called a landmine that covers 76.35% of the area explored, predominates. In addition to this class, other classes such as open low-lying forest, soil without vegetation, flooded herbaceous zone, shrubs (0.5m <height <3m), medium scrub (3m <height <7m), bodies of water also occur in this study area.
From the mapping under analysis it can be seen that in the District of Inharrime, the agriculture of the land, called cultivated as a seapart, predominates. In addition to this class more represented in the district, other classes such as open low-lying forest, soil without vegetation, flooded herbaceous zone, shrubs (0.5m <height <3m), medium scrub (3m <height <7m), also occur in this study area.

While the classes defined for the images of 1980 and 2000 were: soil without vegetation, medium scrub, open scrub, soils without vegetation, dryland cultivated, open low-lying forest, herbaceous zone, flooded herbaceous zone, flooded herbaceous zone, wooded zone, shrubs, lake, natural lagoon, river between banks and canal; for 2020 the classes were: soils without vegetation, shrubs, medium scrub, open scrub, cultivated dryland, river between banks, flooded herbaceous zone, flooded herbaceous zone, lake, natural lagoon, canal. It is important to know the percentages of the classes studied in order to know the area won and the lost in the 40 years of study (1980 to 2020). Table (1) illustrates the area of coverage and percentage changed in the study area, in the period under analysis.

Table 1 - Area of the coverage classes and percentage of altered area (1980.2000, 2020).

Usage and Coverage Classes	1980		2000		2020	
	Area (There)	%	Area (There)	%	Area (There)	%
Shrubbery	11.255	5.25	5.225	2.44	1.355	0.64
Cultivated landandland	29.141	13.59	63.531	29,60	163.715	76.35

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Open low-altitude forest	69.767	32.53	48.812	22.75	0	0
Open scrub	31.787	14.82	35.522	16.55	8.225	3.84
Medium scrub	3.785	1.77	2.875	1.34	9.524	4.45
Soil without vegetation	3.039	1.42	5.923	2.76	6.238	2.91
Herbaceous zone	19.032	8.8	16.702	7.79	2.337	1.09
Wooded herbaceous zone	13.302	6.21	8.321	3.88	3.775	1.76
Flooded herbaceous zone	12.255	5.72	8.369	11,88	2.548	1.19
Flooded herbaceous zone	1.379	0.65	1.126	0.53	1.458	0.68
Bodies of water	19.752	9.21	18.235	8.5	15.265	7.12
Total	214.494	0	214.641	0	214.442	0

