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Whose climate, whose changes? Various views from rural northern Cameroon

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The latest Intergovernmental Panel on Climate Change (IPCC) reports on climate change emphasize Africa's high vulnerability to weather variability and climate change, and climatologists are increasingly knowledgeable about the African climate and its variability (IPCC, 2014, 2018). After the drought periods in the Sahel during the 1970s-80s, rainfall gradually returned to the level of the 1950s (Dardel *et al.*, 2014). In the context of climate change, results of research show a clear trend towards higher temperatures, but precipitation projections are much more uncertain and exhibit high spatial and seasonal dependence (Niang *et al.*, 2014). In the Sudano-Sahel region of Cameroon, the climate is characterized by two seasons. Landscapes, life and human activities are determined by this cycle of dry and rainy seasons. The study of the variability of the climate in this area shows a complex situation. As in the Sahel area, we observe high inter-annual variability. The droughts of the 1970s-80s caused the southward advance of isohyets. Overall, they recently returned to the same annual rainfall after the droughts. However, trends are not very clear, and we observe sizeable local variations. Rainfall projections over the coming decades remain uncertain, but past observed trends have already had significant local impacts (Sultan *et al.*, 2013). In the context of development policies and assistance for mitigation and/or adaptation through agricultural development projects (COP 21), is the perception of climate change by local populations changing in Sub-Saharan Africa? This point remains under-investigated.

Site description

In this region of North Cameroon there are two main opposing political orientations. On the one hand, a biodiversity conservation policy has been pursued since the early 20th century to preserve Sudan's large wildlife ecosystem from logging, agriculture and grazing by livestock. It has led to the gradual creation of three national parks and some twenty hunting zones, which in 2018 covered more than 45% of the surface area of the Northern Region (Figure 1). This system of protected areas is a major spatial constraint and concentrates (theoretically) all human activities on the rest of the territory.

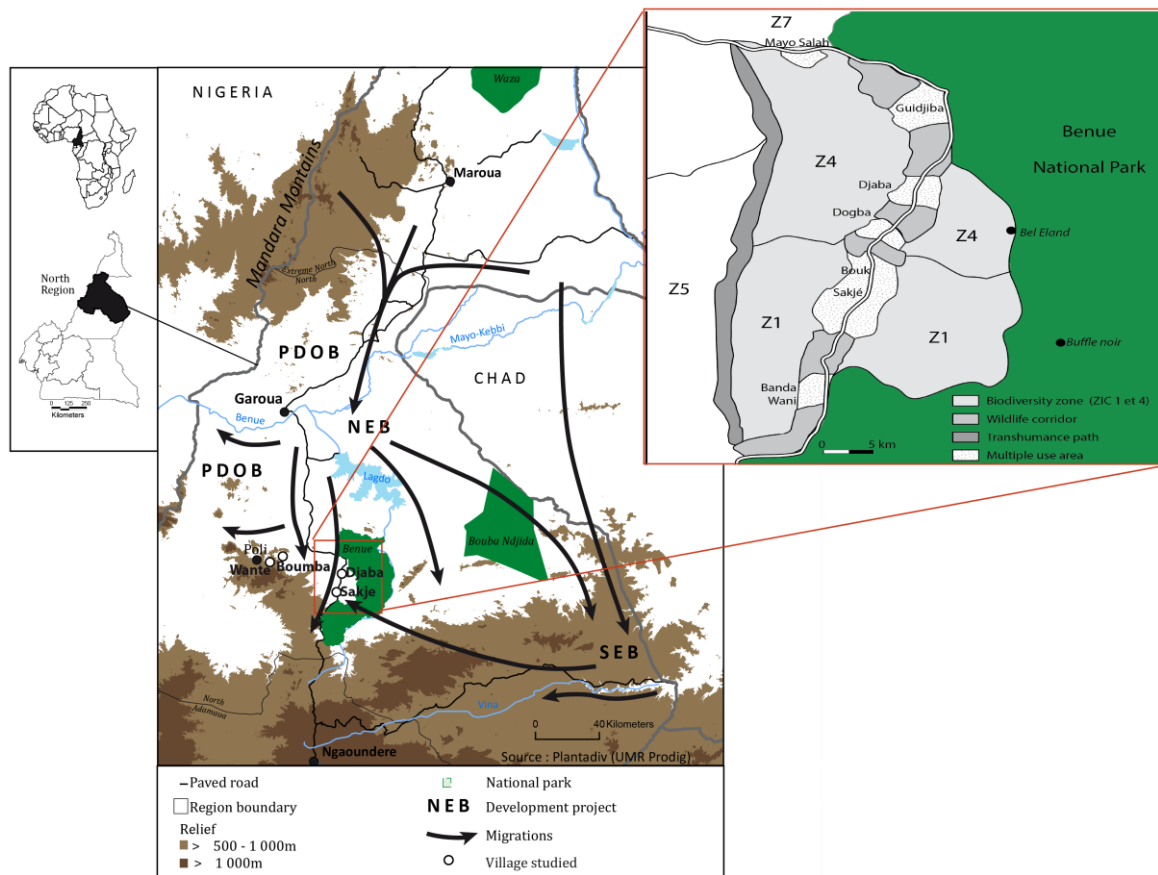


Figure 1. Benue National Park location, agricultural frontier and development plan

As of 2015, several types of stakeholders (note: each stakeholder category is given *in italics* below) with diverging strategies were interacting in the studied areas (Raimond and Aboubakar, 2018).

Indigenous sedentary farmers (Duupa in Boumba and Wanté; Dii in Djaba and Skaje) practiced, before the arrival of the agricultural front, slash-and-burn shifting agriculture incorporating a great diversity of plants that were intercropped in the same plots, and used heterogeneous forest resources for various purposes (Garine *et al.*, 2005). Bush resources were used as additional food (hunting and plant gathering), for cooking, basketry and construction.

The arrival of the pioneer or settler frontier (in Djaba and Sakje in 2005; in Boumba in 2010; in Wanté in 2017) abruptly increased population densities and deeply changed practices by shifting agriculture towards a system of short fallow periods, then without fallow, with a rotation of less diversified crop plots. This trend is especially strong on the edges of the Benue National Park because a development plan strongly restricts land use by delimiting "zones of human use" beyond which inhabitants are not allowed to travel or carry out any activities. *Forest rangers* are responsible for the application of spatial and resource use standards, under the responsibility of the *park conservationist* and in collaboration with volunteer *community rangers* responsible for monitoring the protected areas defined in the development plan.

Migrant farmers (including the Mafa, Tupuri and Guidar farmers interviewed in our survey) have settled in the studied areas within the last 15 years to practice intensive agriculture, often introducing commercial cotton into the rotations. They also raise livestock, with part of the herd remaining in the village, and the other part entrusted to *transhumant herders* to take them to more distant pastures, especially during the crop season.

Transhumant herders are mobile throughout the region and choose their routes according to the availability of pastoral resources (water, grass and tree foliage). Since 2010 and the rise of insecurity in the Sahel zone (Magrin and Perouse de Montclos, 2018), there has been an increasing number of them in the Sudanese zone, and they have invaded protected areas. Some herding families have settled on the outskirts of agricultural settlements and keep the farmers' herds. They were the ones interviewed in this survey, as time and financial resources did not allow us to reach remote groups in the bush.

Finally, the region has not escaped the gold fever that has plagued Sub-Saharan Africa since international prices began to rise in the late 2000s (Chevrillon-Guibert *et al.*, 2018). *Gold prospectors* first entered the territories to prospect for veins abandoned since the 1970s. They then entered protected areas and reached several thousand in Benue National Park by 2015. All sedentary or traveling residents become temporary or permanent gold prospectors. The activity, considered illegal by the administrative authorities and denounced by the park conservationist, nevertheless offers such a financial windfall that a flourishing commercial sector has been set up with a taxation system controlled by the local ("traditional") authorities.

