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# Impacts of drought and responses of rural populations in West Africa: a systematic review

Denis Gautier,<sup>1\*</sup> David Denis<sup>1,2</sup> and Bruno Locatelli<sup>1,3</sup>

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In West Africa, climate variations and droughts have always affected livelihoods but have also triggered adaptation strategies. A better understanding of the impacts of drought and the responses of West African populations is indispensable for researchers and decision makers in the current and future context of multiple socioeconomic and environmental changes, including climate change. We conducted a systematic review of the literature on drought in West Africa. In this paper, we highlight controversial issues and identify knowledge gaps. Although drought has been widely considered as a major problem in West Africa, there is a need to frame it within a set of multiple threats faced by local populations and to understand how droughts act as a trigger in economic, societal, and environmental contexts. The literature on responses to drought focuses on agricultural and individual responses, while diversification, migration, and tree-based or livestock-based responses are less frequently addressed. More research is needed on the effectiveness and on the unexpected effects of responses of populations, states, and NGOs, as well as on the interactions between different responses. To understand the complexity of impacts and responses, the context in which they occur and how individual and collective actions interact within households or communities needs to be taken into account. Ecosystems and agriculture offer many goods and services that are suitable for adaptation and the different landscape components should be analyzed together. Such historical, contextual, and integrated analyses would better inform new policies and projects for adaptation to climate change. © 2016 The Authors. *WIREs Climate Change* published by Wiley Periodicals, Inc.

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## INTRODUCTION

Populations in West Africa have long lived with a dry climate that varies from year to year as well as in the long term.<sup>1</sup> These variations have affected food security, as evidenced by famine in the 17th century<sup>2</sup> but have also triggered adaptation strategies, such as temporary or permanent migration.<sup>3</sup> However, as shown by the droughts in the 1970s and the 1980s, the efficiency of these adaptation strategies may be limited.<sup>4</sup> Since the early 1970s, international attention has focused on the impacts of drought on local populations in

the Sahel and on the risks of famine and malnutrition.<sup>5</sup> When droughts affect the region, the response of the international community is often rapid food aid but the long-term implications of such aid, that is, its effect on the capacity of rural people to cope without external aid, are overlooked.<sup>6</sup>

Farmers and herders in the Sahel have always faced unpredictable variations in seasonal rainfall and made decisions to cope with short-term climate variability.<sup>7</sup> Climate change adds an additional burden on communities: the last IPCC report describes the Sahel as a hotspot of climate change with temperatures expected to increase by between 3°C and 6°C by the end of the 21st century compared to those in the late 20th century, while changes in precipitation are uncertain.<sup>8</sup> Gradual changes in practices by communities have been observed, and these may be part of a process of adaptation to longer term changes, whether climatic or not.<sup>9</sup> Other arid regions already face similar issues or may face them in the future, making the experience gathered in the Sahel valuable in a wider context of climate change.<sup>10</sup>

Sustainable ecosystem management and the capacity of farmers and herders to adapt to climate variations needs to be supported by sound policies.<sup>10</sup> Local rural development projects have been implemented by NGOs and national extension services, and regional cooperation agencies have been created to respond to drought urgency and to reduce the vulnerability of local populations in the long term. At regional level, the Permanent Interstates Committee for Drought Control in the Sahel French acronym CILSS was founded in 1973 and includes AGRHYMET, an institute specialized in meteorological and hydrological monitoring in relation with food security. This monitoring effort, while useful for reactive actions, still need to be better incorporated into regional development and environmental initiatives.<sup>11</sup>

One regional initiative is a mega project called the 'Great Green wall,' whose aim is to fight Sahel desertification with a forest corridor. This idea was born in the 1950s (with local implementations in Niger, Algeria, and Mauritania) and reemerged in 2002 during an African Unity summit. This regional initiative is being transformed into national programs for rural development, which may improve the capacity of local communities to cope with desertification and droughts. At the same time, West African countries are developing national adaptation plans such as the NAPAs and the NAPs under the UN framework convention on climate change, which have led to the design of adaptation projects on the ground. Converting regional and national policies into local projects

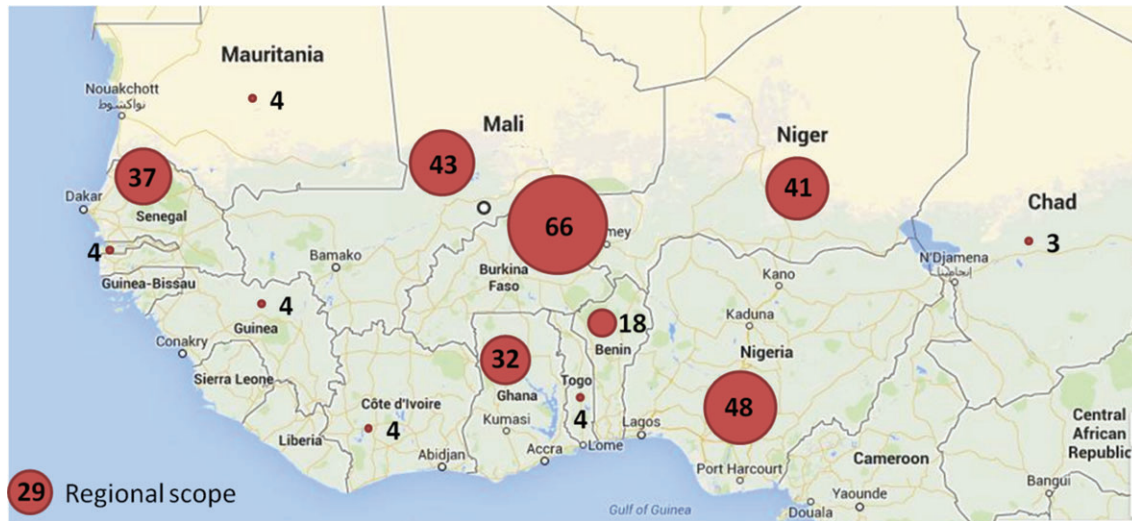
requires adjustment to local contexts: failure to take local practices and knowledge into account may increase the vulnerability of local populations.<sup>12</sup>

