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The shifting epistemologies of vulnerability in climate services for development: the case of Mali's agrometeorological advisory programme

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The field of climate services for development (CSD) is growing rapidly, presented by donors and implementers as an opportunity to address the needs of the global poor, whether informing agricultural decisionmaking in rural communities, facilitating disaster preparedness or promoting public health. To realise this potential, however, CSD projects must understand the information needs of their intended users. This raises a critical epistemological challenge for CSD: how can we know who is vulnerable to the impacts of climate variability and change, and why are they vulnerable to particular impacts? In this paper, we consider both the epistemological tension arising over the construction of vulnerability that emerges at the intersection of the physical and social science communities within CSD and a second, less-discussed epistemological stress surrounding how user identities are understood within the social science community engaged in CSD-related research and implementation. We illustrate these tensions through the example of a climate services programme that delivers agrometeorological advice to farmers in Mali, demonstrating the ramifications of these epistemological issues for the design and delivery of services that further development and adaptation goals.

Key words: *climate change adaptation, climate services, epistemology, vulnerability, identity, Mali*

Introduction

Climate services for development (CSD) refers to the dissemination of climate information to users to mitigate the impacts and/or leverage opportunities arising from climate change and variability with the aim of enhancing the well-being of the global poor. While CSD have tremendous potential for improving development, humanitarian assistance and climate change adaptation outcomes, this potential can only be realised when the information provided matches the needs of presumed end-users. This paper explores two closely related epistemological challenges that lie in the way of this potential. The first challenge emerges between understandings of what constitutes a valid framing of climate-related vulnerability. The second relates to how the CSD community comes to know the presumed users of climate services, the 'vulnerable'. In this paper, we show that (1) the construction of climate-related vulnerability within CSD has undergone a shift from an exposure-led epistemology to one that embraces the exposure, sensitivity and adaptive capacity of the presumed end-users and (2) this shift in the framing of climate-related vulnerability requires a second epistemological reframing, from an essentialist epistemology of end-user identity to a more fluid, intersectional understanding of the identities, roles and responsibilities that shape end-user behaviors. Using a case study of Malian farmers engaged in an agrometeorological advisory programme, we empirically demonstrate that embracing this reframed epistemology of vulnerability and the intersectional epistemology of end-user identify, to provides an opportunity to construct CSD with greater salience, legitimacy and credibility than currently possible.

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Climate services for development: nested epistemological tensions

Much work in the CSD community is 'supply side', driven by climate scientists who frame their epistemology of vulnerability around exposure to climate variability and change, sometimes characterised as climate risk (Hansen 2005; Hansen *et al*. 2009). Under this epistemology, products and information about particular climate challenges, trends or events are assumed to reduce user vulnerabilities by mitigating exposure (for discussion of this issue, see Hansen *et al*. 2009; Millner and Washington 2011; Roncoli 2006; Shankar *et al*. 2011).

A growing CSD literature now challenges this epistemology of vulnerability, demonstrating that good scientific information on exposure alone is often inadequate to achieve development/humanitarian assistance goals (e.g. Hansen *et al*. 2011; Luseno *et al*. 2003; Roudier *et al*. 2012; Tschakert 2007). This literature reflects an alternative epistemology of vulnerability to climate variability and change rooted not only in exposure, but also the sensitivity and adaptive capacity of the systems that users rely on for their livelihoods and well-being (for discussion, see O'Brien *et al*. 2004). This epistemology of vulnerability opens up questions of who uses particular services and why. An emerging literature leverages this epistemological reframing to explore how CSD contributes to user needs related to sensitivity and adaptive capacity, such as livelihood stainability and improved decisionmaking under conditions of uncertainty (Bone *et al*. 2011; Green and Raygorodetsky 2010; Leclerc *et al*. 2013; Luseno *et al*. 2003; Orlove *et al*. 2010; Silvestri *et al*. 2012; Tschakert 2007; Waiswa *et al*. 2007).