Interviews with *village chiefs*, representatives of the *Peul chiefdom* (Lamidat) of Rey Bouba, which controls the territory and people, representatives of the *decentralized territorial community* (town hall) and *sectoral delegates* are not analyzed in this paper because we prefer to give voice to the stakeholders who depend most directly on natural resources for their livelihood. We assume that they are the ones most likely to perceive climate change, as well as changes resulting from biodiversity conservation discourses and devices.

Methodology

How do local populations perceive climate variations? And how do they describe them? Is climate change the most important trend that threatens their livelihood? These are the questions we asked the local population of the Benue valley. They fit into the PIAF¹ program, which aims to compare indigenous change indicators with scientific indicators. In order to verify the place of climate change in all locally perceived changes, and therefore in the adaptation strategies implemented, we asked stakeholders about all the changes they perceive in their immediate environment. The timescale covered is therefore the lifespan of the local interviewees and seldom dates to periods prior to 1950.

We surveyed 121 people living in four villages subject to similar climatic conditions. We choose to illustrate two contrasting dynamics that characterize this area:

¹ PIAF (Programme Interdisciplinaire sur les Indicateurs Autochtones de la Flore et de la faune) is a project funded by the ANR Young Researcher Program #ANR-13-JSH1-0005-01 from 2014 to 2018: <http://www.anr-piaf.org>. PIAF brings together a research team from 6 research institutes and 10 research laboratories and is coordinated by Anne Sourdril (CNRS, UMR7533 Ladyss).

- the low population density enabled the creation of protected areas for wildlife (elephants, giraffes, buffaloes and antelopes)
- recently, population density has increased due to an inflow of migrants seeking to establish farms in the region.

We chose two villages next to the National Park within the migration frontier (Djaba and Sakje, grouped below in the Rural-Protected Area or “protected” group) and two villages in non-protected countryside (Wante and Boumba, located within the migration frontier for agriculture, grouped below in the “rural” group). An opportunistic sample of informants differing in age, sex, activities (farmers, cattle breeders, gold miners, service activities), geographic origin (indigenous communities, migrants), duration of residency, ethno-linguistic group (Duupa, Dii, Fulbe, Mafa, Tupuri, Guidar) and level of education (primary/secondary schooling/academic) was built. In 2015 and 2016, 121 interviews were conducted (Table 1).

Location	Rural-Protected			Rural			Total
	Djaba	Sakdje	Total	Boumba	Wante	Total	
Sex							
F	16	0	16	3	7	10	26
M	58	8	66	16	13	29	95
Total	74	8	82	19	20	39	121

Table 1. Sample of interviewees

In this region, two media discourses on global change intersect: climate change, which has major repercussions on ecology and agriculture, and the protection of biodiversity to preserve the large wildlife population still present in some national parks. Do these discourses have impacts on local populations? After presenting the results of the survey on the perception of environmental changes by the populations of Upper Benue, then the changes analyzed by the researchers, we will show that the perception of changes varies according to the experience of local stakeholders, with little variation according to their economic and cultural profile, and that it is not (yet?) influenced by global discourses on climate change.

The semi-structured interviews were conducted by four fieldworkers in the vernacular language of northern Cameroon (Fulfulde). They are structured around five main questions: what are your activities? Do you depend on the bush for your activities? What changes have you noticed [in the bush/your village]? How do these changes affect you? What are your reactions to these changes?

The interviews were transcribed in French by the fieldworkers in collaboration with the researchers to standardize terminology and coding and build a database.

1. Asking stakeholders about changes

When we asked the question on what has changed in the village and the bush, informants generally cited several changes (six on average with a standard deviation of 2.5) and some would specify up to 13 different changes. As the interview is semi-structured, notes were taken directly in a notebook, which preserved the verbatim statements made by the very different informants. They were recoded into 47 summary expressions (verbatim encoded) that cover similar ideas (see Table 2). Four informants stated that they did not observe any changes; they are grouped together in the wording "there is no change", which may in some cases express a desire to cut the interview short.

When the same idea comes up very often in various expressions (e.g. "the bush has receded", "the bush is destroyed", "the bush has disappeared"), it is recoded in a more general formulation in order not to distort the ideas expressed (for this example, "the bush has changed" or "the rains have changed" for "it no longer rains as before", "the rains stop during the season", "the rains are more variable"; or "humidity changes" for "it is drier", "the drought advances"). On the other hand, very concrete expressions expressing an original idea have been retained, such as "we can't get agricultural land anymore", which expresses a land shortage, "now we plant corn" which evokes changes in agricultural practices, or "we burn savanna to cause the grass to grow again for cattle", which reflects a loss of biodiversity, pressure on the resource, a change in uses (sale) and a change in food.

Type of change	No. of occurrences / type
Recoded verbatim	No. of occurrences
Rains/hydrology	190
Rains have changed	91
The seasons have changed	47
Hydrological changes	32
Agricultural calendar has changed	11
Humidity changes	8
Wind has changed	1
Temperature	41
It's hotter	41
Land cover and diversity of flora	154
The bush has changed	83
There is less grass	25
Useful species are difficult to find	23
Loss of floral species diversity	12
Trees have disappeared	11
Demography/pressure on rural land	124
The population has grown	49
Farms have extended	31
Rising of breeding pressure	23
Gold prospectors are destroying trees and soils	10
Fires have changed	5
We can't get agricultural land anymore	2
There is no place for cattle anymore	2
Sacred places have been destroyed	1
We burn savanna to cause grass to grow again for cattle	1
Fauna	117
Wildlife has disappeared	73
Fewer fish in the rivers	11
Loss of faunal species diversity	10
Birds are less numerous	9
We don't eat bushmeat anymore	8
Monkeys have disappeared	3

There are fewer pests in the fields	2
Monkeys are more numerous	1
Agricultural soil fertility	97
Soil fertility loss	37
Farm production is lower	29
Farming technology has changed	21
Invasive plants proliferate in fields	10
Farm production is higher	1
Political/social/economic change	43
The village is larger	14
There is more infrastructure	7
Cost of living is higher	7
Deaths and illness are numerous	5
There are many ethnic groups	2
Now we plant corn	2
Children are vaccinated	1
People gather grass to sell <i>sekos</i> (woven mats)	1
Immigrants are invading	1
The bush is less safe	1
We no longer see any tourists	1
New products have appeared on the market	1
Nil	4
I don't see any changes	4
Total	771

Table 2. Ranking of 47 verbatim changes recoded into seven kinds of change, plus one “no change” category

1.1. Not only the climate is changing

Table 2 shows the diversity of perceived environmental changes, and only 15% of recoded verbatim changes are directly related to climate change (rainfall, humidity, surface water or temperature). However, since the informants are mainly farmers, changes in the abundance and distribution of rainfall is logically the most frequently mentioned ("less rains", "rains stop during the season", "there are no longer any heavy rains as before") and gathered here in the category "rains have changed". Perceptions of the length of the rainy season ("it starts later", "it is shorter" or "it ends earlier") refine an overall perception of a decreasing trend that is consistent with the diagnosis made by climatologists (see Section 2.2). The consequences of these changes on agricultural calendars are also highlighted by mentioning the difficulties they have in sowing at the right time ("now we sow later", "we must sow again every year"). Changes in the river regime and more rapid well depletion are also observed and grouped under "Hydrological changes". More general perceptions on the drying of soils and vegetation ("everything is drier"), as well as the decrease in dew, are gathered in "humidity changes". Winds are rarely mentioned without prompting, although informants often have a lot to say about winds when specifically asked about them.