Decision makers need a better understanding of the impacts of droughts and of the responses of populations in West Africa in the current and future context of multiple socioeconomic and environmental changes, including climate change.<sup>13</sup> At a time when many adaptation initiatives are being developed in West Africa, existing knowledge on the impacts of drought on socio-ecological systems in the region needs to be evaluated to understand how populations cope with or adapt to drought, and to identify the factors that can influence their vulnerability, including barriers to adaptation.<sup>14</sup> This paper responds to this need in the form of a systematic review and summary of published research on drought in West Africa.

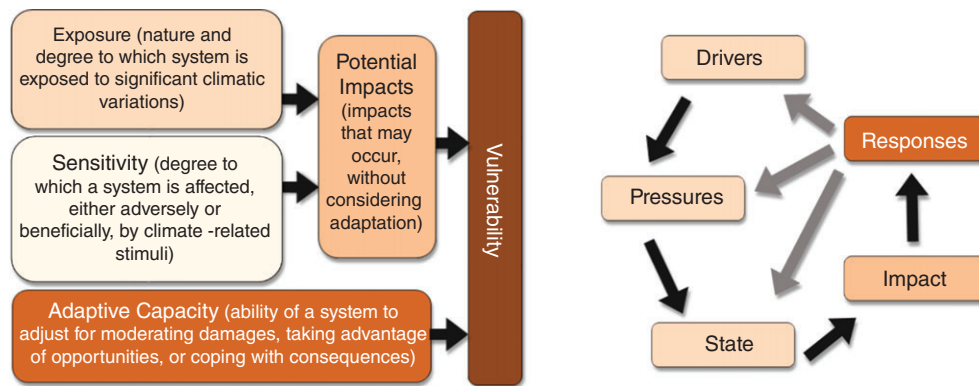
## REVIEW APPROACH AND CONCEPTUAL FRAMEWORK

We reviewed published literature on the impacts of drought and the responses of populations in West Africa through a systematic search of international databases referencing mostly peer-reviewed papers. The review considers three types of drought<sup>15</sup>: meteorological drought (months or years with below normal precipitation), agricultural drought (periods when dry soils lead to crop losses), and hydrological drought (periods with low flow and low levels in water bodies). For our systematic review, the search took the following form (see Appendix S1, Supporting Information, for details): we used 'geographical keywords' (groups of names of regions and countries combined with OR) AND 'exposure keywords' (such as drought, water scarcity, or climate variability) AND ['impact keywords' (such as food security or famine) OR 'response keywords' (such as adaptation, response)]. Ten databases were searched, most were in English but some also in French (with translated keywords): Web of Knowledge, Scopus, Science Direct, Wiley, CAB Abstract, Econlit, Agricola, Agris, Francis, and Pascal. More than 3000 articles were found, among which 241 were selected as they matched the focus of the review. The analyzed papers presented information from 13 countries, mainly from Burkina Faso, Nigeria, Niger, Mali, Senegal, and Ghana (Figure 1).

Two conceptual frameworks were used for analyzing the papers (Figure 2). First, following the IPCC,<sup>16</sup> we defined vulnerability to drought as 'the degree to which a system is susceptible to, or unable to cope with, adverse effects of droughts' and we considered that vulnerability was a function of



**FIGURE 1** | Geographical distribution of the research sites of the reviewed papers (the number of papers reviewed per country are shown inside or next to the red circles).



**FIGURE 2** | The two conceptual frameworks used in this review (left: IPCC vulnerability framework<sup>16</sup>; right: DPSIR framework<sup>17</sup>) and the definition of vulnerability components.

exposure, sensitivity, and adaptive capacity (see definitions in Figure 2). Second, as many papers used frameworks that differed from IPCC's, we considered the more generic DPSIR framework (Drivers, Pressures, State, Impact, and Responses) to classify papers that did not include concepts of vulnerability and adaptive capacity but focused on observations of exposure (P in the DPSIR framework), impacts (I) and responses (R). Our simple conceptual framework thus combined the IPCC concepts with part of the DPSIR sequence (Figure 3).

