Prospective analysis of land use dynamics in the town of N'dali (North-East Benin)

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INTRODUCTION

It's observed that the intense anthropization of land through agricultural activities has caused a retreat of natural vegetation cover in favor of fields and fallows.

The extensive occupation of housing has led to urban sprawl in the municipalities. Failing to address this situation would lead to an ecosystem imbalance in the medium to long term.
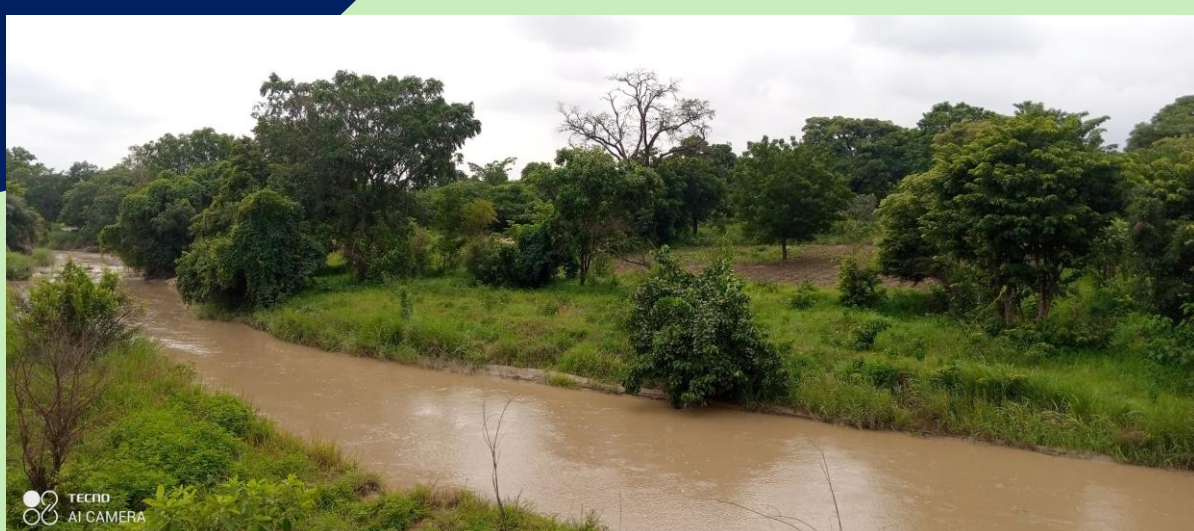
MATERIALS AND METHODS