CSD's relatively new focus on the sensitivities and adaptive capacities of end-users raises the question of how we know these users. As a growing literature in CSD recognises, if vulnerability is not primarily about exposure, the users of climate services cannot be treated as an undifferentiated mass, even at the community or household level (Table 1). The roles and responsibilities associated with different identities shape individual and group sensitivity and adaptive capacity vis-à-vis particular shocks and stressors. Further, these roles and responsibilities shape how those individuals determine the salience, legitimacy and credibility of the information climate services deliver (Cash *et al*. 2003).

As productive as this attention to the diversity of CSD users might be, its potential has not been fully realised. The dominant view in the CSD literature, as in the wider climate change adaptation literature (see Carr and Thompson 2014 for discussion), tends to know users through an epistemology of identity that constructs individuals' identities along single axes of identity (e.g. gender, age, religion or income) that are usually characterised as oppositional binaries (man versus woman, young versus old).

Table 1 Social cleavages considered among CSD user populations

Social category	References
Gender	Ingram *et al*. 2002; Patt *et al*. 2005; Roncoli *et al*. 2001; Tschakert *et al*. 2010; Tschakert 2007; Ziervogel 2004
Age	Akponikpè *et al*. 2010; Ingram *et al*. 2002; Roncoli *et al*. 2001; Tschakert 2007; Waiswa *et al*. 2007
Wealth	Akponikpè *et al*. 2010; Roncoli *et al*. 2001; Tschakert *et al*. 2010
Religion	Orlove *et al*. 2010; Roncoli *et al*. 2009; Roncoli *et al*. 2011
Ethnicity	Roncoli *et al*. 2009
Education	Akponikpè *et al*. 2010; Waiswa *et al*. 2007

Note: Many of these studies often identify more than one social cleavage, but discuss them separately or use them only for the purpose of user description

Taking on board the critiques of single-axis binary approaches in both the gender and development literature, and indeed the wider social scientific literature, there is growing acknowledgement (at least implicitly) of a need for an intersectional epistemology of identity when identifying and interacting with the users of CSD (e.g. Orlove *et al*. 2010; Peterson *et al*. 2010; Roncoli *et al*. 2009; Roncoli *et al*. 2011; Ziervogel *et al*. 2006). Such an epistemology treats different identities not as stand-alone, immutable characteristics of an individual or group. Instead, identities are conceptualised as categories whose associated roles, rights and responsibilities gain meaning through different situational intersections with the roles, rights and responsibilities associated with other identities occupied by that individual (see Carr and Thompson 2014 for discussion). This latter intersectional epistemology of identity demands that we not only consider the differences among end users in the design of CSD, but also think carefully about *which* identities, at *which times*, matter to an individual's determination of the salience, legitimacy and credibility of weather and climate information.

In this article, we employ data gathered in an assessment of farmer use of agrometeorological advisories provided by Mali's Direction Nationale de la Météorologie (Mali's Meteorological Service, henceforth Meteo Mali) to empirically demonstrate two points. With regard to the first epistemological challenge described above, we argue that an epistemology of vulnerability centred on exposure presents a limited view of the different ways in which

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vulnerability emerges and is experienced within CSD end-user communities. With regard to the second challenge, we argue that a reductionist framing of the identities of CSD users limits our ability to engage the causes of the varying perception of CSD salience, legitimacy and credibility among user communities and households. This challenge creates a substantial risk of focusing on the development and delivery of services that meet the needs of only some members of a household, community or other targeted population.

Knowing the users: Mali's Agrometeorological Advisory Programme

In 1981, responding to the drought conditions that had plagued Mali in the late 1970s and early 1980s, Meteo Mali initiated an effort to bring agrometeorological information to farmers (Carr 2014; Diarra and Kangah 2007). Meteo Mali convened an informal, non-hierarchical multidisciplinary working team. This team coordinated the flow of information about user needs and available information to inform the production of agrometeorological advisories. The programme was piloted between 1982 and 1986 and, in light of positive impacts on yields and input efficiency, was scaled up over the 1990s until the end of Swiss funding in 2005. The advisory services, which focus on five crops (cotton, maize, millet, peanuts and sorghum), provide information such as: guidance on the appropriate time to undertake various agricultural activities including field clearing, planting and the application of inputs; daily rainfall figures; guidance on the proper variety cycle length to plant depending on current and forecast conditions; hydrological reports; crop water balance computations at the end of each 10-day period; and daily weather forecasts. The advisory services are spatially coarse, so they are localised with reference to local rainfall totals recorded in village rain gauges. Therefore, the use of the advisory services requires both a rain gauge and at least one community member trained to interpret the broadcast advice with reference to local rainfall. While Meteo Mali no longer has the funds necessary to scale the project up to new communities, it continues to produce and put out advice during the agricultural season (May–October).