The two types of changes, "land cover and diversity of flora" and "demography/pressure on rural land", are closely linked and widely cited by informants. They observe the decline of wild vegetation

(the "bush"), the increasing scarcity of trees and grasses, especially for useful species that have to be sought further and further away. The increase in the number of humans is observed in parallel, in increasing numbers in villages, clearing vast areas of fields and raising a larger livestock population to the point where anthropic pressure leads to new practices ("fires have changed", fires are more numerous, or "we burn savanna to get grass to regrow for cattle") and causes new situations viewed by some stakeholders as being quite harsh: "there is no place for cattle anymore", "we can't get agricultural land anymore" or "sacred places have been destroyed". We will return to these issues in Section 3.

Changes in wildlife are also widely discussed. "Wildlife has disappeared" includes all observations of wild mammals that are fewer in number, have moved further away from the village, or have disappeared. Some observers cite the extinction of particular species, such as elephants, rhinos, spotted hyenas, lion and panthers, which are the most highly valued endangered species in conservation systems, or certain bird species. The latter are also perceived as less numerous, as are fish in rivers. The references to monkeys have not been grouped with the others above, as they represent an interesting indicator of pest pressure in the field. Farmers perceive their disappearance directly in frontier areas, where habitat destruction and poaching reduce their population in the vicinity of fields. Conversely, in areas not affected by the agricultural frontier, their population may increase in a sparsely populated area where food crops are particularly coveted by primates, and the pressure of these pests is acutely felt by farmers. The perception of the trend in fauna in the Upper Benue region is strongly regressive, and all the stakeholders interviewed attribute this decline to the increase in the population and its pressure on the environment and natural resources, like bushmeat, which can no longer be consumed. Interestingly, there is no explicit reference to climatic causes that would influence wildlife.

This anthropogenic pressure is also felt in relation to the decline in agricultural soil fertility, with soils that are "tired" or "no longer produce as before", and lower yields than those obtained with slash-and-burn shifting agriculture or in the first years of migrants' settlement. Another indicator is the proliferation of weeds in the fields. The disappearance of fallow land in the densest areas no longer enables control of weeds, which therefore require the use of expensive herbicides. Some informants cited changes in agricultural techniques, with the use of inputs (fertilizers, pesticides) and plowing. Only one observed an increase in agricultural production, which is nevertheless self-evident given the increase in cultivated areas mentioned above.

Political, social and economic changes are less widely mentioned, but in the end, these cover a rather wide range. They include changes related to the expansion of villages and the arrival of new equipment (creation of a market or school or the arrival of electricity) and services (vaccination). With the increase in the population, inhabitants are observing the appearance of new products on the markets, but also an increase in the cost of living. Changes in local activities are also mentioned, in particular the disappearance of tourists who no longer come to an Upper Benue that is empty of wild animals and changes in agricultural practices with the replacement of millet and sorghum crops – previously the staples of indigenous populations – with corn that is faster to grow and commands higher prices on the market. "People collect grass to sell *sekos* (woven mats)" refers to increased pressure on the resource, but also to the appearance of a commercial use of gathered products transported to the city. Several isolated changes also highlight negative perceptions of the social changes observed: "There are many ethnic groups" or "immigrants are invading" reflect a feeling of being overwhelmed in the face of an uncontrolled situation and a power struggle that is reversed

between indigenous people and migrants who have become the majority in village territories. We could have classified here also the quotations "the Fulani invade the bush", or "the Fulani came to the village" (coded above in "rising pressure on pastures"), because they evoke the deep antagonism between the indigenous Duupa and nomadic herders. "The bush is less safe" refers to the growing insecurity in the region, where the arrival of new stakeholders (*zargina*, armed nomadic pastoralists from the Sahel zone, gold prospectors) makes it difficult to control the area, particularly in protected areas where these activities are illegal (Seignobos, 2011; Raimond and Aboubakar, 2018).

1.2. Specific perceptions of climate change

Figure 2 gives the distribution of the recoded responses. We note three changes that predominate in the interviewees’ perceptions: more than 60% of the informants mention change in the rains, change of the bush and the disappearance of wildlife.

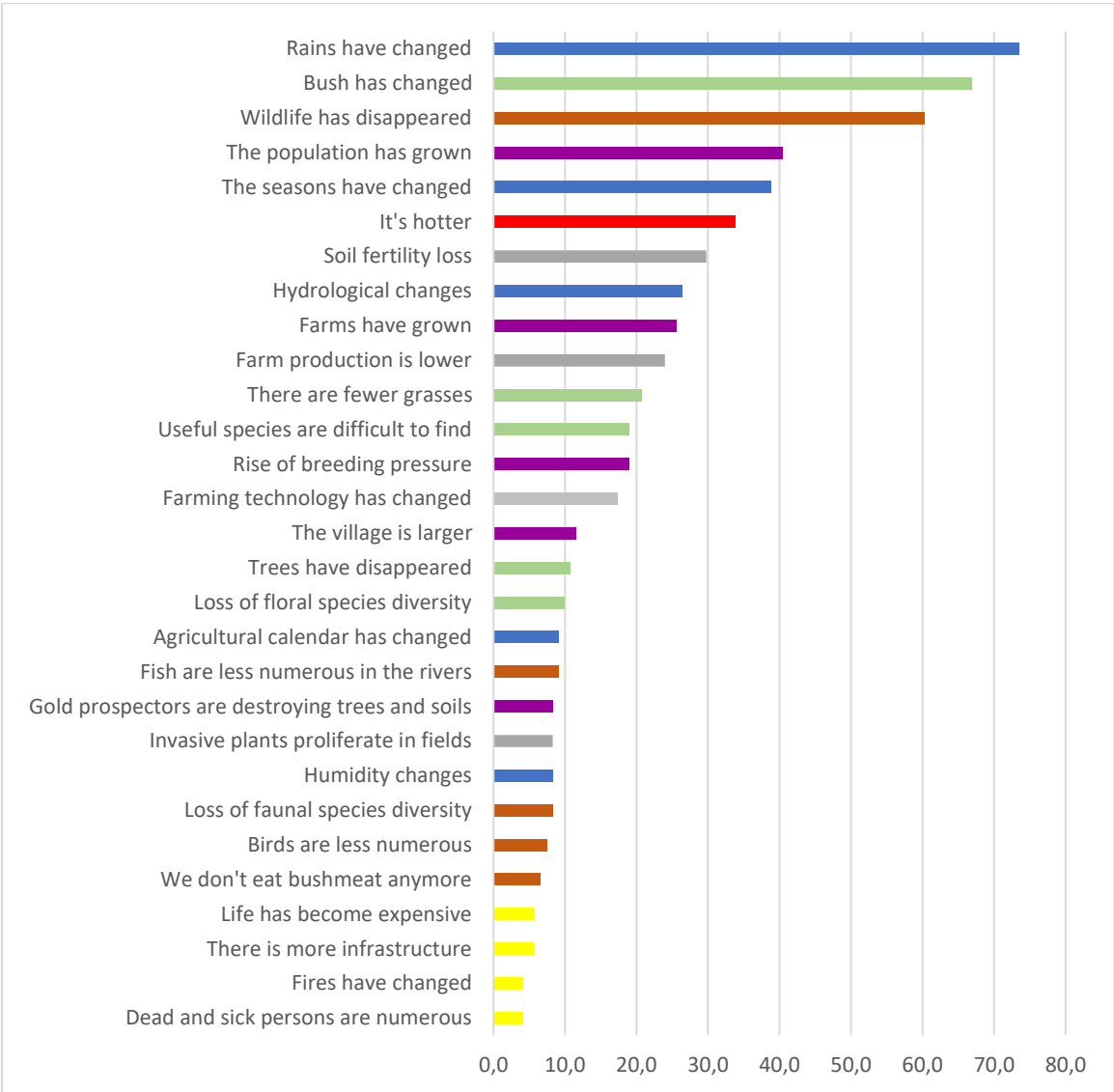


Figure 2: Changes perceived by residents of four Upper Benue villages (verbatim responses recoded into 47 categories, several responses possible, as a percentage of 121 interviewees; changes given by fewer than five people are not included)