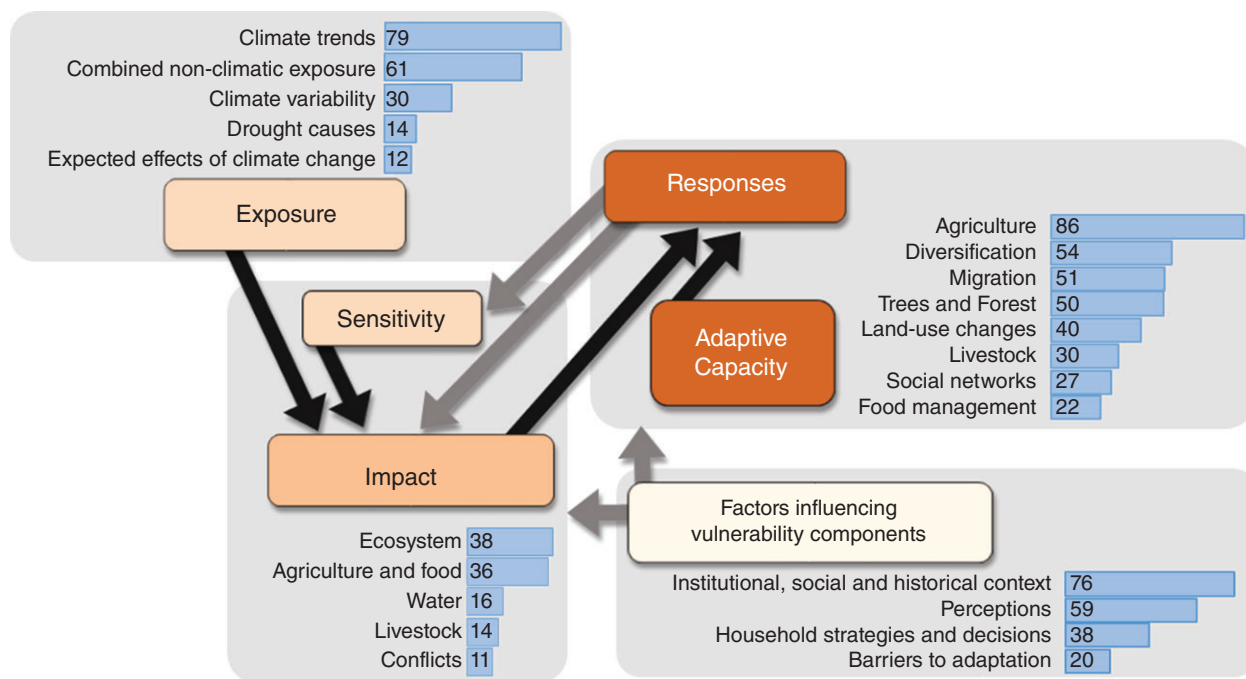
By reading the full texts of all papers, we identified the topics covered by each paper and organized them in four groups, which correspond to the four following sections: (1) Exposure to drought events (sometimes combined with other types of exposure), (2) Impacts of drought (and sensitivity of different sectors to drought), (3) Responses to drought (including

elements of adaptive capacity in some papers), and (4) Factors influencing vulnerability components. We found some overlaps between subgroups of topics: for example perceptions or social context can be barriers to adaptation, but we chose to create a specific topic on barriers to adaptation because of the frequent use of this term in the literature. A detailed list of all the impacts and responses cited in the literature can be found in Appendix S1, Supporting Information.

## EXPOSURE TO DROUGHT

### The Increase in Rainfall since the Dry 1970s and 1980s is Subject to Debate

Rainfall in the whole region was particularly low in the 1960s, 1970s, and 1980s,<sup>18</sup> although the causes of this phenomenon are still the subject of debate, for



**FIGURE 3** | Simple conceptual framework for classifying the topics covered in the reviewed papers and the frequency of the topics in the reviewed papers (the numbers indicate how many papers treated a given topic, the lengths of the bars are proportional to these numbers).

example, rainfall forcing due to changes in sea surface temperature versus the effect of changes in land use caused by human activities in West Africa.<sup>1,19</sup> An increase in total annual rainfall has often been reported since the late 1980s and early 1990s, for example in Burkina Faso,<sup>18</sup> but this trend is not observed everywhere in the region, for example in Niger.<sup>20</sup> Given the high level of spatial variation in rainfall, it is possible that trends may be upward in one area and downward in another, in addition to the bias created by the sparse and irregular network of meteorological stations, which leads to nonsignificant results.<sup>21</sup> While some papers focus on long-term annual rainfall trends, others have shown that people are in fact more affected by much shorter term climate variations including short periods of drought at crucial periods in the agricultural calendar.<sup>22,23</sup>

### Drought Is One Type of Exposure, but It Interacts with Other Types

The literature reports that populations face several different types of exposure, natural (e.g., crops attacked by insect pests), social (e.g., conflicts), economic (e.g., rising prices of inputs) (see Appendix S1, Supporting Information). The harm to a population caused by a climatic event will vary depending on other types of exposure. Drought can act as a trigger for a community already facing other types of

exposure, be they economic, societal, or environmental.<sup>13</sup> For example, in the Afram plains in Ghana, drought events are said to have a considerable impact on farming communities because the farms are small (due to population pressure and land policies), limited access to agricultural inputs (because of financial insecurity, and to the end of subsidies due to structural adjustment programs), and environmental degradation (deforestation to produce charcoal and bushfires) associated with declining fertility.<sup>24</sup> As many West African societies have long adapted to drought, they may only be affected by exceptional drought events (their spatial extent, duration or intensity) or when other changes affect their ability to face drought.<sup>11,25</sup> As a result, although famine is often considered to be a direct result of a drought—with no other type of exposure taken into consideration—it has been demonstrated in Côte d'Ivoire, Nigeria, and Senegal that it is above all a social construct in which power inequalities modify the impact of drought on people.<sup>26</sup>

## IMPACTS OF DROUGHT

### The Impacts of Drought Are Often Studied In Ecosystems

Droughts have an impact on ecosystems. For example, remote sensing has shown that the annual

rainfall amount is positively correlated with the production of aboveground phytomass<sup>27</sup> even though human activities and grazing pressure have been shown to play important roles in the degradation of the plant cover.<sup>28</sup> Species richness decreased in the second half of the 20th century<sup>19</sup> and both tree density and the plant cover decreased significantly during the droughts in the 1970s and 1980s,<sup>19,29</sup> but nonclimatic factors (such as changes in land use due to human activities) could also explain these trends.<sup>30</sup> Although there is a consensus on the negative consequences of drought for the regeneration of tree species,<sup>31</sup> the general impacts of drought on the forest as a whole are still controversial.<sup>29</sup> Bush fires are generally said to be one negative consequence of drought,<sup>31</sup> like in Ghana, where a large proportion of forests and agroforests (mainly cocoa plantations) were destroyed between 1982 and 1984.<sup>32</sup> Droughts also have an impact on non-timber forest products,<sup>31</sup> the composition of rangeland grass<sup>33,34</sup> and on productivity,<sup>35</sup> but combined with other factors, such as human activities through grazing pressure, as demonstrated in northern Senegal.<sup>27</sup> Droughts can also trigger a complete ecosystem shift, for example, the drying of Lake Faguibine in Mali.<sup>36</sup>