One of the initial founders of the advisory programme has argued that the programme was not a research programme, but an emergency effort to address the drought and its impacts on Malian agriculture (Konare 2012). As such, the programme was framed around an exposure-driven understanding of the vulnerability of Malian agriculture to climate variability. This is evident when we look at the patterns of crop selection across southern Mali. Table 2 is drawn from 201 structured interviews with farmers living in villages that have Local Climate Support Groups (Groupes Locaux d'Assistance Meteorologique, henceforth GLAM) and therefore have rain gauges that make the advice give actionable. The crops targeted by the advisories are the five most commonly grown crops in the southern part of the country. These crops are used in different ways, including market sale (cotton), mixed subsistence and market sale (peanuts and millet) and pure subsistence (maize and sorghum). This framing of Malian agriculture creates a generic farmer who emphasises these crops and these uses. As we will see, this framing of Malian farmers inadvertently misrepresents the diversity of agricultural practices, decisions and vulnerabilities to climate variability and change among the programme's targeted population.

As the CSD literature recognises, location greatly shapes the user's climate service needs, because it anchors climate impacts in a particular agroecology (e.g. Patt *et al*. 2005; Phillips *et al*. 2002; Roncoli *et al*. 2009; Akponikpè *et al*. 2010; Silvestri *et al*. 2012; Leclerc *et al*. 2013; Ingram *et al*. 2002). Further, the particular livelihood strategies that users employ are critical to understanding questions of sensitivity and adaptive capacity (Akponikpè *et al*. 2010; Bone *et al*. 2011; Green and Raygorodetsky 2010; Roncoli *et al*. 2001 2002; Roncoli *et al*. 2009; Roncoli *et al*. 2011; Waiswa *et al*. 2007). To control for agroecology and livelihoods, we narrowed our sample to those living in GLAM villages located in what Dixon and Holt (2010) call the ML 10: 'Sorghum, millet and cotton' livelihoods zone (Figure 1).

When we reduce our farming sample to those living in this cluster, a different picture of agricultural strategy emerges (Table 3). The five 'advisory' crops remain the five most commonly cultivated crops, with some shifts in order. However, in this zone both sorghum and maize are associated with at least some market motivation in their production. Indeed, not a single crop in this zone is identified as solely for subsistence. This is probably tied to the fact that this zone usually produces a surplus of food that, because of the proximity of this zone to cross-border trade with Burkina Faso, is sold to both domestic and foreign markets (Dixon and Holt 2010, 93). This suggests a different set of user considerations than those seen in southern Mali as a whole. It appears that farmers in this livelihoods zone are not in need of climate services to stave off food insecurity, but to maximise their yields and improve their market-derived incomes.

This apparently subtle but critical difference in motivations raises important questions for CSD design aimed at Malian farmers, as differing goals shape different potential utilities of CSD. For example, while in aggregate it appears farmers in southern Mali grow maize for subsistence, disaggregating the data shows that the farmers in this zone plan to sell at least some of their maize, even though this crop is generally planted later in the season and is more

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Table 2 All crops grown by farmers interviewed in GLAM villages, organised by the rate of cultivation

All GLAM Farmers (n=201)		
*Peanut	63.27%	Eat more than sell
*Sorghum	58.67%	Eat all
*Maize	46.43%	Eat all
*Cotton	41.84%	Sell all
*Millet	39.80%	Eat more than sell
Rice	37.76%	Eat more than sell
Cowpeas	31.63%	Eat more than sell
Okra	24.49%	Eat more than sell
Onion	14.80%	Sell more than eat
Tomato	11.73%	Eat and sell equally
Fonio	11.22%	Eat and sell equally
Lettuce	11.22%	Sell more than eat
Sesame	10.20%	Sell all
Chili pepper	8.16%	Sell more than eat
Eggplant	4.08%	Eat and sell equally
Hibiscus	3.57%	Eat more than sell
Bambara nuts	3.06%	Sell all
Henna	3.06%	Eat all
Cabbage	2.55%	Sell more than eat
Bell pepper	2.04%	Sell all
Potato	2.04%	Eat and sell equally
Sweet potato	1.53%	Eat and sell equally
Melon	1.02%	Eat and sell equally
Banana	0.51%	
Bissap	0.51%	
Mint	0.51%	
Papaya	0.51%	
Watermelon	0.51%	