Blue: rains/hydrology; green: land cover and diversity of flora; purple: demography/pressure on rural land; brown: fauna; red: temperature; grey: farmland fertility; yellow: political/social/economic changes

Rain-related changes are cited by the largest number of informants (nearly 75%), who often also cite other climate changes (length of the rainy season, increase in temperatures). The local populations have a detailed perception of climatic variations, which validates the results of climatologists:

- The unpredictability of rains is the best indicator they perceive: *"it doesn't rain like before."*
- The causes of the disturbances of the agricultural calendar are well identified: *"The beginning of the rainy season is delayed", "We sow almost one month later than 10 years before", "The dry periods during the rainy season are more frequent", "The seasons have changed."*

Other climate change indicators are also perceived by local people: 34% of informants mention high temperatures, and 26% hydrological changes. To clarify the importance of the perception of climate change in relation to all other types of change, it appears here that variations in water resources in the broad sense (rainfall, rivers and groundwater) clearly dominate the observations and concerns of informants in Upper Benue. If we group all the changes in the "Rains/hydrology" type, this one appears very clearly above all of the others.

When looking at the distribution of change types (Fig. 3), "rains/hydrology" groups the most citations by informants, who cite several of them in their list. "Land cover and diversity of flora" comes next, with informants referring mainly to "the bush has changed", but also to other changes in vegetation, such as the disappearance of grass, trees or useful species. "Demography/pressure on rural land" includes social changes that are cited by fewer people but which when combined in the same category is more cited than the observed changes on the "fauna". Indeed, many informants cite the disappearance of wild animals, but they specify few changes in other categories of animal biodiversity, while anthropogenic pressure is expressed by several indicators, in particular: "The population has grown", "Farms have extended" or "Rising of breeding pressure".

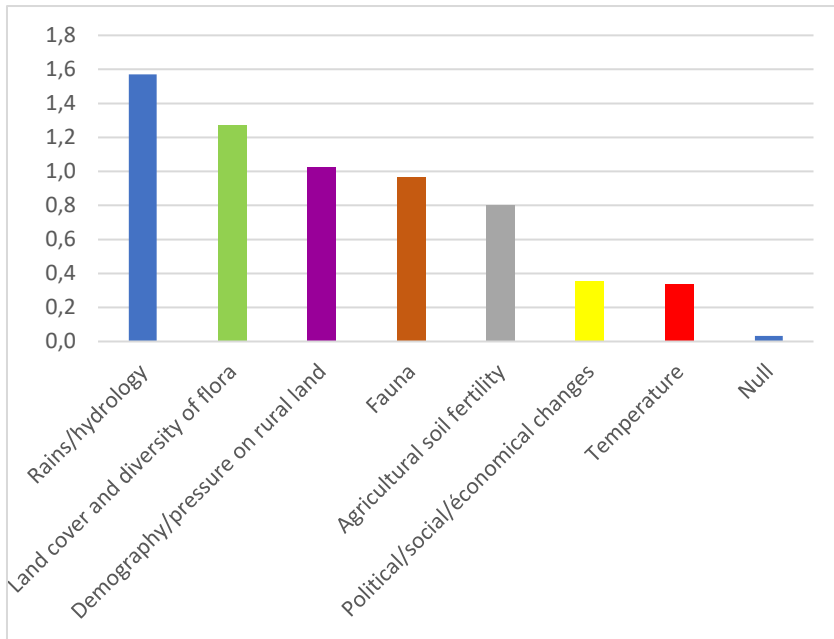


Figure 3. Types of changes perceived by the inhabitants of four villages in Upper Benue (grouping of the 47 recoded responses into 8 types of change, expressed as number of citations of changes by person, 121 respondents; see Table 2 for details of the groupings made)

1.3. Anthropogenic pressure dominates local residents' perception of changes

An analysis of the order of citation of the three most frequently-cited changes adds nuance to the predominance of climate change in informants' perceptions (see Figure 4).

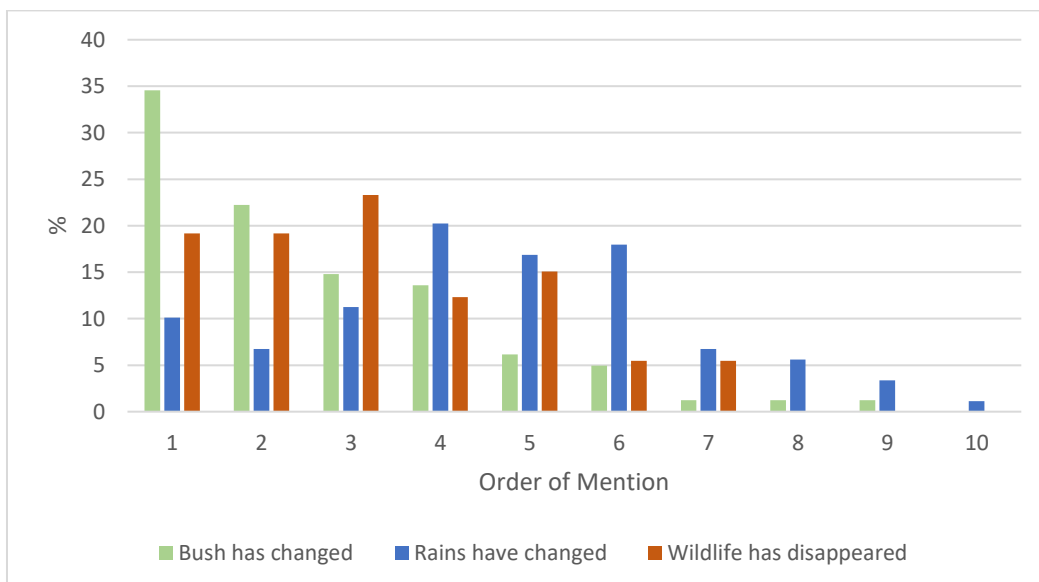


Figure 4: Citation order of the three most frequently-cited recoded verbatims (as a %, 81 respondents "The bush has changed", 89 respondents "Rains have changed", 73 respondents "Wildlife has disappeared")

Informants first cited the retreat of the bush, the disappearance of animals, and later on in the list, climate-related changes. "The bush has changed" is cited by 67% of informants (Fig. 2), slightly less than "Rains have changed", but it most often appears at the top of the list of those who cite it. Similarly, the disappearance of large wild mammals is cited by 60% of informants and also appears at the beginning of the citation list, between 1st and 3rd place. "Rains have changed" comes later, between 4th and 5th place. Thus, while the perception of rainfall changes is obvious, it appears on average less important to informants than landscape changes and the loss of wildlife diversity. The latter two are essentially causes of changing practices and population growth.

The drying out of streams is mentioned by pastoralists and farmers. Their mobility and search for water for cattle explain why they are more sensitive than others to this fact.