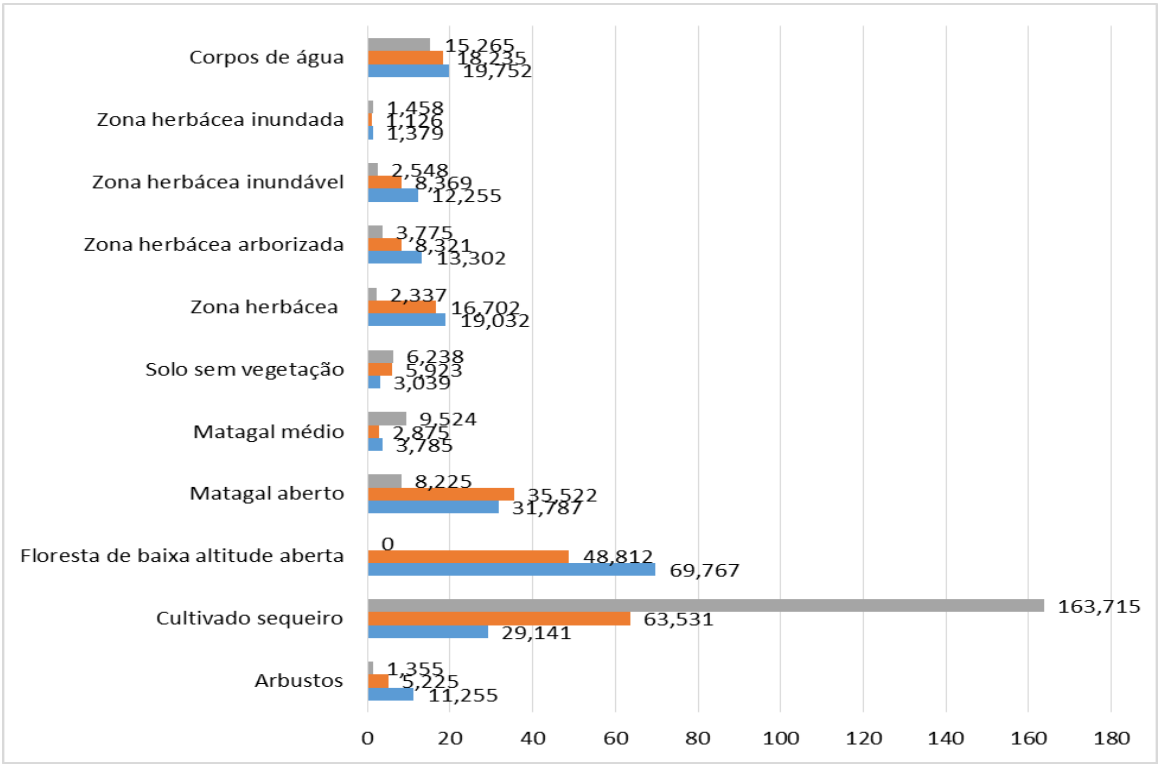

Fig.6 - Dynamics of roofing classes in The District of Inharrime (1980, 2000 and 2020)

Legend: 1980 2000 2020

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4. DISCUSSION

4.1 Use and Land Cover of Inharrime (1980)

In mozambique's history after national independence, the 1980s was marked by strong international pressure that culminated in the introduction of reforms by the government that was forced to release agriculture and reduce state ownership. It was during this period that, due to the war of destabilization and drought that plagued the country in 1982, Mozambicans experienced a severe food shortage.

In the same period, the military incursions of the Mozambican National Resistance began to destabilize the District of Inharrime, since it was the time when the guerrillas of that resistance movement managed to make more attacks in the provinces of Gaza and Inhambane, precipitating the beginning of a wave of forced migrations of local populations.

These migrations led to the abandonment of homes and agricultural activities by most of the population of this district in search of safe areas where with few resources began to settle, in order to escape the terror that the war imposed.

It is in the context of the reality pictured above that the land use and cover map of the Inharrime district in 1980 presents the areas occupied by the open low-lying forest and scrubland with larger areas due to the typical characteristics of its vegetation.

4.2 Inharrime Land Use and Cover (2000)

From the mapping concerned, there is a major change in the class of open low-altitude forest, which passed to other types of use throughout the period under analysis. With the end of the armed conflict that affected the stability of the population of the District of Inharrime, during the period from 1980 to 1994, the demand for areas for housing and the practice of other activities in rural areas increased.

The free movement of people and goods in the post-armed conflict period made many of the areas that were considered inaccessible to be easily accessible, allowing a connection with the urban areas of the different provinces of the country. These facilities, which implied the free mobility of the populations and the resumption of activities in an environment of peace, led to the emergence of other classes and change or decrease in some.

4.3 Inharrime Land Use and Coverage 2020

Poor land use planning and the dominance of unplanned settlements in Inharrime District pose challenges in managing changes in land use and land cover. In 2020, the changes are relatively more pronounced due to the emergence of some rural development programmes.

Sustenta is the national programme for the integration of family farming into productive value chains, whose objective is to improve the quality of life of rural households by promoting sustainable agriculture (social, economic and environmental). This program to encourage rural development contributed to a considerable change of the area once occupied in Inharrime, an extension of 163,715 hectares, corresponding to more than double the area cultivated in 2000 and more than five times the area occupied in 1980.

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5. CONCLUSION

The general objective of this study was to analyze the dynamics of land occupation in the District of Inharrime, using the images of sensors on board landsat 5 series satellites, referring to the years 1980, 2000 and 2020.

Regarding the two specific objectives that were considered, here are the conclusions of each of them: Regarding the first, in which it was intended to identify the changes in land use and land cover through data collection for the District of Inharrime, it was possible to show the change that occurred in the different classes of coverage throughout the 1980s, 2000 and 2020.