Satellite images from 1980, 2000, and 2020 were used. A prediction for 2060 was made through modeling. The method was based on the Markov Chain with the transition probability matrix and the surface transition matrix; the change allocation algorithm is multi-objective.
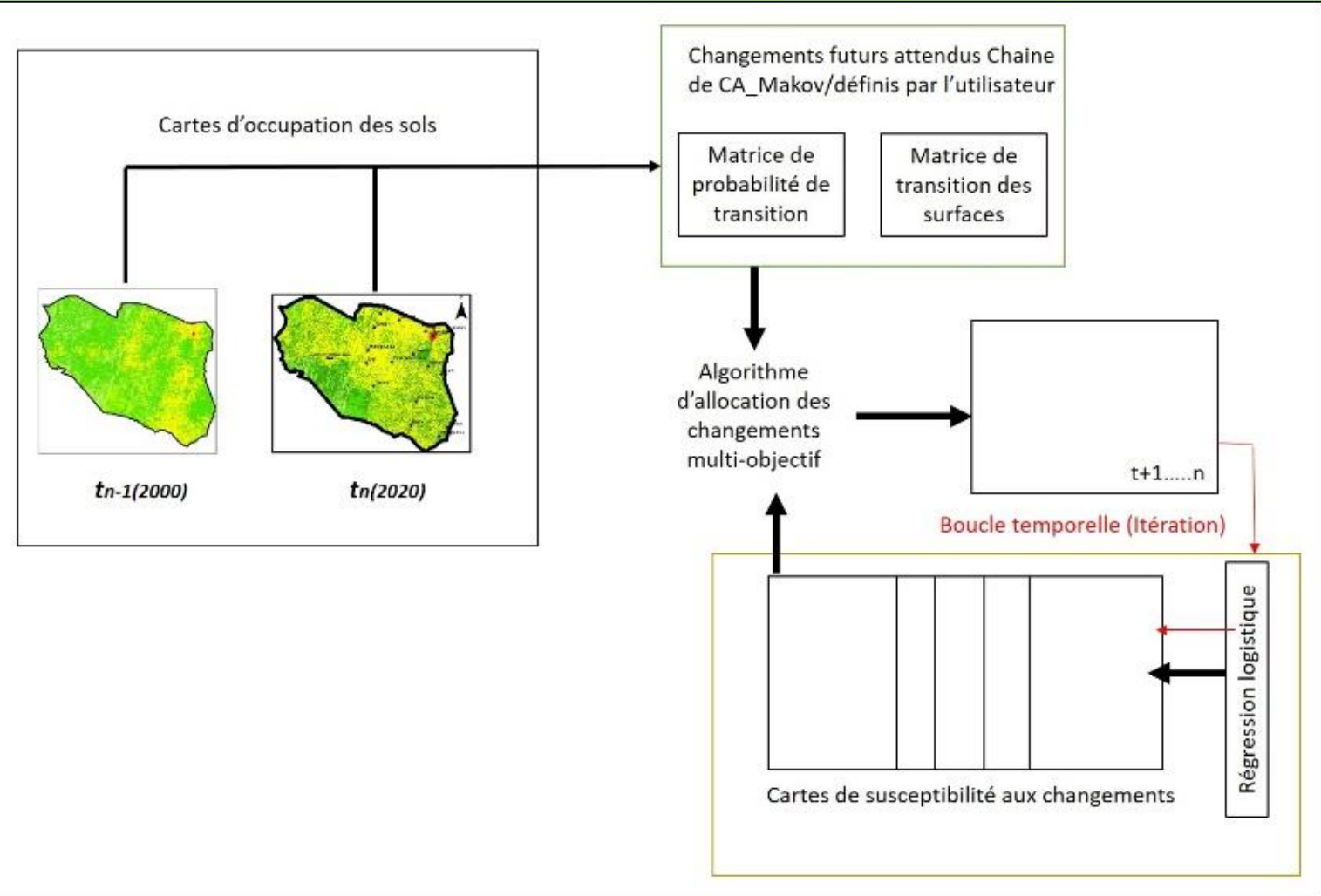
$$E_{(i,k)} = \frac{S_k - S_i}{S_i} \times 100$$

If E (i, k) = 0, stability
If E (i, k) < 0, regression
If E (i, k) > 0, extension

RESULTS

Results 1 : Transition matrix of land-use units between 1980, 20000 and 2020

Table 1: Transition matrix of land-use units between 1980 and 2000

Occupancy unit in 2000	Forest	Savannah	Gallery Forest	Water	Culture	Conurbations	Grand total	Gain
Forest	434.44	522.45	1037.69	11.76	14.39	0.18	2020.92	1586.48
Savannah	76.23	98.85	189.05	2.92	11.78	0.23	379.04	280.20
Gallery forest	150.82	100.12	201.80	15.21	1.20	0.07	469.21	267.41
Water level		0.00		0.16			0.16	0.00
Fields and fallow land	31.40	486.96	100.97	2.93	254.16	3.49	879.91	625.75
Conurbations	0.04	2.22	0.28	0.02	5.51	1.02	9.09	8.07
Grand total	692.92	1210.60	1529.79	32.98	287.04	4.99	3758.33	
Loss	258.48	1111.75	1327.99	32.83	32.88	3.97		

Source: Image processing, April 2023

76.23 Km² of forest was converted to savannah, 150.82 Km² to fallow and 31.40 Km2 0.04 Km² to housing. As for savannah, 522.45 Km² was converted to forest, 1000.12 Km² to gallery forest, 486.96 Km² to crops and 2.22 Km² to housing. It should be noted that between 1980 and 2000, gallery forests, crops and dwellings experienced more gains than losses, as opposed to forests and savannahs, which experienced more losses than gains.

Table 2 : Transition matrix of land-use units between 2000 and 2020

Occupancy unit in 2020	Forest	Savannah	Gallery forest	Water	Culture	Conurbations	Grand total	Gain
Forest	635.598	95.145	148.232		215.986	1.139	1096.102	460.504
Savannah	264.631	105.602	91.613	0.000	49.918	0.231	511.994	406.392
Gallery forest	137.886	26.835	80.792	0.000	45.411	0.355	291.278	210.486
Water level	0.001	0.001	0.124	0.154	0.000	0.000	0.280	0.126
Fields and fallow land	979.966	151.133	148.264	0.001	548.887	4.348	1832.599	1283.712
Conurbations	2.564	0.251	0.083		19.589	3.021	25.508	22.487
Grand total	2020.645	378.966	469.109	0.155	879.791	9.094	3757.754	
Loss	1385.047	273.365	388.317	0.001	330.904	6.073		

Source: Image processing, April 2023

Between 2000 and 2020, more forest was converted to savannah and cultivation (264.63 Km² and 979.966 Km² respectively), followed by residential conversion (2.56 Km²). Savannahs were converted to crops and housing at 151.133 Km² and 0.25 Km². A total of 209.62 Km² of savannah remained stable between 2000 and 2020. Crops, housing and savannah, unlike the other units, have seen more gains than losses.