"The changes I have seen are numerous, if one must count them, one cannot. First, bush patches are destroyed by farmers and one does not know where to lead his cattle. Grass has diminished (...). People have created farms everywhere and they treat grasses with chemicals. And even where there are no farms, grass does not grow normally. The space has become very small for us (...). If we go back 10 years from now, you could not cross (the river) to come where we are. All the streams were full. Today, it is not raining normally and everything has become dry" (IB 43, nomadic herder, Boumba).

This citation is a good example of the local discourse about changes. This herder mentions the main changes in the bush, in relation with his activity and the needs of herds. He identifies the causes of these changes: the climate is cited last, after anthropogenic changes such as farm extension and use of chemicals.

It is interesting to compare this with the speech of an indigenous farmer, who identifies the same trend of dry rivers but does not attribute them to the same causes. For this person, the change in rainfall is partly responsible for the drying of rivers, but larger livestock herds also contribute to higher water withdrawal for their watering.

If we look at all the responses, we observe many converging answers about climate, but an even greater diversity of non-climate driven changes. With "the population has grown", we can summarize the main changes perceived by local people.

"I'm doing many different things [economically] nowadays hoping for a little gain. In farms, when there were too many weeds, we used to leave the place and slash another swidden. Today, space has become small, we just spray chemicals" (IB 20, native farmer, Boumba).

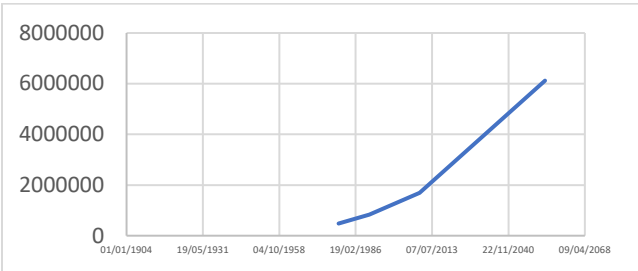
Climate varies, and people can observe its consequences locally, but the main cause of landscape, biodiversity and life changes is population growth.

2. Environmental changes in Upper Benue analyzed by geographers and ecologists

2.1. Land use changes and demographic growth

While the number of migrants has only been counted at the regional level for those who have been enrolled in development projects (between 90,000 and 130,000 people between 1975 and 1993), the continuous arrival of unenrolled migrants has driven a population increase of 4% per year between

1987 and 2005. Census figures and projections indicate that the population doubles every twenty years (Fig. 5).



	1976	1987	2005	2050
Population	480,000	830,000	1,690,000	6,120,000 to 7,950,000
Density (inhabitants/km ²)	7.5	12.3	25.5	90-120

Figure 5. Population growth in the northern region of Cameroon. Two projections are proposed for 2050 using (a) the average intercensal rate for Cameroon as a whole (2.9% per year) and (b) the average rate for the period 1987-2005 in the North (3.5%), which is more likely to take account for internal migration (Source: RGPH)

Land use changes are also measured by scientists. A satellite survey of the area shows the transformation of landscape in the village territory of Djaba and the edge of the park (Fig. 6). Farm extension is shown in white on the left of the image and red on the graph, and indicates in-migration in the area between those two dates. Pastoral pressure and various activities by people in the bush (collecting firewood, grasses for buildings) transform dry forest to wooded savanna (Aoudou *et al.*, forthcoming). All those landscape changes are caused by population growth, especially driven by internal migrations. In the village of Djaba, the population rose from 240 native individuals in 2000 to 6,000 in 2014, with farmland of 80 hectares in 1992, 530 hectares in 2004 and 2,200 hectares in 2012.

These landscape changes are visible in all the countryside along the agricultural frontier, and are spreading even faster because they are not covered by a development plan, unlike the area around the Benue National Park.

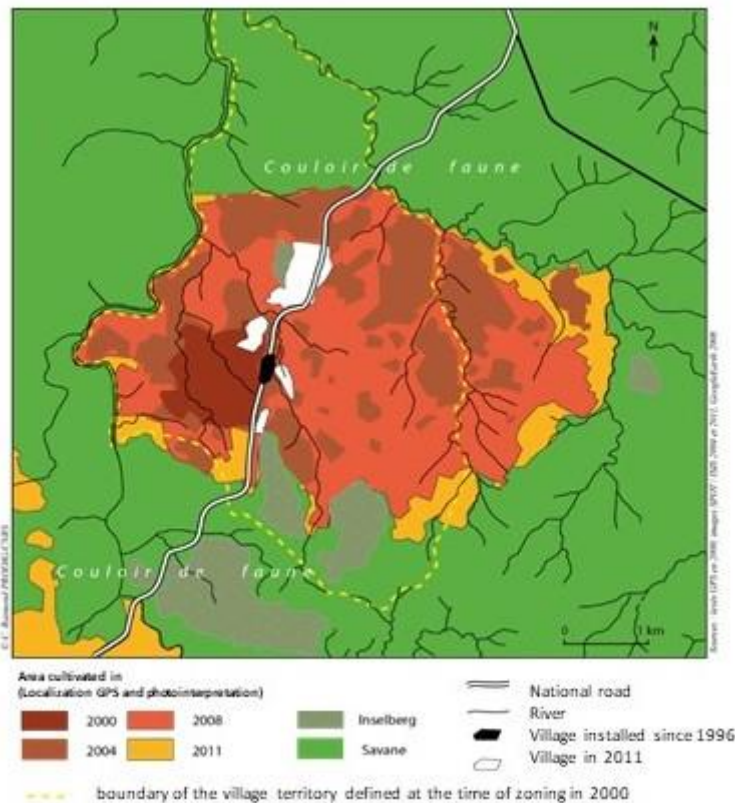


Figure 6. Land use changes in Djaba, 2000 and 2012 (Images: SPOT XS, 087-333/4 dated 3 December 2000 and SPOT DEM dated December 2012; ISIS/CNES contracts)

2.2. Climate changes

Climate research in the Sudanese zone shows a high variability in rainfall during the 20th century, marked by several major droughts (1973, 1984), a net deterioration in climate during the 1990s and 2000s and an increase in rainfall in some Sahel zones that has major consequences on the environment and agricultural practices (Niel *et al.*, 2005; Dardel *et al.*, 2014; Sultan *et al.*, 2013). To verify whether the perception expressed by stakeholders in Upper Benue corresponds to current developments, in particular on changes in rainfall seasonality and temperature increases, rainfall data from five observation stations (Garoua, Guider, Fignolé, Poli and Tcholliré) were analyzed over the period 1960 to 2013. The southern movement of isohyets observed during the major droughts of the 1970s to 1980s was reversed, and they have generally returned to their original position, although some stations lost an average of 200 mm of rainfall between 1960-1975 and 1990-2013. As often mentioned in interviews with stakeholders in Benue, rainfall trends (calculation of moving averages) confirm the increase in rainfall variability, which makes it very difficult to predict when rainfall will start and how long it will last (Aoudoua Doua; unpublished data). In particular, farmers have observed a significant decline over the past several decades, as confirmed by station surveys. The rainy season start date is determined using the Sivakumar method (1987). The criterion used is to collect 20 mm of rain in three consecutive days after May 1, with no dry period exceeding seven days within the following thirty days. At the Fignolé station (Fig. 7), there is a delay of almost a month between the beginning of the rainy season measured in the 1960s and that of the 2010s. The

rainy season now begins later than before the 1970s, which is a major change for agriculture: if they sow too early, farmers can lose their seeds. The farming schedule has changed, and they have to adapt landraces and species of crops.

