"So many things have changed": Situated understandings of climate change impacts among the Bassari, south-eastern Senegal

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Abstract

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Mainstream discourses frame anthropogenic climate change as a biophysical apolitical problem, thus privileging Western science and silencing other worldviews. Through a case study among the Bassari, an ethnic group in South-Eastern Senegal, we assess the local, embodied, and situated understandings of climate change and the tensions that arise when the apolitical global climate change discourse interacts with situated understandings. Drawing on data from 47 semi-structured interviews and 176 surveys, we find that while the global climate change discourse has not permeated into the Bassari, they experience climate change through its many impacts on the biophysical and socio-economic systems. Results also highlight that climate is not considered the main or only driver of change, but that changes in elements of the climate system are inextricably linked with political and economic dynamics and environmental degradation. Finally, our results point toward the importance of values and supernatural forces in defining situated ways of conceptualizing, interpreting, and responding to change. By including situated worldviews in theoretical understandings of climate and environmental change, we contribute to the claims about the need to reframe how climate change is conceptualized. Our research emphasizes the importance of a relational view of climate change, which requires moving beyond understanding isolated climate change impacts towards defining climate change as a systemic problem. Building on feminist and decolonial literature, we argue for the need for more plural and democratic ways of thinking about climate change, crossing epistemological and ontological boundaries and including local communities and their knowledge and understandings.

Key words: climate science, climate justice, environmental change, epistemic justice, Indigenous and local knowledge, network analysis, plural ontologies

1. Introduction

"*So many things have changed! (…) If I am correct, it's because of what we do with our own hands. Before, there would be sacrifices in each house to ask for the rain, or for the trees to give many flowers. (…). The world is changing, and mostly here. We cannot go against climate change, us Bassari*."

- Bassari female elder, May 2021

Anthropogenic climate change is, perhaps, the most urgent global environmental problem, as it threatens life on Earth as we know it. Atmospheric changes have cascading effects on physical, biological, socio-economic, and cultural systems (Adger et al., 2013; Reyes-García et al., 2019; Scheffers et al., 2016).

Scientific explanations present anthropogenic climate change as a biophysical problem, relating it with greenhouse-gas emissions produced by fossil fuels (IPCC, 2021), with growing consensus about the diverse ways of experiencing climate change (Hohenthal et al., 2018; Rosengren, 2018; Tschakert, 2012). The opening quotation from our field research among the Bassari in South-Eastern Senegal illustrates the complexity of local conceptualizations of climate change. It also reflects the tensions, discontinuities, and contradictions that emerge when contrasting local perspectives based on distinct cosmological, ontological, and epistemological grounds with the scientific discourse that dominates climate change debates.

Feminist, post and decolonial studies[1] and critical social scientists have a long tradition of uncovering the uneven power dynamics that shape what knowledge is considered legitimate, showing how power privileges Western science while dismissing other knowledge systems (e.g., Blaser, 2013; Harding, 2009; Jasanoff, 2004; Lizcano, 2006; McLeod, 2000; Todd, 2015). Accordingly, an increasing body of literature critically engages with climate change knowledge politics, analysing how knowledge is

1 Feminist and post and decolonial studies come from very different traditions but are strongly complementary. They both include analysis of power, justice, and knowledge production, decentring the dominant ways of thinking. The feminist lens is crucial considering the historical marginalization of women from Western science and the importance of gender for knowledge production processes. The post and decolonial lens is key to understand how Western scientific knowledge production is deeply imbricated in imperial and colonial relations and their contemporary remnants. Both co-constitute each other by showing how the intersecting and multiple power hierarchies in which we live are crucial to understand how and why the voices of the most affected and marginalized by the colonial, patriarchal and capitalist system (i.e., non-Western local knowledge systems) are also the ones most silenced (Harding, 2009; Hunt, 2014; Todd, 2016).

produced and whose knowledge and voices are heard (Goldman et al., 2018; Hulme, 2010; Mahony & Hulme, 2018). Overall, the global framing of climate change has favoured ‘technical-biophysical’ Western science views, which, despite being presented as objective and value-free, cannot be separated from colonialism, imperialism, patriarchy, and capitalist resource extraction (Bee et al., 2015; Demeritt, 2001; Hulme, 2008; Nightingale et al., 2020). The Intergovernmental Panel on Climate Change (IPCC), a key institution in making and validating scientific climate change knowledge, is a good example of how certain voices are marginalized and suppressed from global climate change discourses – e.g., through participation imbalances between Global North and Global South countries (Hulme & Mahony, 2010), male-dominance (Liverman et al., 2022), underrepresenting humanities scholars (Corbera et al., 2016) and Indigenous and local knowledge (ILK) holders (Ford et al., 2016), or through the ‘strategic unknowing’, including denial, dismissal, diversion, and displacement of other ways of knowing (Arora-Jonsson & Wahlström, 2023).

Feminist post and decolonial studies advocate for collaboration across diverse ways of knowing in climate change research and policy, based on the principles of consent, cultural autonomy, and justice (Orlove et al., 2023), which ensures that gendered and power hierarchies are made visible, questioned, and addressed (Bee et al., 2015; Cameron, 2012; Carey et al., 2016; MacGregor, 2009; Todd, 2016). This entails learning from grounded and localised understandings of climate change and drawing attention to how climate change is differently lived and experienced by different subjects that, through their everyday practices, are located and bound to different power structures and inequalities[2] (Bee et al., 2015; Brace & Geoghegan, 2011; Hulme, 2010). Such an approach implies interpreting climate change’s physical dimensions through cultural meanings[3], e.g., understanding ‘weather’, ‘climate’ and ‘climate change’ as ideas constructed through cultural practices (Hulme, 2008; Jasanoff, 2010). Thus, it is crucial to study how climate change is lived and interpreted by people within particular

2 As opposed to universal, global knowledge, feminist approaches emphasize the importance of looking at climate change knowledge production from the notions of “embodiment” and the “everyday”. By paying attention to the spaces of everyday practice and to the experiences and intersecting subjectivities (gender, class, race, indigeneity, and other dimension of power) of the situated bodies that live and produce climate change knowledge, a focus on “everyday” and “embodiment” make visible how broader uneven power relations shape mundane spaces and experiences around climate change (Bee et al., 2015).
3 Previous research asserts that existing vernacular conceptions of climate and the environment (also referred as local cosmologies or ontological regimes) affect the way people perceive, experience, and react to environmental changes (Pyhälä et al., 2016).

social and historical contexts and how climate change experiences and understandings fit into wider understandings of the world (Bee et al., 2015; Buechler & Hanson, 2015; MacGregor, 2009).

Berkes (2009) suggests that local understandings of environmental (and climate) change must be interpreted within the context of broader knowledge systems developed locally. Literature on ILK highlights the unique, complex, holistic, empirical knowledge that Indigenous peoples and local communities hold about climate and environmental variability, in which human-nature relations and values, knowledge, and behaviour are inextricably linked (Berkes & Berkes, 2009; Pyhälä et al., 2016; Reyes-García et al., 2016). In a similar vein, feminist studies refer to "situated knowledge"[4], emphasizing that knowledge production is embedded in a particular language, culture, and contingent to the history and power relations of the knowledge-holder group (Haraway, 1988).

Recognizing voices and knowledge systems marginalized by mainstream approaches allows to explore different ways of understanding climate change impacts, as well as a deeper understanding of the complex web of relations between climate (and environmental) change and cultural, political, and socio-economic changes at the local, regional, and global scales (Boillat & Berkes, 2013; Li et al., 2021). Moreover, using multiple perspectives helps to think about the current gaps in climate science, question assumptions, and pose new questions – e.g., Goldman et al., 2018; Mahony & Hulme, 2018; Nightingale, 2016. While scholarly interest in introducing local worldviews into theoretical understandings of climate change is growing, the approach continues to be marginalized in global debates (Barnes et al., 2013; Castree et al., 2014; Reyes-García et al., 2019).