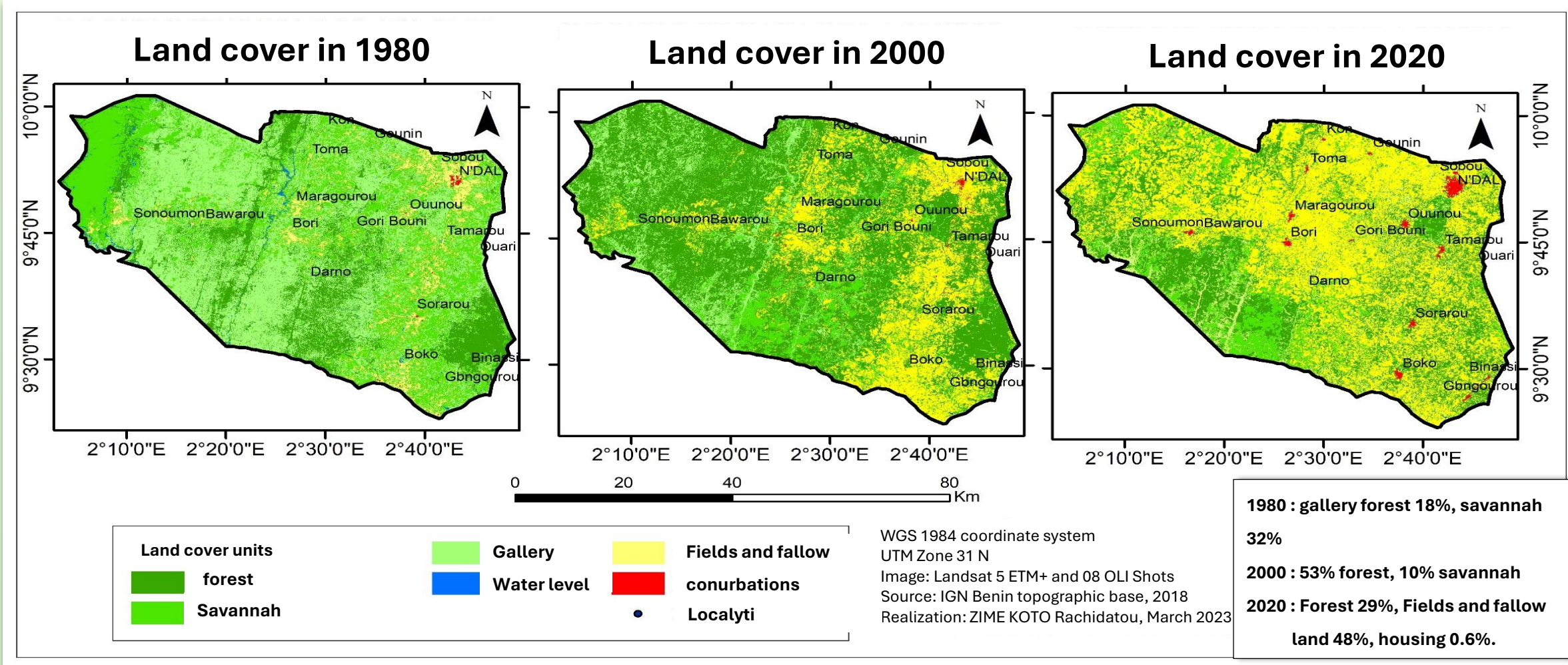### Results 2: Summary map of land use conversion in 1980, 2000 and 2020

Figure 1 : Land use maps for 1980, 2000 and 2020

The results show that the different land use maps have the following proportions.

➔ 1980: Gallery forest 18%, Savanna 32%;

➔ 2000: Forest 53%, Savannas 10%;

➔ 2020: Forest 29%, Fields and Fallow 48%, Housing 0.6%.