Droughts are responsible for a reduction in available water and for degradation of water quality, resulting in health problems, such as bilharzia or diarrhea in Ghana,<sup>37</sup> or limiting some activities such as herding, beer brewing, and dry season cultivation, or fishing.<sup>24</sup> In some countries, including Ghana, droughts can also cause electric power shortages by limiting available water in hydroelectric dams.<sup>38</sup>

Droughts have an impact on rangeland production and on the water needed to water animals and thus, indirectly, on livestock<sup>37</sup> and milk production.<sup>39</sup> Drought can reduce the size of herds through animal mortality,<sup>40,41</sup> or because herders have to sell their animals to cope with the consequences of the drought.<sup>4,41</sup> This has happened to a large extent in major droughts, for example in 1983–1984 when 75% of the herds in the Sahel died or were sold.<sup>42</sup> When animals are weakened by a drought, they are also more sensitive to the epizootic diseases that occur during subsequent wet periods.<sup>43</sup>

Droughts can also exacerbate conflicts over scarce resources, particularly water. Drought-induced changes in natural resources can create conflicts concerning access, for example the drying of lake Chad resulted in tension over the newly emerged lands.<sup>44</sup> In addition to conflicts about tenure or resource management that oppose communities and even states, most conflicts occur within

one community or between communities and are more frequent during drought years.<sup>45</sup> Poor or marginalized groups are more prone to using violence when faced with difficult climatic situations because of a lack of opportunity and also a feeling of injustice,<sup>46</sup> as demonstrated by a meta-analysis (of the whole continent of Africa).<sup>45</sup> The links between droughts and conflicts are the subject of debate: for example, conflicts can be explained by structural factors (e.g., agricultural encroachment on pastoral lands and political corruption),<sup>47</sup> which are the same factors that affect people already vulnerable to droughts.<sup>48,49</sup>

### The Impacts of Drought on Agriculture and Food Are Also Widely Studied

The impacts of drought on agriculture and food are the second most quantitatively and thoroughly studied, after the impacts of drought on ecosystems (Figure 2). Crop failure due to drought has been widely reported in West Africa, particularly in the 1970s and 1980s.<sup>19,39</sup> In 1983 and 1984, the whole Sahel was affected by a rainfall deficit that reached 80% of mean annual values in Nigeria,<sup>50</sup> leading to failed food production.<sup>4,51</sup> However, low production is not always due to an abnormal annual amount of rainfall but sometimes to intraseasonal climate variability, as reported in northern Nigeria in the 1979–1983 period.<sup>50</sup> Droughts do not only reduce yield but also the quality of the grain and hence the sales price, as pointed out by Nigerian farmers.<sup>37</sup>

The consequences of production losses include rises in food prices,<sup>4,52</sup> food scarcity, and reduction in food consumption, with consequences on human health (including diseases and mortality, childhood malnutrition affecting child growth and brain development).<sup>19,53</sup> Tens of thousands of people died<sup>54</sup> and massive migrations took place during the 1983–1984 drought in the Sahel.<sup>42,55</sup>

The link between droughts and famine is not a simple cause-effect relationship and consequently needs to be carefully analyzed. The 2005 famine in Niger revealed the complexity of the political, social, and economic processes that exacerbated the effect of drought on the famine, for example because of unexpected effects of external assistance and the opportunistic behavior of local businesses.<sup>56</sup> Although droughts may be a trigger, famines usually have well-documented political and socioeconomic roots,<sup>57</sup> for example in northern Nigeria after the droughts in the 1970s.<sup>26,58</sup>

## RESPONSES OF POPULATIONS FACED WITH DROUGHT

### Agricultural Responses Are By Far the Most Frequently Reported

The most frequently reported agricultural responses are changes in cropping systems and patterns,<sup>37</sup> crop diversification or changes in crops and varieties,<sup>59</sup> exchange and selection of seeds,<sup>60</sup> changes in sowing dates or in the agricultural calendar,<sup>61</sup> changes in the location of fields,<sup>23</sup> the adoption of water saving and soil conservation techniques (stone bunds or 'no tillage' for example),<sup>62</sup> and finally agricultural intensification.<sup>59</sup> Because most Sahelian States have neglected rainfed agriculture since the 1970s, most agricultural strategies to cope with droughts have been developed by farmers themselves, with the support of NGOs and, in some cases, of extension services.<sup>63</sup> Most changes in agricultural practices that reduce vulnerability to drought are actually driven by nonclimatic factors. For example, practices for enhancing productivity and diversification strategies are often explained by population growth, land scarcity, and new market opportunities rather than climate variability, as demonstrated in Northern Burkina Faso.<sup>64</sup> Labor shortage in agriculture caused by income diversification and outmigration strategies can be a barrier to the implementation of agricultural responses and may lead to the total or partial abandonment of agricultural fields.<sup>65</sup>

### Diversification Is One of the Main Adaptation Strategies to Climate Variability

Diversification is frequently studied as a livelihood strategy and less frequently as a way to adapt to climate variations. Nonetheless it has been argued that it is a major adaptation strategy<sup>59</sup> and can take three forms: permanent diversification (e.g., associating farming and herding), seasonal diversification (e.g., gold mining or wood gathering during the dry season), and 'crisis' diversification (for example selling wood, livestock, or shea nuts to compensate for a bad harvest). Permanent or seasonal diversification can be considered as an anticipatory adaptive strategy, whereas crisis diversification is a reactive coping strategy.