Building on previous work calling for epistemological and ontological plurality in understanding climate change (Orlove et al., 2023), our work aims at empirically exploring the local, embodied and situated understandings of climate change through a case-study among the Bassari, an ethno-linguistic minority inhabiting South-Eastern Senegal. To do so, we first investigate whether the global scientific concept of 'climate change' has made its way to the Bassari, and if so, who has access to this knowledge

4 We use the concept "situated knowledge" (Haraway, 1988) to emphasize the extensive body of critical research that challenges the historical Western categorization of non-Western cultures as "local", "traditional", or "Indigenous" while considering (Western) science as universal (e.g., Cameron, 2012; Todd, 2015). The notion of situated knowledge recognizes the knowledge-practice-belief based on the multigenerational cultural transmission and evolving adaptive processes that characterizes ILK (Berkes, 1999) and brings attention to colonial legacies and contemporary power dynamics.

and how it merges with local notions of change, resulting in local meanings of 'climate change'. Then, we explore local reports of environmental changes and the perceived importance of climate change amongst other drivers of change. Finally, building on feminist and decolonial literature we discuss the frictions that arise when the apolitical, global, science-based framings of climate change interact with the local, embodied, and situated understandings of local communities with nature-dependent livelihoods, considering the implications of these frictions for adaptation and climate change governance, and arguing for more diverse representations and conceptualizations of climate change.

2. Case study and methods

2.1. The Bassari of South-Eastern Senegal

The Bassari country, Southeast Senegal, is a region characterized by tropical savannah with dry-winter characteristics (Peel et al., 2007) and mean annual rainfall ca. 1172 mm (2005-2015) distributed along one rainy season (June-July to October-November) (ANACIM, 2020). The landscape and livelihood activities are determined by the yearly rhythm of dry and rainy seasons, which, as in the rest of the Sahel area, shows high inter-annual variability. During the 1970s and 1980s, the region was affected by intense droughts, and thereafter, there has been an increase in annual rainfall, widespread warming, and an increase in climate extremes (IPCC 2007, p. 299). These trends, however, are not clear, and climate change projections for the area remain uncertain and subject to large local variability (Sultan & Gaetani, 2016).

Situated in one of the most remote regions of Senegal, the Bassari country has historically been socially, politically, and economically isolated from the rest of Senegal. Historical accounts depict the Bassari as hunter-gatherers and small-scale subsistence farmers, with dispersed settlement patterns and a self-sufficient lifestyle until the beginning of the 20th century. Most social changes in the area accelerated in the 20th century, with French colonialism and increasing integration into the mainstream market economy (Porcuna-Ferrer et al., under review).

French colonial rule (1900-1960) placed the Bassari territory in a particular development trajectory, characterized by the imposition of a tax-system, forced labour recruitments, the establishment of French schools and Catholic and Protestant missions, the creation of transport infrastructure and weekly markets, and the establishment of the Niokolo Koba National Park in an area traditionally used for hunting and gathering by local populations. After Senegal's independence (1960), the Bassari territory integration into the Senegalese economy continued through development projects and NGOs, which enhanced access to health and education and promoted agricultural mechanization, the use of chemical inputs, and new improved seed varieties. Small-scale tourism developed in the area in the 2000s, bolstered by UNESCO's designation of the Bassari Country as a World Heritage site.

The study area is located at the foothills of the Fouta-Djallon mountain range, below the Gambia river and is bounded to the West and North by the Niokolo Koba. A paved road connects the departmental capital, Kedougou, with the market town of Salemata, which is about 11 kilometres away (Figure 1). Nowadays, the main livelihood activity in the area is slash-and-burn agriculture, mostly for subsistence and cereal crops, with some legume and vegetable cultivation and cotton as the only cash-crop. Most Bassari families own some cattle as a cash-saving strategy. Bassari are increasingly involved in market-based economic activities such as construction, tourism, and gold mining (Porcuna-Ferrer et al., under review).

[FIGURE 1 ABOUT HERE]

2.2. Methods

Data collection took place over 16 months between 2019 and 2021. We worked on three Bassari villages, with populations of approximately 200, 433, and 986 inhabitants, representing the area's diverse environmental and socioeconomic conditions (see below). Using a combination of qualitative and quantitative methods (Reyes-García et al., 2023a), we collected and interpreted data on Bassari familiarity with the Western concept of climate change as well as situated reports of environmental change. We collected data in French, with translations into Bassari by two experienced local research assistants, one man and one woman, who assisted us in ensuring that the questions were culturally-appropriate and correctly translated and understood. Research assistants belonged to the biggest village. When conducting research in the other two villages, a local interpreter belonging to each community also accompanied us. All members of the communities that participated in the research agreed research assistants and interpreters to be financed during the research period.

Before starting data collection, we obtained permission to conduct research from the official and customary authorities at village level (i.e., the *préfet*, the *chefs de village* and the *chefs coutumiers*) and each household and individual participating in the research. The research protocol was approved by the ethics committee of the Universitat Autònoma de Barcelona (CEEAH 4781). All authors of this paper are European, as such, we acknowledge that not being Bassari scholars might limit our understanding of Bassari knowledge and cosmologies, affecting our interpretations of Bassari reports of climate and environmental change and their drivers.

2.3. Bassari's familiarity with Western scientific notions of climate change

To explore whether the scientific concept of 'climate change' had permeated in the local communities, we conducted a survey (n = 176). Participant selection followed stratified random sampling, balancing the number of selected individuals per case-study village, and gender and age quotas (Table 1). We asked survey participants: (i) Have you heard the term 'climate change'? (yes/no); If yes: (ii) where did you learn about it? (i.e., TV, radio, other people, health post, school) and (iii) what does 'climate change' mean to you? (open text, documented verbatim). We also documented basic individual socio-demographic characteristics (i.e., biological sex, age, level of schooling, and village of residence).

[TABLE 1 ABOUT HERE]

We coded the answers into a variable called "matching", which took the value of "yes" if the interviewee referred to changes in the atmospheric system and (but not necessarily) CO_2 emissions or pollution; "partially" if the interviewee referred to environmental changes potentially driven by changes in climate (e.g., crops produce lower yields, wild trees decrease production, etc.) but did not specify the driver; and "no" if the interviewee mentioned changes that were not related to climate or environmental change (e.g., arrival of phones, radio, new crops, etc.).

We used percentages to quantify people's level of familiarity with scientific understandings of climate change and assessed whether responses to the variable "matching" were associated to informants' sex, age and level of schooling. To test independence between response and explanatory variables, we used the Exact Fisher's test for categorical variables (i.e., sex and level of schooling) instead of a Chi-squared test for which we had too few observations. A Kruskall-Wallis test was used for the numerical variable (i.e., age). The association between source of information and the variable “matching” was assessed with a Chi-squared test. In the text, we mention the test name when referring to the Kruskal-Wallis test or to Chi-squared test; otherwise, p-values were obtained through the Exact Fisher’s test.

All data analyses were run in R (R Core Team, 2021). We used the ggplot2 package (Wickham, 2016) and Inkscape v.1.2 for other visualizations.

2.4. Situated reports of environmental change and its drivers

We used a two-step process to assess situated reports of environmental change and the relative importance of climate change as a driver. We first conducted 47 semi-structured interviews (SSIs) with people locally recognized as knowledgeable, selecting individuals who could hold different knowledge on local environmental changes (Table 1). We tried to balance our sample across age, sex, and main livelihood activity, selecting the most common activities performed in the area (i.e., farming, hunter-gathering, fishing). Women participation was lower than desired (28%), which we primarily attribute to the fact that, for logistical reasons, we had no option but to conduct SSIs during the main harvest time. Since women, besides being farmers also shoulder most responsibilities of household caregiving, they were less available than men for interviews.

Following Reyes-García et al., 2023a, SSIs started with the question “compared to your youth, what changes in the environment have you noticed?”; followed by questions about changes in a) the weather, seasons, temperature, rain; b) soils, river, and streams; c) wild plants, animals, and fish; and d) farming, livestock-keeping, or any other livelihood activities. For each change mentioned, we asked *why* the informant thought it happened and *what* was causing it. We then organized three focus group discussions, one in each village, to assess the community consensus regarding environmental changes and their drivers and to clarify unclear or contradictory observations.