4.5–5	Sell all
3.5–4.49	Sell more than eat
2.5–3.49	Eat and sell equally
1.5–2.49	Eat more than sell
1–1.49	Eat all

Notes: The shaded column indicates the average use for the crop mentioned by farmers. This average was obtained by assigning five different uses (see the key) values between 1 and 5, and then taking an average of the values for each crop. This value is only displayed for crops cultivated by two or more farmers to provide some control for individual idiosyncrasy. Crops marked with * are those for which advisory services are provided

sensitive to variations in precipitation (both volume and duration) than crops such as millet and sorghum. To ensure a large enough surplus to enable such sale, farmers in this zone require more information on the length of season and total seasonal precipitation. As a result they are more likely to act and switch varieties grown based on this information than farmers in the wider population who have no expectation of a surplus and can tolerate losses. This has implications for how we think about climate change adaptation in this zone, as it suggests that farmers in this zone have differentiated vulnerabilities when compared with those of the wider sample: they are exposed to the same climate variability and trends, but have different sensitivity to that exposure because they are engaged in different livelihoods strategies (Carr and Thompson 2014, 183). This is a clear challenge to any epistemology of vulnerability to climate variability and change that focuses principally on exposure.

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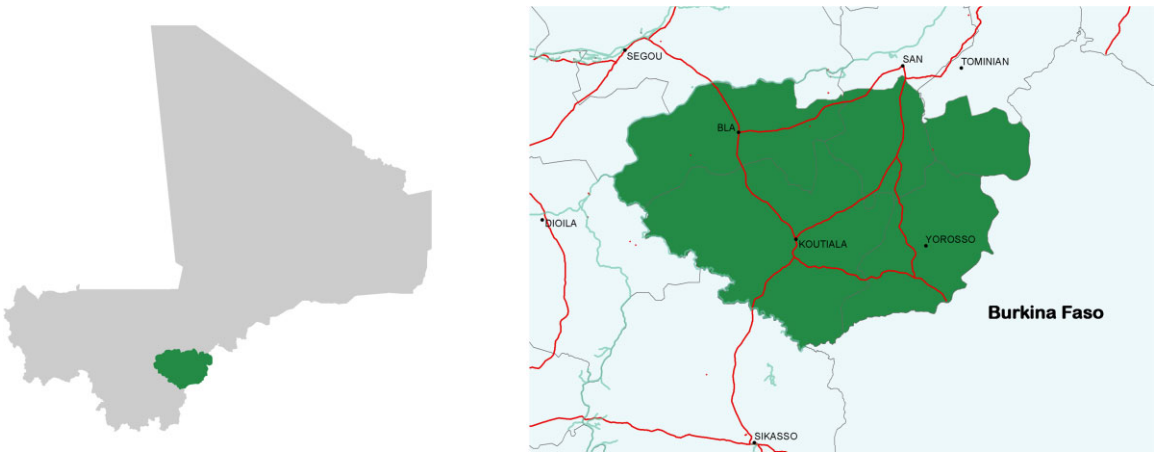

Figure 1 The location of zone ML 10: 'Sorghum, millet and cotton' livelihoods zone, after Dixon and Holt (2010, 93)
Map credit: Christopher J. Witt, Department of Geography, University of South Carolina

Table 3 All crops grown by farmers interviewed in GLAM villages in livelihoods Zone ML 10: 'Sorghum, millet, and cotton', organized by the rate of cultivation