The most frequently reported diversification strategy is mixed farming, which is, associating livestock herding and cropping. While herding and cropping have long been two complementary activities,

exerted by different social groups,<sup>66</sup> today they are being combined to such an extent that some farmers now own more animals than herders<sup>3</sup> and in some areas, even the distinction between herders and farmers is no longer applicable.<sup>55</sup> In addition to the multiple roles played by livestock in society (as capital or savings, as a source of income to buy cereals, etc.),<sup>3</sup> associating livestock with cropping reduces the vulnerability of the production system because livestock and crops are not sensitive to climate variations in the same way.<sup>67</sup>

There are many other ways of diversifying (see Appendix S1, Supporting Information), including trade, crafts, and artisanal works, irrigated cultivation of vegetables, processing food or beverages, selling forest products or natural products (wood, charcoal, NTFP, wild animals and fish), etc. Many diversification options affect adaptation to climate change because in rural households, nonfarm income accounts for a large share of total income<sup>68</sup> in times of drought, as observed in Burkina Faso during the 1983–1984 drought.<sup>69</sup> It has also been shown that people living in the drier parts of Burkina Faso have more diversified livelihoods,<sup>39</sup> and that the diversification process was stimulated by the droughts in the 1970s and 1980s.<sup>70</sup>

There was a debate in the 1990s about whether or not Sahelian people practiced sequential diversification. Sequential steps in diversification were described as economic diversification within the farming system, animal ownership, off-farm income sources, and finally migration and remittances.<sup>3</sup> Conversely, diversification was described as an intentional mix (also called 'bricolage') of agriculture, livestock, migration, and trade.<sup>71</sup>

### Seasonal and Permanent Migration as a Response to Drought and As an Effect of It

Herders' mobility (over short distances or for transhumance) is a 'prime strategy in Sahelian countries'<sup>72</sup> to access and manage resources; and labor migration (as far as coastal cities) makes it possible for farmers to work when the cultivation season is over.<sup>54,72</sup> Migration is thus an important routine strategy but also a way to cope with drought, for example, during the 1973 drought when outmigration reached 40% in some villages in Burkina Faso.<sup>73</sup> In times of drought, migration is conceptualized both as an effect and as a response<sup>23</sup> because beyond the positive effects of migration, for example, reduced consumption<sup>74</sup> and remittances,<sup>59</sup> household production capacity is reduced due to the loss of its labor force<sup>74</sup>

and loss of human capital if educated people leave.<sup>74</sup> Poorer households are more affected by these negative consequences and migration is often chosen as a last resort.<sup>73</sup> Despite the very high number of environmental migrants in West Africa, droughts were cited as the direct cause of migration by only 4% of migrants.<sup>73</sup>

### Forest and Tree Resources: Important Assets for Coping with Drought

Different parts of trees can be consumed, processed or sold, routinely, or only when the harvest is not sufficient<sup>3</sup> particularly during droughts<sup>75</sup>: wood, fruits, seeds, flowers, or leaves,<sup>76,77</sup> but also other resources such as grasses<sup>33</sup> and wild yams, which grow in the forest and are an important source of calories and nutrients, especially for children.<sup>78</sup> Data on the importance of forest products for nutrition vary from 4% of caloric intake in a drought year in northern Burkina Faso<sup>39</sup> to 21% of the diet.<sup>79</sup> Methodological issues may explain this notable difference. Some groups may be reluctant to answer questions about the food they eat during a famine because eating it is often perceived as degrading and it may be a signal of extreme distress.<sup>75,78</sup> In addition to human consumption, herders often make intensive use of the leaves of trees as animal fodder.<sup>66,80</sup> Wood or charcoal can also be sold in response to a drought that affects crop yields and which helps people to obtain the cash they need to buy some cereals for their own consumption. A 'desperation strategy' can lead to illegal cutting of trees.<sup>81</sup>

As community woodlots,<sup>82</sup> trees in degraded areas,<sup>83</sup> or agroforestry<sup>32</sup> provide important resources for coping with dramatic climate events, their management can be part of anticipatory adaptation strategies to climate change. For example, assisted natural regeneration in the form of regreening using coppicing of drought-resistant species in the Maradi region of Niger is generally presented as a success story.<sup>77</sup> The success of this adaptation initiative has been mostly in the hands of rural communities but this is rarely the case in a region where many reforestation programs depend on external assistance and funds<sup>77,83</sup> and fail when NGOs leave the project because local people have not been sufficiently involved or lack the motivation or the means to continue the activity.<sup>31</sup> Actually, the increasing urban demand for food and energy, as well as the global demand for agricultural lands may threaten the ability of these forest-based adaptive strategies to face drought.