Verbatim environmental change observations were coded into summary indicators following the hierarchical classification system proposed by Reyes-García et al., 2019 , where environmental changes are classified according to the ‘system’ (i.e., atmospheric, physical, biological, socio-economic), ‘sub-system’ (e.g., temperature, terrestrial physical system, cultivated plant species) and 'impacted element'[5] where they are observed (e.g., seasonal temperature, wild flora productivity, cultivated spp. productivity). For example, we coded similar expressions (e.g., "now it rains less", "it does not rain like before") into an indicator (i.e., "changes in mean rainfall") which, following the classification used, was assigned to an impacted element ("mean precipitation"), a subsystem ("precipitation"), and a system ("atmospheric system").

When a change was reportedly driven by another environmental change, we used the same process to classify the driver. However, when drivers of change were not environmental, we drew on the IPBES classification of drivers, which distinguishes between 'direct' drivers of change (i.e., land-use change, resource extraction, pollution, invasive alien species) and 'indirect' drivers of change (i.e., values, demographic, technological, economic, governance) (Balvanera et al., 2019). We extended the IPBES classification by adding 'supernatural forces' as driver of environmental change (e.g., "trees have stopped producing fruits as a punishment because now we sell their fruits", "because of God"). To integrate both classification systems (IPBES and LICCI), we chose to work at the level with the highest correspondence between them, although we are aware that this correspondence is not exact.

We used network analysis to assess interactions between reported environmental change impacts and their drivers (Brandes, 2005), focusing on the relationships between changes rather than on the changes themselves. For this, we created an edge-list, with one column indicating the list of environmental change impacts and another indicating the reported drivers (adding one line per additionally reported drivers for the same impact). We only used impacts and drivers for which there was consensus in the focus group discussions. When visualizing the edge-list as a network, nodes represented either drivers or impacts of environmental change, and ties represented directed relations between nodes. So, an oriented tie from change (i) to change (j) indicated that change (i) drives change (j).

To analyse the network, we calculated two measures at the node and network levels: (i) *Indegree.* At node level, indegree, i.e., the number of incoming ties, represents the number of drivers reported for a particular change. At network level, a high indegree centralization indicates that a limited number of impacts are linked to many drivers

5 In the text we also refer to 'impacted elements' as 'environmental change impacts'

while the rest are linked to a few. (ii) *Outdegree.* At node level, outdegree, i.e., the number of outgoing ties, represents the number of times a change is mentioned as driver. At the network level, high outdegree centralization indicates that a small group of drivers causes most impacts. We calculated all directed networks using the R package "network" (Butts, 2015).

3. Results

3.1. Bassari's familiarity with Western scientific notions of climate change

Fifty-three percent of the sample (n=176) reported hearing about climate change; but only 55% of those provided a definition. 59% of respondents who had never heard the term climate change were women, 68% were over 40, and 58% had never attended school (Figure 2).

Younger people (Kruskal-Wallis test, $p = 0.003$) and people with higher level of schooling were significantly more likely to have heard the term 'climate change' than their peers ($p < 0.05$). Everyone who had reached high school had heard about 'climate change'. We found no statistically significant relationship between gender and having heard the term climate change ($p > 0.05$). Men ($p = 0.02$), young people (Kruskal-Wallis test, $p = 0.02$), and people with schooling ($p < 0.05$) provided explanations that most closely matched scientific notions of 'climate change' (Figure 2).

The most common sources of information about 'climate change' were other people (54.73% of the interviewees) and the radio (30.52%). Informants of different age, gender, and level of schooling used different sources. In general, men accessed climate change knowledge through the radio more often than women, who mostly accessed this knowledge by talking to other people ($p < 0.01$). Similarly, people who had completed middle school had heard about climate change at school, whereas people with no schooling generally accessed climate change knowledge by talking to other people ($p < 0.01$). We also found an association between the climate change knowledge source used and providing explanations that match Western scientific notions of 'climate change' ($p = 0.002$). Standardized residuals of the Chi-squared test show a positive association between providing explanations of 'climate change' that do not match Western scientific meanings and relying on 'other people' as climate change information source (std.res = 3.66). On the contrary, providing climate change explanations that match

Western scientific notions of climate change was positively associated with school attendance (std.res = 2.05) and access to TV (std.res = 2.49).

[FIGURE 2 ABOUT HERE]

In explaining ‘climate change’, informants often referred to broader socio-economic changes affecting them (i.e., globalization and integration into market economy). From those that provided an explanation (n = 51), 48%, 41%, and 9% referred to atmospheric, socio-economic, and biological changes, respectively. Meanwhile, 14% of respondents referred to change in general. Only 17% referred to combined effects in more than one system. For some, ‘climate change’ was not an unprecedented phenomenon, but part of a cycle, like exemplified by the definition provided by a young male informant: ‘*Sometimes there is a lot of rain, sometimes not. The elders explain there was a time when no rain came in a whole rainy season*” (Anonymous, April 2021).

When explaining the meaning of ‘climate change’, the most reported atmospheric changes were temperature increase, lack of rain, shift and shortening of the rainy season, drought, and general changes in weather patterns. Changes in the biological system included forest degradation, plant and animal diversity loss, and soil erosion, and those in the socio-economic system referred to changes in crop phenology or productivity, but also the increasing use of technologies, access and importance of money and material goods, pollution, dietary changes, and changes in knowledge access and circulation. Some informants also associated the concept of climate change with changes in habits and customs. Specifically, interviewees mentioned changes in the traditional value-system, abandonment of ancestral practices, and intensification of a utilitarian relationship towards nature. For example, one informant mentioned: ‘*There used to be a clan that was in charge of asking for the rain, but now they don’t do it anymore, so the rain does not come*’ (Anonymous, April 2021). Some informants also referred to super-natural forces and considered ‘climate change’ as their punishment. Bassari view spiritual beings as having a conscious agency in the physical world, which depends on the good relationship and mutual respect between humans and spiritual beings. In that sense, interviewees often referred to the punishment of ‘super-natural forces’ for the abusive or cultural disrespectful exploitation of nature. Like a middle-aged male explained: ‘*Nothing is like before; the people of nowadays are not anymore like the people of before. Before, there used to be more respect* [to the customs and traditions], *now there is no respect. This is why things get worse*' (Anonymous, May 2021).

3.2 Bassari reports of environmental change

Beyond the definition of the term 'climate change' prompted in surveys, during SSIs and focus group discussions Bassari did report many environmental changes. Most observations referred to changes in the socio-economic system (37% of the total), followed by changes in the physical (30%), atmospheric (18%), and biological systems (15%) (Supplementary material 1).

Most changes in the atmospheric system referred to a decrease in precipitation, including changes in the abundance and distribution of rainfall and fog decrease. As a middle-aged woman described, '*Nowadays, it does not rain as before*. *Before, when the first rain arrived you knew there would be rain. Nowadays, sometimes the first rain arrives and there are four days without rain or even a whole month!*' and she continued '*Sometimes you could spend two or three days with "okubina"* [specific type of fog], *but last year we did not even see it one day*' (Anonymous, January 2020). The general perception of a drier climate was noticed in the shortening of the rainy season (later onset, earlier end). Informants also mentioned temperature rises. Wind changes were rarely mentioned without prompting, but those who reported them provided extensive information about changes in wind strength and temperature.

Changes in the physical system related to river regimes, well depletion, soil erosion, and wildfires increase. During focus group discussion, hydrological changes seemed to be of especial concern, e.g., '*Behind my house there was a stream where we fished during the rainy season. It does not exist anymore*' (Anonymous, February 2020). Informants widely discussed the faster depletion of water in the wells, which posed problems, particularly for women, who are obliged to carry water from a greater distance. Furthermore, soils were said to have warmed up due to a lack of humidity. Decreased soil fertility was also reported, which informants closely linked with soil erosion: '*When we open a new field, it does not give like before. The soil is dry and tired (…). The wind and the strong rains take all the richness away. When a heavy rain comes, water cannot penetrate the soil and just runs off all the soil'* (Anonymous, February 2020).