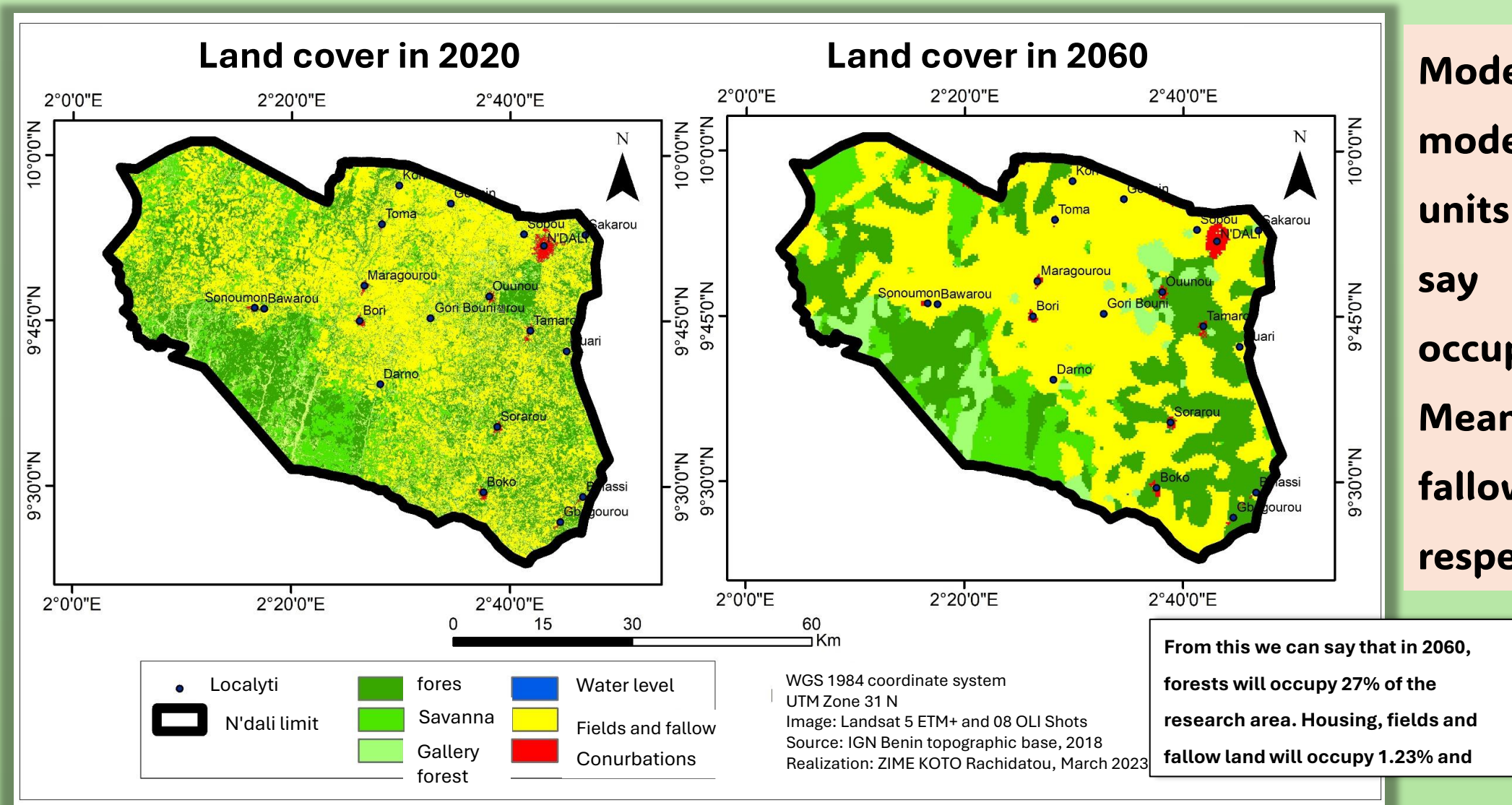### Results 3 : Summary map of land use conversion in 2020 and 2060

Modeling with the CA MARKOV model provided a map of land use units for 2060. From this, we can say that by 2060, forests will occupy 27% of the study area. Meanwhile, housing, fields, and fallows will occupy 1.23% and 52%, respectively.