GLAM Farmers in Cluster 4 (n=75)		
*Sorghum	66.67%	Eat more than sell
*Peanut	64.00%	Eat more than sell
*Millet	54.67%	Eat more than sell
*Maize	50.67%	Eat more than sell
*Cotton	45.33%	Sell all
Cowpeas	25.33%	Eat and sell equally
Rice	25.33%	Eat more than sell
Okra	16.00%	Eat more than sell
Onion	10.67%	Sell more than eat
Tomato	8.00%	Sell more than eat
Fonio	6.67%	Eat and sell equally
Chili pepper	4.00%	Eat and sell equally
Lettuce	2.67%	Sell all
Banana	1.33%	
Cabbage	1.33%	
Hibiscus	1.33%	
Sesame	1.33%	

4.5–5	Sell all
3.5–4.49	Sell more than eat
2.5–3.49	Eat and sell equally
1.5–2.49	Eat more than sell
1–1.49	Eat all

Notes: The shaded column indicates the average use for the crop mentioned by farmers. Crops marked with * are those for which advisory services are provided

It is at this point that the question of how we know the end-users of CSD becomes critical. The literature clearly recognises that users cannot be treated as an undifferentiated mass, even within a particular agroecological zone and operating under similar livelihoods. Thus, we must decompose our sample further to identify relevant identities and attendant roles and responsibilities that might shape the salience, legitimacy and credibility of CSD within this zone. In this case, we begin with the limited literature on Bambara agriculture, land use and

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Table 4 All crops grown by men and by women farmers interviewed in GLAM villages in livelihoods zone ML 10: 'Sorghum, millet, and cotton', organized by the rate of cultivation

Women (n=34)		
*Peanut	76.47%	Eat more than sell
Okra	32.35%	Eat more than sell
*Sorghum	29.41%	Eat all
Cowpeas	26.47%	Eat and sell equally
Onion	23.53%	Sell more than eat
Rice	23.53%	Eat more than sell
*Millet	17.65%	Eat all
Tomato	17.65%	Sell more than eat
Chili pepper	8.82%	Eat and sell equally
Lettuce	5.88%	Sell all
*Maize	5.88%	Eat all
Banana	2.94%	
Cabbage	2.94%	
Hibiscus	2.94%	
Sesame	2.94%	

Men (n=41)		
*Sorghum	97.56%	Eat more than sell
*Maize	87.80%	Eat more than sell
*Millet	85.37%	Eat more than sell
*Cotton	82.93%	Sell all
*Peanut	53.66%	Eat more than sell
Rice	26.83%	Eat more than sell
Cowpeas	24.39%	Eat more than sell
Fonio	12.20%	Eat and sell equally
Okra	2.44%	

4.5–5	Sell all
3.5–4.49	Sell more than eat
2.5–3.49	Eat and sell equally
1.5–2.49	Eat more than sell
1–1.49	Eat all

Notes: The shaded column indicates the average use for the crop mentioned by farmers. Crops marked with * are those for which advisory services are provided

livelihoods, because this ethnicity dominates both this livelihoods zone as well as much of southern Mali. The Bambara operate under what Becker (1990, 315) calls a patrilineal gerontocracy, where the most senior male member of a lineage, which in smaller villages may be the village chief, apportions the land of the lineage to the different households of the men of that lineage. Women gain access to land through their husbands (or, at times, from their husbands' lineages, or even other male-led lineages in the community) and generally only retain use rights to the land (Akeredolu *et al*. 2007; Grigsby 2004). As a result, what they cultivate can be regulated by men, making land tenure what Carr (2013) refers to as a tool of coercion in livelihoods. Therefore, we begin by looking for gendered differences in decisionmaking and vulnerability that could be addressed through the advisory services.

In Table 4, we can see that men in this zone raise the five crops for which advisory services provide frequent information while largely incorporating the other four crops in an incidental manner. Dixon and Holt (2010, 94) identify cotton as the main cash crop in this zone. Table 4 demonstrates that men farm this crop exclusively. Men also appear to grow fonio (a grain of the millet family) with the intent of selling at least some of the harvest regardless of production. All other agricultural market engagement by men appears to come from marketable surpluses of their other crops, as opposed to a direct effort to raise these crops for sale. In short, the advisory programme's 'generic farmer' closely resembles the situation

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of men in all of southern Mali (represented in Table 2) or in livelihoods zone ML 10 (Table 3).