Interviewees also mentioned several changes in the biological system, with the disappearance of wild fauna as a major topic. Bush-meat plays a central role in Bassari culinary culture, but it is no longer (or rarely) consumed. Observers cited the local extinction of elephants, panthers, hyenas, hippopotamus, crocodiles and other large animals, as well as certain bird and fish species, which "*had run away*". Certain monkey species were also mentioned as having vanished, a local extinction seen as 'positive' since monkeys damage food crops. Concerns were also raised about the disappearance of certain wild plants; respondents mostly mentioned a decrease in edible species for household consumption and sale, such as baobab, weda or madd, shea tree and African locust bean, as well as trees and other species specially valued for their timber, such as the local raffia palm.

Bassari also mentioned changes in livelihood activities, primarily in agricultural practices. People were acutely aware of changes in crop sowing times, lower harvests due to drought, and increased crop pest pressure, particularly during grain storage. As a young woman farmer explained: '*Last year, I stored my peanuts in these recipients, and three months later, it was all powder!'* (Anonymous, February 2020). Interviewees also mentioned that livestock had to travel further to find fresh pasture and they all agreed that livestock epidemics were becoming more common.

3.3 A network of changes

Most reported changes drive other environmental changes. Only a few socio-economic changes were exclusively mentioned either as impacts (i.e., infrastructure and human health) or as drivers (i.e., governance, demographic, economic, supernatural forces) (Table 2).

[TABLE 2 ABOUT HERE]

In general, elements of the 'atmospheric' (32.1% of observations) and 'socio-economic' systems (32.1%) were reported in a higher number as drivers of environmental changes, compared to elements of the 'physical' (18.5%) and 'biological' systems (17.3%). Impacts on the 'socio-economic' (31.5% of observations) and 'physical' systems (31.5%) were more frequently reported than impacts on the 'biological' (23.5%) and 'atmospheric' systems (13.6%) (Figure 3).

[FIGURE 3 ABOUT HERE]

3.3.1 Drivers of environmental change

The relationships among changes reported by the Bassari underscores the complex interrelations and multiple reinforcements among environmental change impacts and drivers (Figure 4).

[FIGURE 4 ABOUT HERE]

The centralization outdegree score of the network was low (1.72%), suggesting that the Bassari perceive many drivers of environmental change. Moreover, 65% of the impacts mentioned were associated with more than one driver.

Our measure of nodes' outdegree suggests that water-related changes, specifically changes related to 'precipitation' and 'continental waters', were the most important drivers of environmental changes. Another important driver was 'resource extraction', which had the third highest outdegree (Table 3). The decrease in seasonal precipitation impacted a wide range of elements including wind temperature, aquifer recharge, wildfires, soil fertility, wild plants productivity and distribution, livestock, pasture availability, and crop yields and mortality. Given the local importance of farming, the effects of precipitation changes on the agricultural system were a common concern. As an old man explained: '*Before, there was less rain, but it would last for the whole day, we called it "tib ind eyam"* [=rain of the good harvest]. *Nowadays it rains for a shorter period of time but stronger and the rain takes away the soil and plants*' (Anonymous, February 2020).

[TABLE 3 ABOUT HERE]

Changes in 'continental waters' (i.e., rivers and streams) were also reported to impact many other elements, including wild flora and fauna, pastures, crops, livestock, transport infrastructure, and human health. Interviewees also reported that the drying up of rivers resulted in temperature increase and changes in wind seasonal patterns.

Bassari related increasing resource extraction with impacts on the atmospheric, physical and biological systems. In general, interviewees referred to the overexploitation of nature mostly through small-prey hunting (e.g., birds, small mammals), honey, palm-wine, wild edible fruits and timber harvesting, and well-water consumption. For the Bassari, intensification of species extraction drives defaunation and deforestation, as one of the interviewees explained: '*When the season comes, everybody goes in search of madd* (wild edible fruit with high market value). *Before we would leave some fruits for the birds or animals to eat. Also, some fruits would fall near* *the mother tree and produce new seedlings. Now fruits do not reach the ground, that's why it's rare to see a small tree!*' (Anonymous, March 2020). Bassari also related increasing extraction with rainfall decrease arguing that tree species that 'call for the rain' are now rare. As explained by an elder woman: '*The rain does not come like before because we cut many trees'* (Anonymous, February 2020). Moreover, as explained by a focus group discussion participant, the decrease in forest surface and river-bank vegetation also impoverishes local diets, as many wild edible plant species became rare.

Finally, some changes in elements of the socio-economic system were regarded as drivers of environmental change (Table 2). These include population growth and village expansion, access to services (e.g., schools, doctors) and material goods (e.g., solar panels), technological innovations (e.g., introduction of new crops and varieties, pesticides and fertilizers), land-use changes (e.g., agricultural expansion), and changes in governance and the economic regime. One interviewee, for example, explained land-use change as follows: '*If you go back 15 years from now, to go from our household to the household of X you had to cross a lot of bush. Today, all this bush are fields, and the land can't rest*' (Anonymous, February 2020). Bassari often refer to the shift in local values as a driver of change, and particularly the growing importance of money, the abandonment of local traditions, and the instrumentalization of nature. For example, some interviewees linked the decline in game productivity to abusive hunting, while others suggested that the decline in wild fruit productivity was a punishment for harvesting too much for commercialization: '*Trees do not give like before (...) because now people harvest to sell, not to eat. That's why trees have stopped giving*' (Anonymous, February 2020).

3.3.2 Impacts of environmental change

The centralization indegree score of the full network was low (1.06%), indicating that there were many impacts connected to many drivers. According to the indegree node measure, the nodes impacted by the most drivers are 'terrestrial wild flora', 'continental waters', and 'soil and land'.

Changes in 'terrestrial wild flora' were reportedly driven by changes in the atmospheric, physical, and socio-economic systems, including precipitation decrease, temperature increase, decreased availability of continental waters, higher rates of species extraction, demographic and land-use changes, and changes in values. On the latter, one informant commented: '*We used to have ceremonies and many cultural practices for trees to give a lot of flowers. Now nobody practices them anymore, therefore trees give less fruits*' (Anonymous, December 2019). Some informants specially highlighted the impact that practices oriented to generate income have in wild flora: '*Nowadays people cut trees near the river because they only think of earning money. Those areas are forbidden by the tradition*' (Anonymous, December 2019).

Changes in 'continental waters' were allegedly driven by decreased precipitation, intensification of agricultural practices and livestock keeping, land-use change, and increased extraction of terrestrial wild flora. Increased resource extraction was also linked to the drying of rivers: '*We cut all the raphia. It was the raphia that retained the water'* (Anonymous, February 2020*)*. The disappearance of freshwater fauna is also mentioned as a cause of river drying up.

Changes in 'soils and land' were reportedly driven by changes in rainfall and wind patterns, wild plant species abundance and distribution, and agricultural practice changes, such as shorter fallow periods, chemical inputs increasing, or changes in ploughing methods.

Finally, some changes in socio-economic system elements are predominantly or exclusively considered environmental change impacts (Table 2). These include transportation infrastructure expansion and improvement, effects on human health, and changes in pastures and grasslands, livestock, and cultivated plant species. Impacts on human health were deemed positive due to increased access to health services, but also negative, owing to the increase of vector-borne diseases and the adoption of diets high in processed foods and sugar. The effects on pastures, crops and livestock were complex and steamed from many simultaneous environmental and socio-economic drivers of change. A good example of the complex local discourse about the synergic effect of multiple drivers is one from an old local male farmer: '*It's now that the livestock need to go that far looking for food. Before there was always a "bas-fond"* [lowland fertile areas] *with good grass and herbs for eating, but now bas-fonds are for rice and rivers have become dry. People used to have only few cows, now there are many cows. And not only ours! "Aga"* [transhumant herders] *coming from the North arrive each year with their big herds, they cut down the trees to find fodder for their sheep, but they do not respect anything. They leave the cut branches around the trunks and then big trees are also burn with wildfires'* (Anonymous, February 2020).