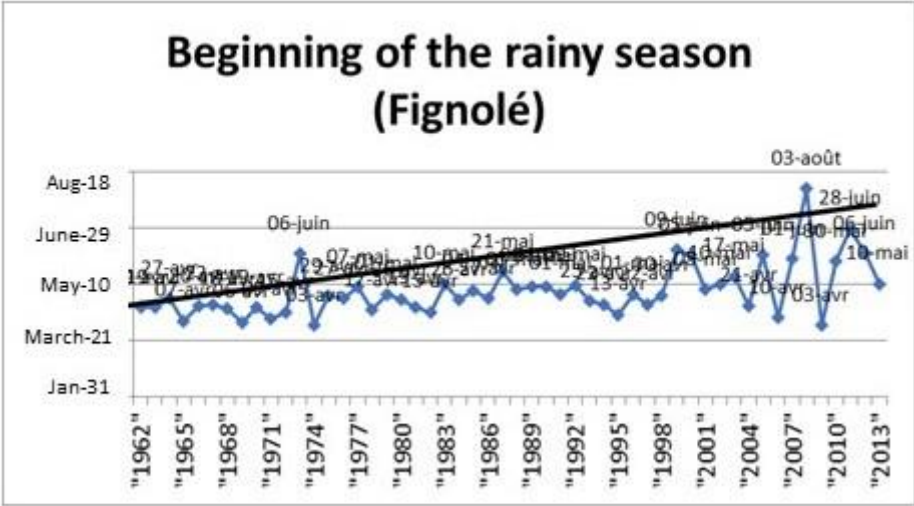


Figure 7. Shift in the start of the rainy season between 1962 and 2013 (Figlolé Station, source : Sodecoton, Cameroon)

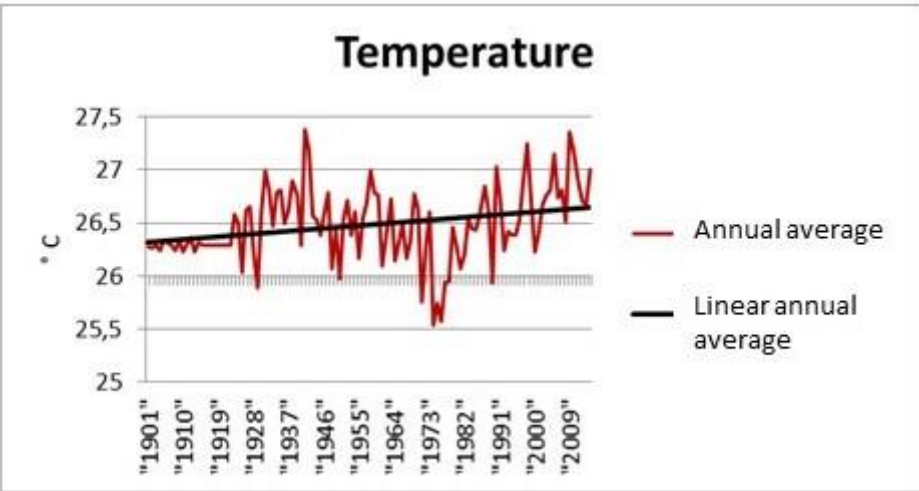


Figure 8. Rise in temperatures between 1900 and 2009 (source: cruts_3.23)

Moreover, as in the Sahel area, we observe a rise in temperatures. It is proved that it is now hotter than fifty years ago (Fig. 8). This 1°C increase, on average, over the past century confirms local populations’ perceptions and also has major ecological effects. Upper Benue residents often relate this higher temperature to deforestation, which is also said to reduce local rainfall. While scientists have not confirmed this direct effect, the link with global climate change is not proven, either, and is not referred to as an explanation for changes in the local climate.

3. Do perceptions of change vary according to the economic and cultural profiles of stakeholders?

Scientists and local people agree about features of climate change and the importance of demographic pressure on the environment. However, we tried to verify if the perception of changes is different according to one's economic and cultural profile. We tested various hypotheses. To do so, all the items cited by the informants were grouped into eight types (Table 2). For these data, the p-value significance test is good (less than 0.0001), except for the Null category, which is too small to be statistically reliable.

Variable	Observations	Min	Max	Average	Stand. Div.
Rains/hydrology	121	0	5	1,57	1,109
Land cover and diversity of flora	121	0	3	1,27	0,796
Demography/pressure on rural land	121	0	4	1,02	0,899
Fauna	121	0	3	0,97	0,806
Agricultural soil fertility	121	0	3	0,80	0,928
Political/social/économical changes	121	0	2	0,36	0,590
Temperature	121	0	1	0,34	0,475
Null	121	0	1	0,03	0,180

Table 3. Number of recoded responses per person and type of changes (descriptive statistics)

3.1. Age influences the perception of change

We test first an age hypothesis, assuming that personal experience and reference to more or less remote periods of the past can influence the perception that one has of changes. We were expecting three contrasted answers:

- Elders know and observe biodiversity changes better (flora and fauna)
- Elders notice the rise in temperatures more than young people
- Young people, because their activity depends directly on natural resources, suffer from the loss of such resources more intensely than elders

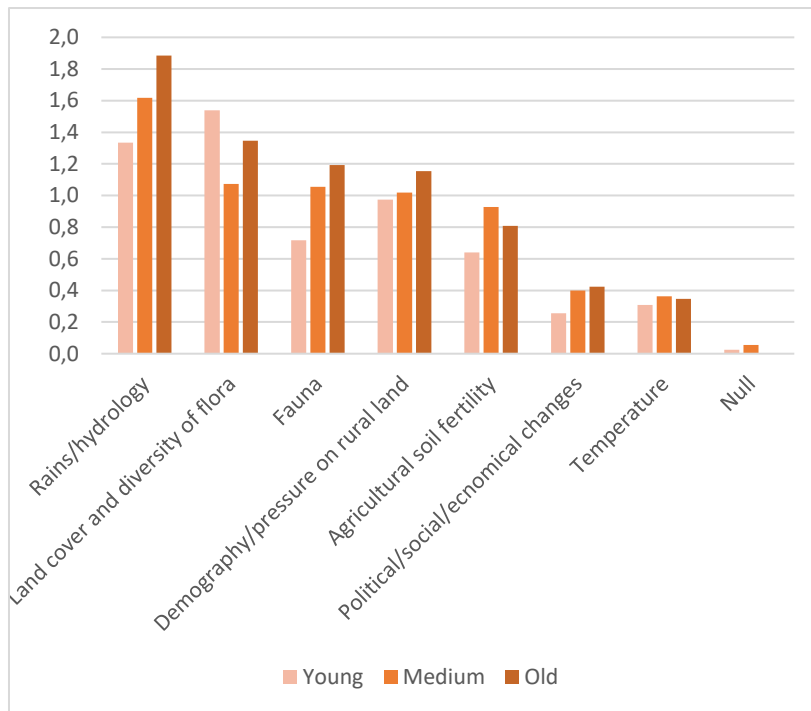


Figure 9. Perception of changes by age (39 young people aged 20-35, 55 aged 35-50, 26 over 50 years old; **expressed as number of citations of changes per person by age type**)

Overall, the results are relatively consistent across the seven categories of change (Fig. 9). Logically, because they have less experience than older people, young people under 35 perceive less change than others. This is particularly true for changes related to climate (rainfall, hydrology and temperature), wildlife loss and agricultural soil fertility. On the other hand, young people report more changes in vegetation than their elders because they are particularly dependent on this resource. Thus, of the 47 responses "Useful species are difficult to find", 22 are provided by young people: natural resources collected in the bush (grass, wood, fish are the most cited) are indeed an important source of income, especially for young unmarried people who do not yet have plots to farm. The disappearance of these resources in the vicinity of villages and the increasingly remote location of supply sites are therefore particularly perceived by this category of actors.