### Important, But Overlooked, the Role of Social Networks in Response to Climate Variations

Transactions such as gifts and transfers, loans of money or food, or exchange of labor are almost never mentioned as responses to drought even though social solidarity is an important pillar of community adaptive capacity. Women's organizations that provide access to credit,<sup>84</sup> increase negotiation power,<sup>59</sup> or enable the installation of an irrigation scheme<sup>85</sup> show that women have become more autonomous thanks to their willingness to create social organizations. Such organizations are also a way to cope with dry spells and to diversify production. For example, Farmers' groups and the exchange of labor make it possible to introduce water and soil conservation techniques.<sup>61</sup> Nevertheless, the organizational level is often reported to be low. Farmers generally invest limited time and effort in this kind of community-level activity and families remain the nexus of livelihood decisions and negotiations on labor allocation, among other subjects. However there are notable exceptions, particularly in contexts of major environmental challenges like in the central Plateau of Burkina Faso and parts of south-western Niger where the large amount of labor required to restore highly degraded soils led farmers to organize themselves in associations and use large-scale strategies for adaptation.<sup>86</sup> In these sites, the existence of farmer associations is reported to be the main driver of land restoration and protection with stone bunds.<sup>87</sup> These associations often rely on support provided by soil and water conservation projects, particularly for transporting stones.<sup>88</sup>

Social relations as responses to drought can also have negative effects on people. For example, the poorest people may remain vulnerable because of their inability to reciprocate, making wealthier households reluctant to help them.<sup>84</sup> They may then fall into a poverty trap if they have to borrow money from money lenders by pawning or mortgaging their land or production,<sup>89</sup> especially if the following harvest is bad. The influence of climatic events on social relations and power relations remains largely uninvestigated. The context may play a determining role in the evolution of social relations toward the abandonment of social obligations in times of need<sup>4,43</sup> or, on the contrary, the continuance of social networks even in times of drought.<sup>75</sup>

### Purchasing and Storing Food Are Emergency Responses to Drought

The purchase and storage of food is rarely described as a response to drought despite the fact it is one of



the most common ways to cope with food shortages, as demonstrated during the 1983–1984 drought in Burkina Faso.<sup>69</sup> As households generally have no savings,<sup>75</sup> they have to sell their assets, mainly livestock, if available.<sup>43,52</sup> If the situation worsens and the household has no animals to sell, family members are obliged to migrate, find wage labor, or sell other assets<sup>4,69</sup> which, in the case of productive assets, may jeopardize the following harvest.

When the food reserve is expected to be insufficient, notably after a drought year, households reduce their consumption of their stores of grain by having family members migrate, preparing common meals, reducing the size of each meal, or reducing the number of meals per day.<sup>75</sup> A household may choose to reduce food intake rather than sell assets, because of the risk of jeopardizing their future activities by selling some essential production assets<sup>89</sup>—or because of a preference for saving, lack of cash or other urgent need, or overestimating the length of the crisis.<sup>90</sup> These choices may have long-term consequences such as delayed child development or irreversible damage to children<sup>89</sup> and a reduced labor force the following year.<sup>75</sup>

Price dynamics weaken the food purchasing power of farmers. In bad harvest years—due to drought, for example, the price of grain rapidly goes up while the price of livestock drops<sup>67</sup> to such an extent that poor households are rapidly unable to buy grain, or are obliged to purchase small amounts at a high cost.<sup>75</sup> When the harvest is good, the price of grain goes down, thereby limiting the capacity of households to repay any loans or credits contracted during a past drought year,<sup>4</sup> and people are forced to sell their grain at a low price because of their immediate need for cash or limited harvest storage capacity.<sup>91</sup>

## CONTEXTUAL FACTORS INFLUENCE THE IMPACTS OF DROUGHTS AND PEOPLE'S CAPACITY TO RESPOND

### Adaptation Practices Were Shaped by Colonial and Postcolonial Regimes and Policies

The colonial period had a major impact on West African societies, resulting (among other effects) in the promotion of a more intensive agriculture focused on cash crops<sup>3</sup> and migration for wage labor in southern countries.<sup>54</sup> A controversial theory suggests that it has created a climate of competition and

destroyed the moral economy and the solidarity that existed in villages previously,<sup>66,92</sup> thereby reducing their adaptive capacity. The marginalization of herders and of nomad livelihoods is thought by some to have started at this time.<sup>93</sup>

After obtaining their independence in the 1960s and 1970s, most West African countries were socialist and the agricultural sector was strongly supported by governments.<sup>62</sup> The structural adjustment programs introduced in the 1980s and 1990s had many consequences for rural livelihoods. Subsidies for the purchase of farm inputs or investment programs to support agriculture and agricultural development were drastically reduced. Other consequences were the privatization of state companies, the end of price controls, and the removal of trade barriers.<sup>70,94</sup> These measures harmed small producers.<sup>67</sup> Market competition resulting from subsidized agriculture in developed countries and in Asia became a threat for African producers<sup>59</sup> and integration in world food markets has made farmers vulnerable to global price fluctuations,<sup>62</sup> while simultaneously creating pressure to privatize land.<sup>11,47</sup> West African countries started to be more vulnerable to food crises even in years when the harvest was good because of fluctuations in the price of food.<sup>95</sup>

By their effects on communities, agricultural practices, and market functioning, these historical legacies have shaped the exposure and sensitivity of rural communities to droughts and other threats, as well as their capacity to react. While there is little documented evidence, the example of Cameroon is instructive: yields were less affected by drought when there was government support for agriculture than after the structural adjustment programs.<sup>94</sup>

### Current Threats and Opportunities in Product, Job, and Land Markets

The role of markets in improving farmers' adaptive capacity is the subject of controversy.<sup>9</sup> On one hand, integration in markets exposes farmers to market variations and shocks, which create an additional source of vulnerability. On the one hand, market integration can be an advantage if it mitigates the rise in food prices in times of drought or local crises<sup>4</sup> and enables access to markets where the demand is higher in hard times—for instance, the increased demand for meat in Nigeria, which allowed herders in Niger to sell their cattle at a decent price during a crisis in Niger.<sup>66</sup>

Urbanization can present an opportunity for rural populations to diversify their activities and sources of income, particularly during the dry season