4 Discussion and conclusions

Before discussing the main findings of this work, we start by acknowledging three important limitations. We are aware that 1) due to epistemological differences it is not possible for us to fully assess Bassari knowledge by just interacting with community members for a limited period, 2) by focusing on consensual information, we are ignoring the sociological complexity that determines how knowledge is locally distributed and how environmental change impacts are differently lived by different socio-demographic groups within the Bassari (e.g., according to gender, age, or social status), and 3) that some of our conclusions are drawn from information collected using different samples. Thus, while not claiming that the results presented here represent Bassari worldviews, but rather our interpretation of them, we believe this representation can help to better understand the impacts of climate change in the context of global change.

Herein, we discuss the main results and debate the existing tensions between scientific and situated and plural understandings of climate change, based on Indigenous, embodied, and experiential knowledges.

4.1 Situated perspectives of the global climate change discourse

Bassari were, in general, not very familiar with the term 'climate change'. Most interviewees had either never heard the term or provided definitions that do not match the Western scientific meaning of the concept. These results resemble those among other local communities of the Global South, where the scientific discourse of climate change has barely reached (e.g., Byg, 2009; Fernández-Llamazares et al., 2015), suggesting a lower familiarity with the Western scientific discourse of anthropogenic climate change than in less isolated regions. For example, on the Marshall Islands (Pacific archipelago), 80% of the interviewees had some awareness of the Western scientific notion of climate change (Rudiak-Gould, 2011), and in South England, only 2.9% of respondents were not familiar with the term 'climate change' (Whitmarsh, 2009). Overall, however, it is difficult to draw a conclusion, as there are very few studies explicitly asking about the term 'climate change' in Global South communities (Rudiak-Gould, 2011), and most studies have assessed this familiarity indirectly, by documenting local observations of climate change and its impacts (Boillat & Berkes, 2013; Marin, 2010).

Our results show how access to global ‘climate change’ knowledge is mediated by gender, age, and level of schooling. Among the Bassari, young well-educated men were more familiar with the Western scientific concept than the rest of the population. Our results also point to wealth as a mediating factor for access to the Western scientific discourse on climate change, as people with access to TV were more aware of the Western scientific discourse around climate change and locally only members of few wealthy households own and have access to TV. Since people’s perceptions and understandings of climate change can influence their behaviour toward adaptation and mitigation strategies (Naess, 2013; Patt & Weber, 2014; Spence et al., 2011), differential access to Western scientific climate change knowledge may lead to wealthy young well-educated men being more engaged in the implementation of externally-driven (often top-down) climate change adaptation interventions, and thus to a better representation of their interests and needs compared to those of elders, women, or people without access to schooling. However, we recognize that to build effective adaptation strategies, a focus on the diversity of people’s lived experiences and everyday adaptation is crucial (Moulton & Carey, 2023). Drawing from our ethnographic experience, we recognize the pivotal contribution of women and elders to local adaptation. Despite not accessing Western scientific representations, through decades of observation and experimentation other groups have accumulated a wealth of knowledge that ensures that adaptations respond to the needs and desires of local communities’ and are culturally appropriate and locally feasible.

To the level to which the concept of ‘climate change’ has made its way to the Bassari communities, it has merged with situated notions of change to form new meanings. Survey participants who stated familiarity with the Western scientific ‘climate change’ concept, did not only refer to changes happening in the atmospheric system, but also referred to climate change information and meaning with local beliefs and their own traditional representations of the world. Several interviewees stated that ‘everything is changing’ (referring to changes in the environment, socio-economic system, and way of life). Drawing on situated knowledge and worldviews, others interpreted ‘climate change’ as cyclical or as a punishment from super-natural forces for inappropriate behaviour. Thus, our findings agree with those reported for other Indigenous peoples and local communities, showing that situated interpretations of changing climatic conditions have ontological foundations (Boillat & Berkes, 2013; Rosengren, 2018; Scoville-Simonds, 2018). Our research also confirms that local communities do not always absorb the Western scientific climate change discourse despite having access to it (Fernández-Llamazares et al., 2015; Marin & Berkes, 2013), which might be explained by the epistemological gap between the information heard and the one perceived (Hulme, 2009; Marin & Berkes, 2013) and the lack of trust on Western scientific experts (Hmielowski et al., 2014).

4.2 Climate change from the lens of the 'everyday'

While Bassari people are not necessarily familiar with the 'climate change' concept, they reported many changes in the atmospheric system, with cascading effects on the physical, biological, and socio-economic systems. Similarly, previous research showed that communities that live in close proximity to the environment have detailed perceptions of weather changes (Fernández-Llamazares et al., 2015; García-del-Amo, 2021; Green & Raygorodetsky, 2010; Reyes-García et al., 2023b). However, by employing a network approach, our results quantitatively assess the relative importance of the various drivers and interactions between climatic and non-climatic changes, with conceptual and practical implications.

Conceptually, the complex network of drivers and impacts derived from Bassari responses revealed the difficulty of disentangling climate change from the web of material and inmaterial relations that shape people's interactions with their environment (Barnes et al., 2013). Comparably to other Indigenous and local communities (Boillat & Berkes, 2013; García-del-Amo et al. 2023; Peloquin & Berkes, 2009), the Bassari did not see climate change as an isolated phenomenon. Atmospheric changes were inextricably linked to other environmental, social, spiritual, and politico-economic changes that are transforming their life. Interestingly, this blurs the conceptual distinction between climate change impacts and impacts from other socio-economic and environmental drivers, implying that viewing atmospheric changes solely through a climate change lens marginalises and obscures other changes with more immediate significance for people (Nyantakyi-frimpong & Bezner-Kerr, 2015; Ribot, 2014). Accordingly, current scientific research also underscores the importance of shifting away from disciplinary approaches to climate change research and acknowledges the importance of synergies and trade-offs between climate, environmental, and other underlying socio-economic and cultural changes (Arneth et al., 2020; IPCC & IPBES, 2020).

From a practical perspective, these findings highlight the importance of shifting our focus away from conceptualizing climate change as a biophysical problem that can be tackled in isolation. Understanding ‘climatic’ drivers as distinct from ‘biological’, ‘physical’, and ‘socio-economic’ drivers leads to the development of climate-change policies that are disconnected from broader trajectories of socio-environmental change, preventing holistic action.

Regarding the local mechanisms of causality and role of immaterial / spiritual entities in Bassari explanations of change, Bassari rationales for the causes of local environmental changes combined a mix of material – i.e., changes in elements of the atmospheric, physical, biological, and socio-economic systems – and immaterial causes – i.e., super-natural forces and changes in the value system. Similar elements and mechanisms of causality can be found in traditional Tibetan (Byg, 2009; Huber & Pedersen, 1997), Amazonian (Reyes-García et al., 2023c; Rosengren, 2018), and Andean communities (Boillat & Berkes, 2013; Scoville-Simonds, 2018), with interpretations of weather/climate change where local people also experience, know, and understand many of the complex environmental changes through super-natural forces and spiritual entities. Importantly, in most cases, material and immaterial explanations were linked to local human behaviour, either through direct environmental impacts (e.g., overhunting, deforestation) or indirectly, by influencing super-natural forces (e.g., angering them).

In this regard, Bassari’s holistic perspective provides an alternative view of climate change, focusing on the complex synergistic effects between drivers of change, moving beyond the understanding of single elements to the understanding of these elements through their interrelations. Additionally, incorporating perspectives from other knowledge systems necessitates the inclusion of a set of political questions concerning not only whose and what knowledge counts, but also “what worlds” are permitted to exist (Goldman et al., 2018). While most climate change research has focused on material aspects of adaptation, resilience, and vulnerability, our findings highlight the importance of immaterial aspects (such as values or super-natural forces) in the way Bassari understand and interpret change. This entails that values, beliefs, and symbolic representations of the world absent from Western science need to be taken seriously if we want to foster inter-epistemological and inter-ontological dialogue for a fairer climate knowledge.

4.3 Other framings, other responses: epistemological and ontological plurality for justice and change

Global framings of climate change privilege Western science, marginalizing other ways of knowing that are embedded in lived experiences and cultural memories (Bee et al., 2015; Hulme, 2010; MacGregor, 2009). Climate change assessments reproduce power dynamics that stem from colonial histories and their continuity in current capitalist relations (Corbera et al., 2016; Hulme & Mahony, 2010; MacGregor, 2009). The consideration of 'climate change' as a discernible and abstract problem that stems from greenhouse gas emissions happens within a set of values and social relations that are embedded in the status quo of a global and patriarchal capitalist economy and is not free from political implications (Demeritt, 2001; Hulme, 2008, Nightingale et al., 2020).