The changes linked to the fertility of agricultural soils most often cited by the 35-50 age group can also be explained by their activity. Among the population interviewed, whose activity is mainly agriculture, this age group corresponds to people who have the largest families and therefore the most labor to farm large fields. They therefore tend to cite more the decline in soil fertility and agricultural production, the invasion of plots by weeds. This is particularly true, as we will see below, in villages on the periphery of the national park where cropping systems have evolved from slash-and-burn agriculture to a fallow-free system confined to the human areas delineated by the development plan.

The changes observed in rainfall and wildlife are all the more noticeable when the person is older, which validates our initial hypothesis.

Despite these variations, the result shows an agreement between generations. We obtain the same result between sexes, despite an imbalance in the sampling between women and men (26 and 94 respondents, respectively; Table 1). However, women are less likely to cite changes related to wildlife than men (54% of responses versus 77%), and less likely to cite changes related to social, economic and political changes (15% versus 44%). Some of these results can be explained by the gendered distribution of work, in particular the fact that most of the hunting work is done by men.

3.2. Length of residency in the locality affects perceptions in complex ways

The second hypothesis tested here is that more time spent in one place gives a more acute perception of gradual changes (wildlife, demographic growth, soil fertility and climate). The results are contrasted between people living in the region for a short or a long time.

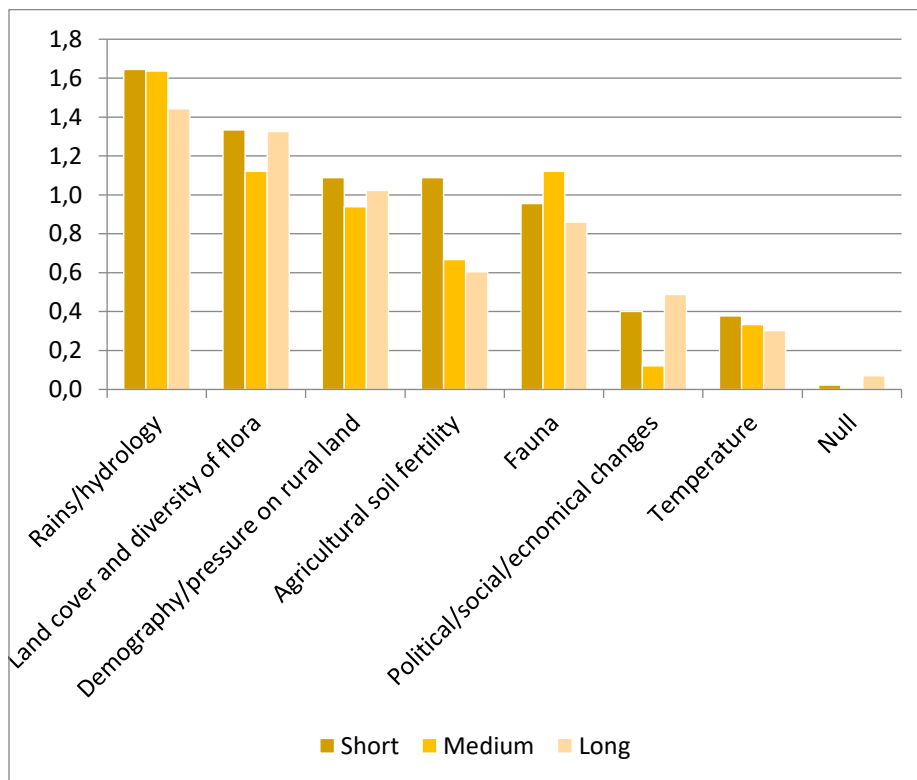


Figure 10. Perception of changes according to the length of stay in the place (45 people who stayed less than 10 years (“short”), 33 people between 10-20 years (“medium”), 43 people over 30 years (“long”); expressed as number of citations of changes per person by length of stay)

Contrary to our hypothesis, it appears that the longer the period of residence in the place, the less people cite changes, on the one hand, and that the results are mixed according to the types of changes, on the other hand (Fig. 10). The perception of demographic pressure, climate variability and temperature depends little on the duration of residency in the region, because it has the same impact on all the stakeholders in the territory. On the other hand, the decline in soil fertility is strongly felt by people who have been settled for less than 10 years, who are primarily migrants (Table 4).

In the migratory context of northern Cameroon, migrant farmers have been living in the villages studied for less than 15 years. They come either directly from northern areas where the shortage of available land pushed young people to leave to clear plots in other regions, or from former migration areas where they flee the increased number of land conflicts with indigenous people. They arrive with already large families and a desire to clear large plots of land in the still uninhabited bush. Their perceptions of change are mainly focused on the result of their actions on the environment, i.e. the modification of vegetation cover, the development of agricultural land and the decline of wildlife. They also strongly feel the vagaries of rainfall (less the faster drying of rivers due to a lack of perspective to compare), as well as the constraints of soil fertility in savanna areas, where the disappearance of fallow land in favor of an intensive input-based system makes it very difficult to control weed growth in plots and the renewal of organic matter. These changes are also felt by the natives:

	Short	Medium	Long	Total
Sample				
Native	9	16	35	60
Migrant	36	17	8	61
Total	45	33	43	121
No. of citations of changes				
Average	6.9	5.9	6.1	6.4
Std deviation	1.81	2.21	3.13	2.47
Min	3	1	1	1
Max	11	10	13	13

Table 4. Number of changes cited by categories of people based on time living in the place (121 respondents)

What is remarkable about this analysis is that newly settled people report on average more changes (7), with a smaller standard deviation, than those who have lived in the region for longer (6). Among people who have lived in the place for longer, the variability in citation is the greatest, with people who cite no change (an easy way to escape the researcher's tedious questions) or a lot. The comparison between the two categories of indigenous and migrant (regardless of the duration of the relationship, an elderly migrant can live in the place for a longer period of time than a young indigenous person) shows a consensus on the variables observed. The differences observed in the responses (Fig. 10) therefore show that it is duration in place that is the relevant variable to capture these variations in the perception of changes.

3.3. Proximity to the protected area has a large effect on perceptions

One assumption of participatory biodiversity protection programs is that environmental education promotes the perception of nature-related changes, and thus interventions for their mitigation. In the region studied, the rehabilitation program for Benue National Park includes a development plan, the participation of local residents in the monitoring of protected areas, and also awareness-raising among local populations to limit tree cutting and prohibit poaching. Thus, we hypothesized that

populations located near the protected area and benefiting from this awareness would perceive changes in vegetation and wildlife more than those living in an “ordinary” rural area (i.e., one with no biodiversity protections) who would perceive other types of changes better (or who have not been trained to respond with conservation statements). We tested this hypothesis on our dataset by comparing responses according to the proximity of informants to the protected area.

Overall, residents of the protected area perceive more changes than others, the responses are particularly distinct for three types of changes: those related to wildlife, farm land, and temperatures.