(woodcutting, market gardening, jobs in the city, etc.), even if the sustainability of these activities remains questionable.<sup>96,97</sup> Land grabbing is a threat posed by both the international and the domestic land market that can exacerbate the vulnerability of local communities. In most parts of the Sahel, which are almost entirely highly dominated by small-scale family farming and where the social and political cost of expropriation can be very high, land acquisitions by foreign investors represent just a small part of land grabbing. Most land grabbing is by national urban elites who generally have no professional competence in agriculture.<sup>98</sup> Although the average size of the plots acquired by these investors is small (usually less than 80 hectares), the cumulative effect may be significant, particularly in the periphery of major cities.<sup>99</sup>

### Decentralization Processes Shape People's Capacity to Respond

Local natural resources management has been impacted by the decentralization processes that have been the centerpieces of many policy reforms in West Africa since the 1990s, although decentralization is by no means new in Africa.<sup>100</sup> The most recent waves of decentralization have been presented as a way to secure local rights and improve local adaptation, but in practice, decentralization reforms have rarely been carried through completely and there has been no full transfer of authority over natural resources to local authorities. For these reasons, decentralization has not really enhanced local resources management but has increased the marginalization of both herders<sup>101</sup> and women.<sup>102</sup> Decentralization processes have led to the multiplication of local institutional mandates and the weakening of traditional authority, which started during the colonial era and continued after independence.<sup>100</sup>

Power relations within the communities and the way natural resources are managed were affected by the incomplete decentralization processes, as was people's capacity to respond to drought. The multiplication of institutions has resulted in confusion and left room for free-rider behavior, even though local institutions limit the direct influence of governments in whom people have little confidence.<sup>92</sup> In this context, customary norms and rules remain a guarantee of access to resources for all, including land, which were generally gifted or lent in traditional tenure regimes but are now increasingly being purchased or rented, as witnessed in northern Ghana<sup>59</sup> and in Niger.<sup>103</sup>

### The Influence of External Interventions on Local Responses Is the Subject of Debate

Adaptation programs designed by the state or by NGOs that target populations do not always match the local population's priorities<sup>104</sup> and can reduce their adaptive capacities. For example, many West African states promoted irrigation to improve food security and increase food production but many irrigation programs appear to have been badly designed and today more than 30% of systems are degraded, resulting in land salinization,<sup>105</sup> and in difficulties for their neighbors.<sup>24</sup>

Large-scale adaptation programs, for example the National Adaptation Programmes of Action (NAPAs), are being developed, but are often based on a simplistic discourse about environmental degradation,<sup>104</sup> have a short-term focus,<sup>106</sup> are disconnected from other policies,<sup>106</sup> or propose measures that are inappropriate.<sup>23,104</sup> Large-scale programs and emblematic measures, such as the Green Belt, are criticized for focusing on very visible actions, which are generally not innovative, and for not taking local priorities and the needs of the local population into account.<sup>104</sup>

In addition to the adaptation measures proposed by states or NGOs, the international community has put forward ideas on how to cope with droughts. One example was food aid during the droughts in the 1970s and 1980s, which effectively limited mortality in rural populations.<sup>4,64</sup> However, despite its immediate benefits, food aid was criticized for unequal distribution of food,<sup>6</sup> for creating new social inequities,<sup>67</sup> for corruption and misallocation<sup>3,40</sup> as well as for being responsible for the destabilization of the local economy and existing food-aid system.<sup>6,67</sup>

How external interventions affect local responses is the subject of debate. Some projects only benefit a small proportion of the population and increase existing inequality,<sup>38,61</sup> while others improve equity (including gender equity) and sometimes reduce the workloads of the most vulnerable people.<sup>107</sup> External interventions not only affect rural populations but also shape their perceptions: too many actions may encourage people to rely on external aid and discourage them from becoming involved in spontaneous or organized local strategies. On the other hand, it has been shown that local people turn natural resource management projects to their own ends, and so reap social benefits from them.<sup>108,109</sup> Moreover, some external interventions are necessary, for example when local people require more information about climate and adaptation issues.<sup>110</sup>

## DISCUSSION

The responses most often reported in the literature are not necessarily those that are most frequently used by people but are those that are most widely studied. For example, the focus on agriculture and on individual responses may reflect a particular interest or approach by the scientific community. One research gap in the reviewed literature is related to multiple exposures, as droughts are frequently considered to be the main risk faced by populations in West Africa and other risks that affect the systems under study are rarely taken into consideration. A small number of articles did report that populations are exposed to several different kinds of risk, some natural (e.g., crops attacked by insect pests), some social (e.g., conflicts), some economic (e.g., rising prices of agricultural inputs), and pointed out that the social, political, and economic context is important in understanding the impacts of drought, for example, climate-induced conflicts.

Further research is also required on the ways in which the context influences the impacts of droughts or the responses of the population. Too few studies analyze the institutional, environmental, political, and social context of rural communities and particularly the role of power relations at different scales. Such studies are needed to rebut the widespread discourses that simplify the causal relations between droughts and their outcomes in the Sahel, for example those that depict crop failure and famine in the Sahel as a direct consequence of droughts and overlook the social construct and the role of power relations and politics in mediating vulnerability and responses to drought. There is evidence that small and politically unrepresented ethnic groups suffer most from environmental and drought-related conflicts.<sup>46</sup> To be successful, climate change adaptation policies need to consider the political dimensions of local adaptation, existing power structures, and conflicts of interest.<sup>111</sup>

Many population responses are designed to face exposure to multiple exposures and not only drought. For example, intensification of agriculture through increased use of inputs is as much a response to the lack of agricultural land, food insecurity, and opportunities to sell production surplus to expanding markets<sup>112</sup> as to climate variability.<sup>70</sup> And the use of short-cycle cereals or a mix of different varieties enables better management of the labor force in a context of outmigration of young people and of the failure of labor markets.<sup>60</sup>