By prioritizing certain voices in the generation of climate change knowledge, certain interests are prioritized in the design of adaptation and mitigation strategies. For example, the Western scientific construct of climate change has constrained the conception of solutions, leading to the prioritization of 'technical fixes' (e.g., carbon offsetting) that do not challenge the root causes of climate change (Nightingale et al., 2020). As argued by Hulme, instead of addressing why our society is designed around emission intensive production and consumption processes, the global construction of climate change as a physical problem "*readily allows climate change to be appropriated uncritically in support of an expanding range of ideologies… of green colonialism, of the commodification of Nature*" (Hulme, 2008, p. 9). Accordingly, feminist and decolonial scholars argue that efforts to promote climate change adaptation need to ask critical questions about how climate change knowledge is generated and by whom, directly addressing structural social inequalities and social and epistemological justice questions (Bee et al. 2015; Cameron, 2012; Todd, 2016). Such effort will be fruitless without a deep understanding of how climate change differently affects people on the ground – mediated by gender or other key intersectional dimensions of difference and inequality, whether ethnicity, race, poverty, indigeneity, or coloniality (Buechler & Hanson, 2015).

Contrastingly, when the knowledge systems and views from marginalized voices are acknowledged and inherent power inequalities rooted in histories of colonial extraction made explicit, very different research and policy priorities emerge, which can lead to more transformative solutions (Orlove et al. 2023). Our results highlight the complexity of social, ecological, economic, and cultural relations that mediate how local people experience, interpret, and enact change, contributing with empirical ground to the claims about needing to reframe the way we, as Western scientists, conceptualize and engage with ‘climate change’. Our research brings at the forefront people’s lived experiences – including emotional, spiritual, and moral dimensions –, pointing to the importance of considering climate change from a relational perspective. Understanding climate change within the broader trajectories of socio-environmental change will encourage acting systemically, beyond technical fixes.

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Figures

Figure 1: Location of the study area and illustrations of environmental changes reported by the Bassari. (A) Map of the study villages. (B) A spontaneous wildfire near a household. (C) A Bassari artisan transporting bamboo stripes for the construction of fences. Due to higher rates of resource extraction, the plant is becoming increasingly rare.

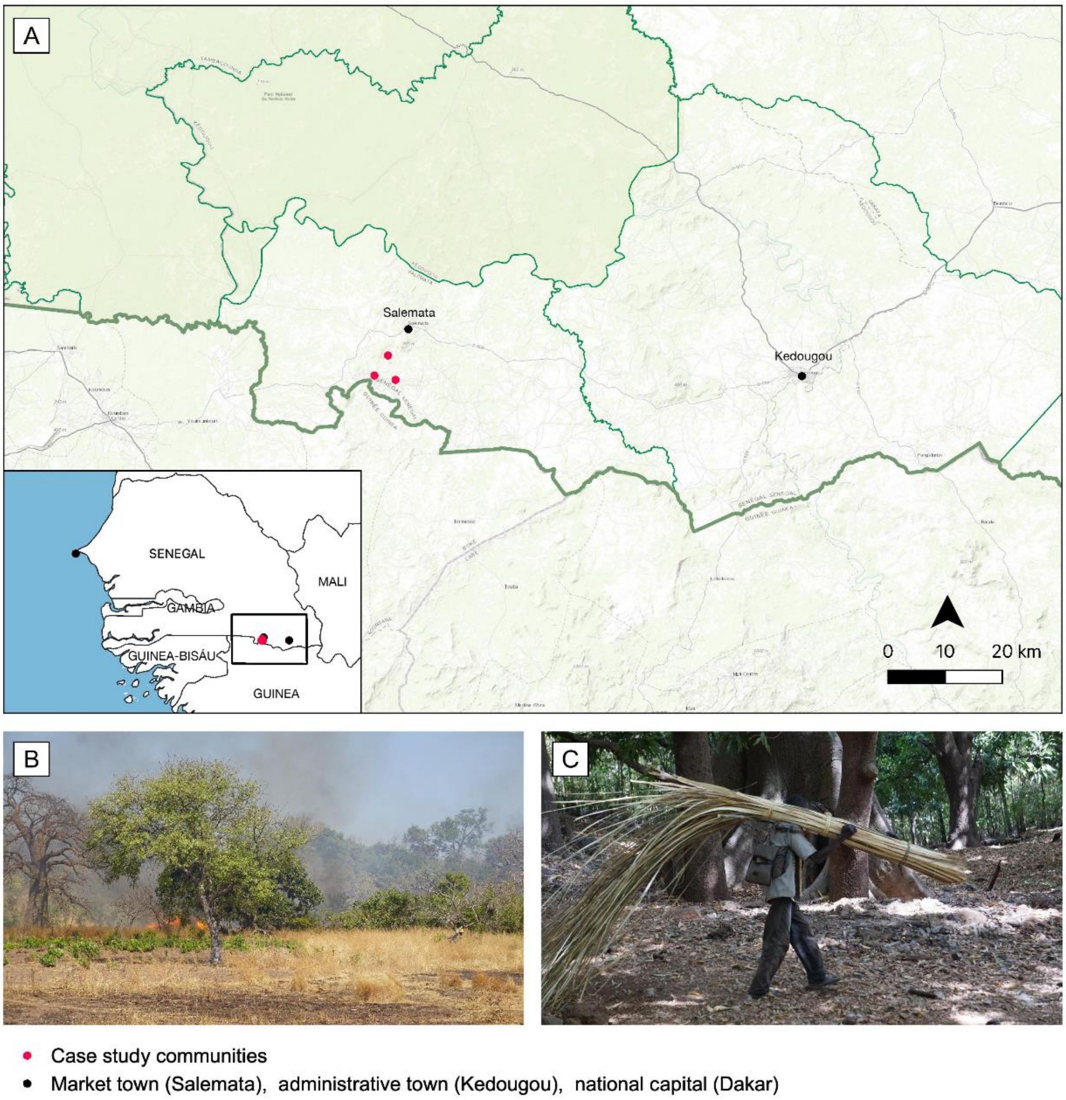


Figure 2: Socio-economic correlates to the local understanding of the scientific concept of ‘climate change’. (A) The first bar displays familiarity with the term ‘climate change’, and the second matching between people’s definitions and the scientific understandings of ‘climate change’. Pie charts (B) and (C) and violin plots (D) represent the distribution of individual socio-demographic characteristics within each subgroup.

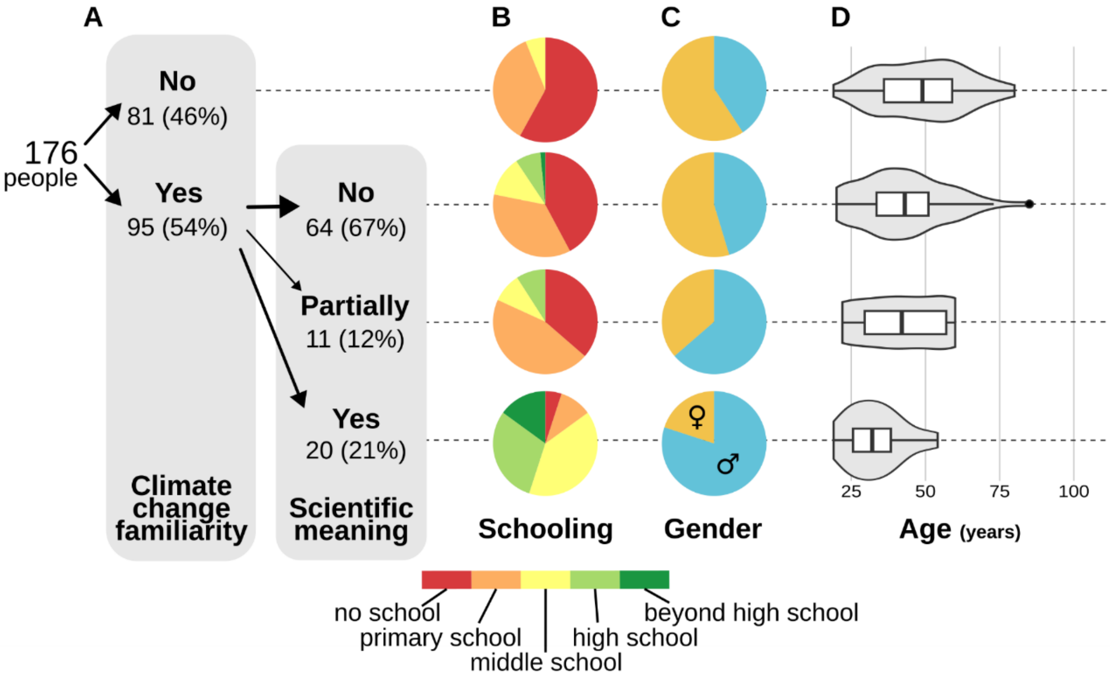


Figure 3: Sankey diagram showing the reported relation between atmospheric, physical, biological, socio-economic drivers and socio-environmental changes.