The second objective was to identify the differences in the mode of occupation of the areas and to elaborate hypotheses that justify the disparities between the three years analyzed, was achieved and the results subsequently validated statically. It was possible to verify, in the study area, that the numerical results allow a more accurate analysis of land use and occupation, which suggests that it is indispensable that in the management of issues related to land use and occupation the existence of an updated database is guaranteed.

REFERENCES

Alcamo, J., Schaldach, R., Koch, J., Kölking, C., Lapola, D., Priess, J. (2011). Evaluation of an integrated land use change model including a scenario analysis of land use change for continental Africa. Environmental Modelling & Software, 26 (8), 1017–1027.

Ayash, L. R., R. E. Cunha., F. L. Silva., & M. V. Bacani (2012). Use of Google Earth images for mapping the use and land cover of the indaiás stream hydrographic basin. Master's thesis. São José University- Brazil.

Caetano, M., 2012, Manual of the Remote Detection chair of the Graduate Studies and Master's degree in Science & Geographic Information Systems, ISEGI-UNL, Lisbon.

CENACARTA, (1999). Land Use and Cover. Available in: htpp://www.cenacarta.com> Access in 2015.

Clerici, N., Paracchini, M.L., Maes, J., (2014). Land-cover change dynamics and insights into ecosystem services in European stream riparian zones. Ecohydrology & Hydrobiology 14, 107 – 120. doi:10.1016/j.ecohyd.2014.01.002.

Coppin, P. et al. (2008). Digital Change Detection Methods in Ecosystem Monitoring: a review. International Journal of Remote Sensing. Taylor e Francis Ltd., n. 9, p. 1565-1596, 10 may.

Dobson, J. E. et al. NOOA Coastal Change Analysis Program: Guidance for Regional Implementation. NOAA Tecnical Report NMFS 123. National Marine Fisheries 61 Service Department of Comerce United States of America, abril de 1995. Disponível em: http://www.csc.noaa.gov/products/sccoasts/html/pdecript.htm> Access in 2015.

Fisher, P., A. Comber, e R. Wadsworth (2005). "Land use and land cover: contradiction or complement".

Foody, G. M. Status of land cover classification accuracy assessment. Remote Sensing of Environment. New York, NY: Elsevier, n.80, (2002). Available in: http://www.yale.edu/ceo/OEFS/ClassificationArticle_by_Foody_2002.pdf> Access in 2015.

Francisco, A. (2016) - Demographic Transition in Mozambique: Myth or Reality? (pp.20-62). In: Feijó, J. (coord.). Migratory Movements and rural-urban relations: Case studies in Mozambique. Reach Editors, 1st Edition, May 2016, Maputo.

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Kiel, R. (2008). Detection of changes in land use and cover in a time series of images from the rio grande do sul campaign region. Master's thesis, Federal University of Rio Grande do Sul, Brazil.62

Lillesand, M. T. & Kiefer, F. W (1994). Remote Sensing and Image Interpretation. John Wiley & Sons, Inc. 3ª edição.

Lillesand, T. M.; Kiefer, R.W.; Chipman, J.W (2004). Remote Sensing and Image Interpretation. NY: John Wiley & Sons Inc., 5ª edição.

Lu, D. et al. Change Detection Techniques. International Journal of Remote Sensing. Taylor e Francis Ltd., n. 25, p. 2365-2407, 20 jun. 2004. Disponível em: <http://www.tandf.co.uk/journals> Acesso em Set.2015.

MAE (Ministry of State Administration) (2014b). Inharrime District Profile. Inhambane Province. 68 pp. Maputo, Republic of Mozambique, MAE.

MICOA (Ministry for the Coordination of Environmental Action) (2007). National report on the marine and coastal environment. 63pp. Maputo, Ministry for the Coordination of Environmental Action.

Teixeira, Jerónimo Victor (2018) The participation of local communities in forest management in Mozambique: case of the districts of Montepuez, Maúa, Marrupa and Majune. PhD thesis. New University of Lisbon.

Tucker, C. J., Grant, D. M., Dykstra, J. D. 2004. NASA's Global Orthorectified Landsat Data Set. Photogrammetric Engineering & Remote Sensing, 70 (3), 313- 322.