Figure 2 : Land use maps in 2020 and 2060

Results 4: : Analysis of the table shows that the declining classes are savanna and gallery forest, while the increasing classes are Housing and Crops.
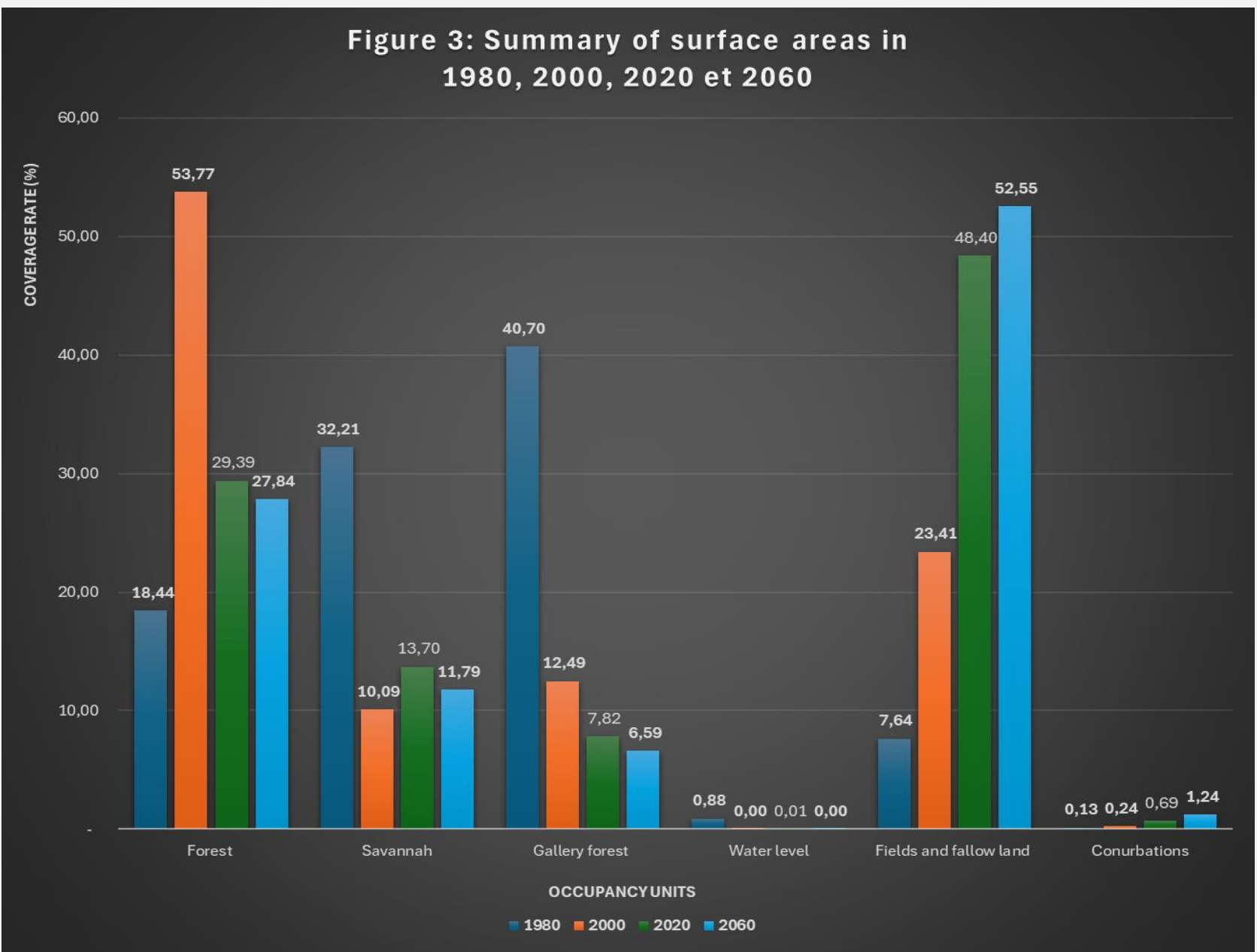

Figure 3: Summary of surface areas in 1980, 2000, 2020 et 2060

Table : Evolution rates of land use units between 1980-2000 and 2000-2020

Land cover units	Evolution rate (1980-2000)	Evolution rate (2000-2020)	Evolution rate (2020-2060)
Forest	191.652	-45.762	-5.283
Savannah	-68.690	35.076	-13.924
Gallery forest	-69.328	-37.922	-15.781
Water level	-99.530	80.412	-61.568
Fields and fallow lands	206.544	108.271	8.578
Conurbations	82.082	180.479	79.583

Progression :   Regression :

CONCLUSION

➔ Human pressure is causing rapid expansion of agricultural and residential areas at the expense of natural vegetation formations.

➔ Human activities are the main factors behind the observed spatial changes.