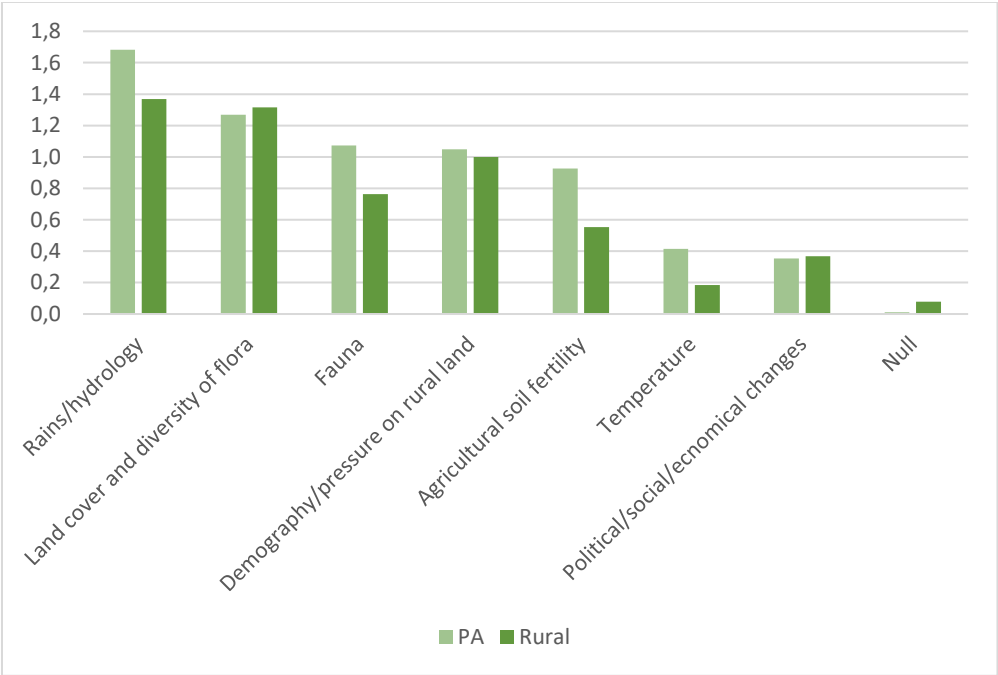


Figure 11. Perception of changes according to proximity to the protected area (82 people in the villages of Djaba and Sakje near the National Park (“PA”), 38 in the villages of Wante and Boumba remote from the Park (“Rural”); expressed as number of citation of changes per person by type of residence)

The increased perception of changes, on rains/hydrology, temperature, fauna, farmland fertility and pressure on land, on the periphery of the Benue National Park is explained not by the effect of awareness of conservation issues, but by the policies of protected area management which has concentrated and accelerated regional trends inside the zones of human use. Indeed, the Benue National Park development plan consists of zoning between biodiversity areas where no human activity is permitted, wildlife corridors to facilitate wildlife movement between the national park and other protected areas, and human use areas where all agricultural, pastoral and collection activities must take place. By concentrating these activities within village areas without controlling the continuous arrival of migrants, the development plan has artificially increased population densities and human pressure in these areas. One of the consequences has been the disappearance of wild

animals near these overcrowded areas, perceived not only as a loss in relation to the supply of bushmeat (which everyone consumes in the region, as well as in the large Cameroonian cities that represent the main outlet for this product), but also as a benefit with the reduction of crop predators. It is possible that the environmental education programs conducted by Benue National Park, particularly to ensure compliance with the delimitation of wildlife corridors, which is a major objective of the development plan, may be an explanation of the particular attention given to the disappearance of wildlife by riverside residents when asked about changes in their environment. However, the interviews show that personal experiences are at the root of this perception. In the two villages far from the protected area, the disappearance of wildlife is older and less cited by the interviewees, both by native people and migrants. Anthropogenic pressure is also very high, particularly in Boumba, where migrants began settling in 2010, which explains why the perceived changes in demography, vegetation cover, anthropogenic pressure and social, economic and political changes are not very contrasted.

The greater perception of soil fertility loss in villages bordering the PA is also explained by the development plan: by forcing the location of cultivated plots within authoritatively delineated human areas, it has also accelerated the disappearance of the fallow practice that allowed farmers to control grass cover and renew soil fertility. This change in farming system has been imposed on both migrants and native people, despite an attempt to set aside land to maintain their practices and set aside land for future generations (Raimond *et al.*, 2017). In villages located outside the development plan, a system of more or less short fallow cultivation for migrants and slash-and-burn shifting agriculture for native people still persists, even though practices are beginning to change ("now we grow corn", "we use inputs").

The contrast in the perception of temperatures is more difficult to explain, as it combines a perception related to the practice of artisanal gold panning that extends near and inside the national park, in excavations where the heat quickly becomes stifling, with the passage from a shaded forest cover to an agricultural season where very few trees are kept in the plots. It could also be an effect marked by the level of education (47% of informants with a secondary level of education mention temperatures, compared to 26% in primary studies, 12% with no educational attainment), but this factor is difficult to interpret on the basis of this survey alone.

Conclusion

All classes of informants have observed changes in biodiversity, but climate variations are rarely cited as the main proximal cause of these changes in environmental conditions.

"So many things have changed. First, the trees you see there, they are just the few that remain from slashing. Before, where we are now, it was the bush. Now, everything has been cut, there are no animals left. Today, it is difficult to see animals. Even monkeys are scarce, but there were plenty of them before. They were even coming home to eat, they were not afraid of us. Today, even ordinary birds, like fowls and guinea fowls, are scarce. We can hear them sometimes, but we don't see them anymore. They are much too afraid of humans. For sure, it is because they are hunted, and because the places they used to stay have deteriorated" (IB 13, native farmer, Boumba).

"Changes are affecting me in everything I do or eat. Today, you cannot come back from the farm with a guinea fowl, and it is scary. For sure, it is better for us that there no more animals and birds close to

the fields (less depredation), however one would like to see or have it” (IB 40, migrant farmer, Boumba).

It is difficult to draw conclusions, on the basis of this survey, about the effects of global discourses on perceptions of local change in Sub-Saharan Africa, but it is shown that these discourses focus on changes that are directly perceived by all respondents. Disappearance of wildlife, population pressure, and climate change are not only ideas conveyed by whistleblowers from various sectors who are seeking answers to problems coming from other places, such as the Benue National Park rehabilitation project for wildlife conservation (2000-05), or successive development projects that have promoted tree conservation in cultivated fields to preserve soil and soil fertility and tree cover favourable to rainfall (North East Benue 1975-93, Water Sol Arbres 2002-11). They are also actual daily reality, which northern Cameroon residents perceive through a number of indicators. Changes are perceived by local people and their consequences are anticipated and managed. We have not underlined a clear signal of differing perceptions of change according to stakeholders' specific characteristics (age, ethnicity, education, etc.). Perceptions of change appear to be weakly influenced by global media narratives about global change, and are more influenced by local experience and native strategies for mitigation and adaptation to change. Despite differences in ratings of the various changes and priorities, there is an overall consensus about ongoing changes. Biodiversity indicators are recognized according to their value for the subsistence of various stakeholders (fodder, firewood, pasture, bushmeat, etc.). However, whether for domesticated plant crops and animals or wild fauna and flora, the climate is neither the sole nor the most important perceived driver of ecological change.

The explanations for these changes differ completely from the global to local scale. For the inhabitants of the rural area of northern Cameroon, the changes are not due to increased greenhouse gas emissions that disrupt atmospheric circulation and warm the planet, but to population increases in local villages that lead to more people clearing the bush, killing wild animals for food, increasing their consumption of grass and wood, and removing trees that promote rainfall and dew. Different causes and explanations, but identical effects: global and local discourses on change should be able to come together to define appropriate public policies.

While the relationship between deforestation and dewfall has long been demonstrated (Ellison *et al.*, 2017), the correlation with the decline in local rainfall is not, although it is an idea that is well rooted in the minds of an African population that has been aware of the issue of deforestation for several generations. It is perhaps in this explanatory trait that we must see, today, the effects of an awareness discourse on the perception of a very diverse population.

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