Another research requirement is analysis of the effectiveness and of the unexpected effects of the

local population's responses and of projects implemented by NGOs or governments. Many responses can have perverse effects, for example, migration or the sale of productive assets to buy food. Government and NGO projects need to be assessed in terms of their usefulness to local populations, which is not always clear.<sup>38</sup> The perverse effects of food aid have already been highlighted, that is, that food aid undermines local food systems and creates long-term problems for farmers, causes dependency and limits incentives for adaptation.<sup>3,113</sup>

Yet another gap concerns collective action for adaptation, as most studies focus on households or individuals. The complexity of West African tenure systems and social organizations is not enough taken into account, for example, the role of solidarity networks in times of drought and collective adaptive responses. Social networks and tenure systems as endogenous factors influencing coping strategies are the subject of far fewer studies than demographic structure and the socioeconomic status of households,<sup>6</sup> although their roles have been highlighted by some scholars.<sup>114–116</sup> As increasing food and energy demands from growing cities create new pressures on and rivalry for customary lands, options for adaptation will depend on how social interactions and tenure systems evolve in this context.

In addition to the knowledge gap on collective responses, information is lacking on the internal dynamics and the complexity of households. Despite important studies on this issue,<sup>117–119</sup> households are often conceptualized as homogeneous entities,<sup>38</sup> whereas each household member has his or her own social network, assets, and objectives that may conflict with the objectives of other household members.<sup>43</sup> There is evidence that household strategies rely mainly on household members with marginal access to resources, such as women or young people.<sup>75</sup> Moreover, after a drought, budgetary struggles within households may lead to the transfer of wealth from household heads to their wives and dependent male members<sup>43</sup> but also to cooperation between household's members.<sup>110</sup>

Our review of the responses cited in the literature revealed that poor households have fewer opportunities than wealthy households. The latter are able to take advantage of price dynamics, are more likely to benefit from a loan, or have more diversified livelihoods.<sup>52,68</sup> A framework could help understand the different choices made by wealthy and poor households, and help distinguish between pull and push factors in the choice of a response.<sup>52,120</sup> Pull factors correspond to opportunities a household can intentionally use to its advantage, while push factors

correspond to situations in which the household acts out of desperation and take decisions under pressure (adapted from<sup>91</sup>). For example, concerning diversification, poor households diversify because they are highly vulnerable and need to spread risk across different activities and also because they need cash for essentials, while wealthy households diversify to maximize the profitability of their strategies<sup>120</sup>; but wealthy farmers can also focus on full-time farming to maximize their profits and because their large assets make them less vulnerable.<sup>75</sup>

Some studies use a comprehensive approach based, for example, on perceptions<sup>61</sup> or on past livelihood trajectories.<sup>25</sup> Comprehensive approaches make it possible to reveal the influence of ideology, cultural values, or self-perception in the choice of a response.<sup>113,121</sup> For example, some pastoralists will not diversify their activity to include gardening or waged labor because they perceive themselves strictly as herders.<sup>113</sup> Meanwhile, most studies on decision-making are only based on correlations between responses (or vulnerability) and variables, and have produced few significant results.

## CONCLUSION

This review of the impacts of drought and the responses of rural populations in West Africa highlighted certain controversial aspects of the current state of knowledge and identified some knowledge gaps and avenues for future research (Box 1). West Africa has been widely associated with drought as a major problem, however, it is important to frame droughts in a set of multiple threats faced by local populations. Droughts often act as a trigger in contexts of economic, societal, and environmental change. The literature on responses focuses on agricultural and individual responses, whereas diversification, migration, and tree-based or livestock-based responses are less frequently addressed. In addition to technical agricultural responses that are well described, social capital and networks are often identified as an important part of the response to drought in West Africa, but their roles are overlooked even though they may be crucial for the most vulnerable. Research is needed on the effectiveness and the unexpected effects of responses implemented by populations, states or NGOs, as well as on the interactions between different responses. To grasp the complexity of impacts and responses, it is important to consider the context in which they occur and to analyze how individual and collective actions interact within households or communities. There is a pressing need

### BOX 1

#### KEY ISSUES FOR FUTURE RESEARCH

- The role of the goods and services from the broad landscape, beyond agricultural production, in buffering the impacts of drought, and facilitating responses.
- The reasons why there are few locally driven collective initiatives for the sustainable management of trees and woodlands, despite the role these resources play in the coping and adapting strategies of households.
- The effect of social relationships, political-economic dynamics, and power inequalities in the outbreak of famines and their impacts after the droughts has ended.
- The importance of social capital and networks in livelihood responses to droughts, particularly for the most vulnerable.
- The social, cultural, and institutional structures and processes through which the impacts of droughts are amplified or reduced.
- The consequences of migration as a short- or long-term strategy to cope with drought that affect both the place of origin and the destination of the migrant.
- Ways to better integrate local responses to drought in sectorial or territorial policies and in national or local adaptation plans.
- The role of institutions at different levels in collecting environmental and socioeconomic baseline data and in monitoring the impacts of drought.
- Collaboration among scientists, governments, NGOs, and local institutions to share information on droughts, their impacts, and the responses of populations to them.

to identify the social, cultural, and institutional structures and mechanisms at play in rural communities through which the impacts of droughts may be amplified due to resistance from economic and political elites. An integrative approach including the environmental and social spheres is thus recommended to analyze and propose sustainable adaptation strategies. Ecosystems and agriculture offer many goods and services that can usefully be adapted and the different landscape components need to be analyzed together. Such historical, contextual, and integrated analyses could better inform new policies and projects for adaptation to climate change.

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