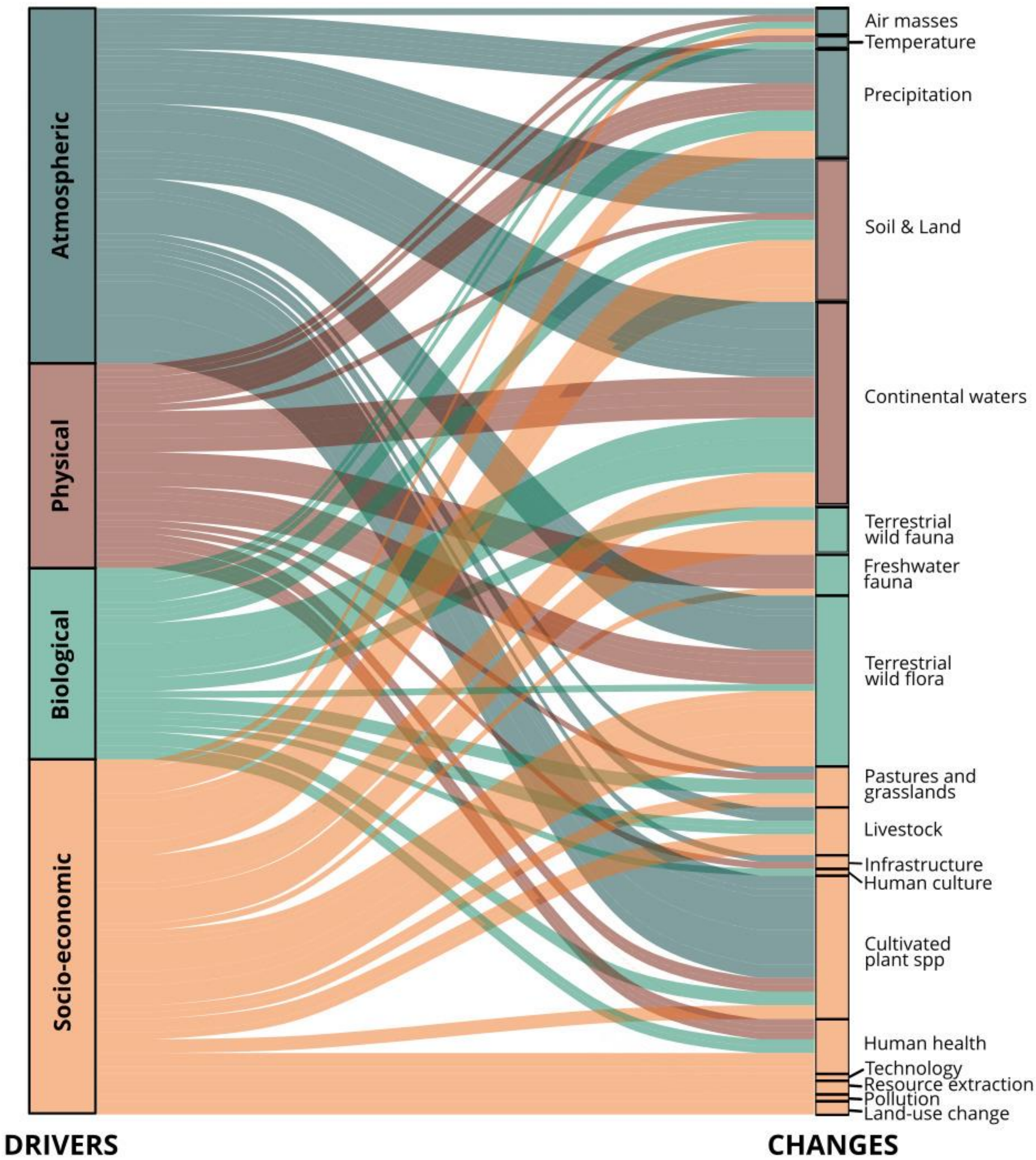
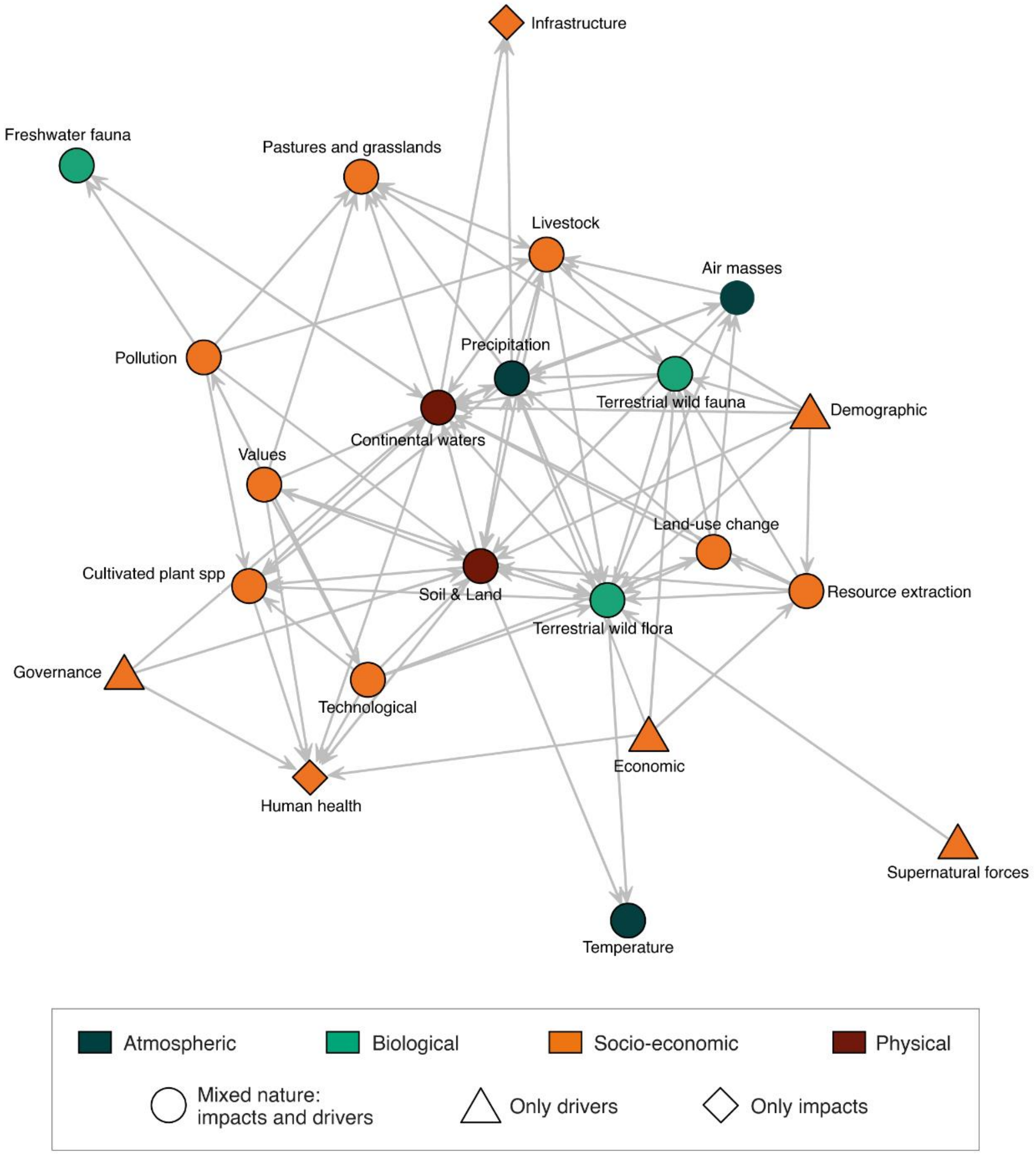


Figure 4: Network plot: representation of changes (drivers and impacts) collectively perceived by the Bassari.



Tables

Table 1: Summary descriptive statistics of the sample composition

Method	Sample size	Variable name	Descriptive statistics
Survey	176	Age	21 from 17-25 years (12 %) 58 from 26-40 years (33 %) 74 from 41-60 years (42 %) 23 from 61 to 100 years (13 %)
		Sex	48 % men 52 % women
		Level of schooling	79 no schooling (45 %) 59 primary school (34 %) 21 middle school (12 %) 13 high school (7 %) 4 beyond high school (2 %)
Semi-structured interview	47	Age	0 from 17-25 years (0 %) 10 from 26-40 years (21 %) 19 from 41-60 years (41 %) 18 from 61 to 100 years (38 %)
		Sex	72 % men 28 % women
Focus group discussions	69 (in 3 groups)	Age	4 from 17-25 years (6 %) 10 from 26-40 years (14 %) 39 from 41-60 years (57 %) 16 from 61 to 100 years (23 %)
		Sex	49 % men 51 % women

Table 2: Categorization of subsystems according to whether they are only impacts, mostly impacts, mostly drivers, or only drivers

Categorization	Subsystem	Ratio (Indegree/outdegree)	Outdegree	Indegree
Only impacts	Infrastructure	Inf	0	2
	Human health	Inf	0	10
Mostly impacts	Pastures and grass-lands	6.00	1	6
	Cultivated plant spp	5.00	4	20
	Freshwater fauna	3.00	2	6
	Terrestrial Wild Fauna	2.67	3	8
	Terrestrial Wild Flora	2.17	12	26
	Soil & Land	2.09	11	23
	Temperature	2.00	1	2
	Continental waters	1.92	13	25
	Livestock	1.20	5	6
Mostly drivers	Air masses	0.57	7	4
	Land-use change	0.50	6	3
	Precipitation	0.30	40	12
	Resource extraction	0.17	12	2
	Pollution	0.17	6	1
	Values	0.11	9	1
	Technological	0.11	9	1
Only drivers	Governance	0	3	0
	Demographic	0	8	0
	Economic	0	4	0
	Supernatural forces	0	2	0

Table 3: Ranking of indegree and outdegree values for each of the subsystems

Rank	Subsystems	
	Outdegree	**Indegree**
1	Precipitation	Terrestrial Wild Flora
2	Continental waters	Continental waters
3	Resource extraction	Soil & Land
4	Terrestrial Wild Flora	Cultivated plant spp
5	Soil & Land	Precipitation
6	Values	Human health
7	Technological	Terrestrial Wild Fauna
8	Demographic	Pastures and grasslands
9	Air masses	Livestock
10	Pollution	Freshwater fauna
11	Land-use change	Air masses
12	Livestock	Land-use change
13	Cultivated plant spp	Infrastructure
14	Economic	Resource extraction
15	Governance	Temperature
16	Terrestrial Wild Fauna	Values
17	Freshwater fauna	Technological
18	Supernatural forces	Pollution
19	Temperature	Governance
20	Pastures and grasslands	Demographic
21	Infrastructure	Economic
22	Human health	Supernatural forces

Supplementary material

Supplementary material 1: Classification and coding of the observations of environmental change and respective drivers reported by the Bassari in the semi-structured interviews with consensus in the focus group discussions. Numeric values correspond to the proportions of times a driver system was cited for a given change.

System / Subsystem	Changes	Drivers (in %)			
		Atmospheric	Physical	Biological	Socioeconomic
Atmospheric system					
Temperature	Changes in mean temperature (not further specified)	0	50	50	0
Precipitation	Changes in the amount of rainfall in a given season	0	16.6	33.3	50
	Changes in the length /duration of dry spells	0	0	0	100
	Changes in the predictability of rainfall	50	0	50	0
	Changes in fog thickness / density	50	50	0	0
	Changes in the frequency of fog or misty days	50	50	0	0
	Changes in the length / duration of fog	50	50	0	0
	Changes in air moisture / humidity	100	0	0	0
Air masses	Changes in wind strength or speed	0	0	50	50
	Changes in wind temperature	50	50	0	0
Physical system					
Continental waters	Changes in freshwater availability	0	22.2	44.4	33.3

	Changes in freshwater quality (not further specified)	0	100	0	0
	Changes in the phreatic level	100	0	0	0
	Changes in abundance of rivers or streams	33.3	0	33.3	33.3
	Changes in river / stream water flow, volume, level and/or depth	100	0	0	0
	Changes in the timing of seasonal fluctuation in river / stream / lake water level	20	0	60	20
	Changes in the number of natural freshwater springs	33.3	66.6	0	0
	Changes in the intensity of river / lake floods	100	0	0	0
	Changes in the speed of aquifer recharge	100	0	0	0
Soil & Land	Changes in soil fertility	33.3	0	0	66.6
	Changes in soil moisture / humidity	66.6	0	33.3	0
	Changes in soil temperature	0	50	50	0
	Changes in soil water infiltration	50	0	50	0
	Changes in rain-induced soil erosion and soil loss	50	0	0	50
	Changes in wind-induced soil erosion and soil loss	50	0	0	50
	Changes in wildfire frequency	20	0	0	80
Biological system					

Freshwater fauna	Changes in the abundance of freshwater animal species, excluding fish (mammals, birds, amphibians, reptiles, crustaceans, etc)	0	66.6	0	33.3
	Changes in the abundance of freshwater fish	0	100	0	0
Terrestrial Wild Fauna	Changes in the abundance of terrestrial fauna (mammals, birds, reptiles, insects, etc)	0	0	28.57	71.42
Terrestrial Wild Flora	Changes in the abundance or density of wild plant or fungi species	0	40	20	40
	Changes in the distribution of wild plant or fungi species	16.6	16.6	0	66.6
	Changes in the regeneration of wild plant species	0	50	0	50
	Changes in wild plant or fungi species mortality	66.6	0	0	33.3
	Change in the productivity of wild plant or fungi species (without further specification)	55.5	11.1	0	33.3
Socio-economic system					
Livestock	Changes in the frequency of livestock disease	25	0	25	50
	Changes in livestock behaviour	33.3	0	33.3	33.3
Cultivated plant spp.	Changes in crop maturation time	100	0	0	0

	Changes in crop mortality rates	83.3	66.6	0	0
	Changes in crop productivity / yield	62.5	12.5	25	0
	Changes in the frequency of crop ´pests´ (insects, birds, larvae, etc)	0	0	0	100
	Changes in the frequency of successful cropping seasons	100	0	0	0
	Changes in length of cropping ´season´ (not further specified)	100	0	0	0
Pastures and grasslands	Changes in pasture cover, surface or abundance	33.3	33.3	0	33.3
	Changes in the species composition of pastures	0	0	66.6	33.3
Human health	Changes in the frequency of conflicts over natural resources	0	33.3	33.3	33.3
	Changes in the incidence of human diseases (flu, allergies, etc)	0	33.3	0	66.6
	Change in the incidence of human waterborne diseases	0	100	0	0
	Changes in the shelf life of food products	0	0	100	0
Infrastructure	Changes in frequency of problems with transportation	33.3	33.3	0	0
Values	Changes in cultural-identity-spiritual values	0	0	100	0

Other drivers	Land-use change	0	0	0	100
	Pollution	0	0	0	100
	Resource extraction	0	0	0	100
	Technological	0	0	0	100