CSD have a much more limited effect on women's production. First, while women cultivate peanuts at a slightly higher rate than men, women cultivate maize, millet and sorghum at much lower rates than men. Women cannot simply take up the cultivation of these cereals because they do not own land, and therefore have very insecure land tenure. This prevents them from improving fields, planting long-term crops such as tree crops and may even push them to raise fast-maturing crops lest the landowners re-appropriate the land and crops before the harvest (Akeredolu *et al*. 2007; Grigsby 1996). Therefore, much of women's production is not in rain-fed cereals, but in irrigated gardening of onions, tomatoes, cowpeas, chilli peppers and lettuce that is not very sensitive to climate variability, and only becomes sensitive to longer-term climate change if temperatures rise enough to move seeds outside their germination zones or groundwater supplies dry up. Thus, women's and men's agricultural outcomes have differentiated vulnerabilities to climate variability and change (i.e. they are exposed to the same climate stressor, but have different sensitivities and adaptative capacities; see Carr and Thompson 2014). It is therefore unsurprising that 29 per cent (n = 11) of the women interviewed in this cluster argued (unprompted) that they did not receive the advice, or that the advisory services 'were for men'.

A single-axis representation of identity such as that presented above, however, does not do justice to the full set of roles and responsibilities that shape livelihoods decisions and agricultural strategy. The literature notes that the Bambara operate under a patrilineal *gerontocracy*, suggesting that age is also a critical consideration shaping livelihoods decisionmaking. For example, Becker (1990) notes that the household model of agricultural decisionmaking parallels the larger village-level structure of authority. Where at the village level the oldest male member of the chief's lineage becomes the new chief, within the household the oldest male makes all agricultural decisions until such time as he is unable to go to farm himself, and even after that continues to control the proceeds of the family farm (*forobaforo*). While this control is contested within households by, for example, younger men, such contestation generally manifests in efforts to cultivate farm plots separate from that of the household plot *after* completing obligations to the household plot (Becker 1990). This practice of granting greater authority to older people crosses gender lines. For example, Akeredolu *et al*. (2007) note that junior wives in polygamous households have less say regarding major household decisions than do older senior wives. Thus, while gender matters to Bambara agricultural practice, it is gender's intersection with age that shapes individual farmers' ability to make decisions about their farming activities. User perceptions of the salience, legitimacy and credibility of the agrometeorological advisory services in this livelihoods zone are therefore shaped by this particular intersection of identities.

When we disaggregate the population of livelihoods zone ML 10 by gender and age (where interviewees were self-identified into two categories: junior or senior[1]), a new set of differences emerges (Table 5). Both junior and senior women appear to centre their production on one or two rain-fed crops (peanuts and either sorghum or millet), complemented by one or two gardened crops. Senior women have a greater emphasis on crops that receive advisory services, growing sorghum at a much greater rate than junior women. The need for animal fodder probably drives some of the greater focus on sorghum among senior women, as 80 per cent of senior women were engaged in animal husbandry, while only 45 per cent of junior women in this sample reported this activity. This difference is likely a product of age, as senior women have had more time (or their husbands have had more time) to accumulate animal assets than more junior members of the community.

The agricultural strategies of senior and junior men are also different. Senior men focus on cotton production for their cash income, with all other crops (except rice) contributing principally to subsistence needs. Junior men, while also heavily focused on cotton for cash income, appear to cultivate nearly all of their crops with the intent of producing a marketable surplus. The data at hand do not explain the motivations behind this pattern, but the pattern itself speaks to differentiated vulnerabilities to climate variability and change among men that depends on age. Here, advisory services for sorghum, maize, millet and peanuts serve to shore up the subsistence base for senior men, while for junior men these same advisory services speak to both subsistence and the success of efforts to diversify their agricultural incomes across a range of crops.

The differing agricultural strategies that emerge at the intersection of gender and age in this livelihoods zone suggest different needs among these groups to ensure the salience, legitimacy and credibility of CSD. For example, among women, the advisory services speak to crops that principally serve as a means of subsistence in their livelihoods. However, younger women have a more overt market orientation in their peanut production than their more senior counterparts. Thus, for junior women the advisory services for this crop address risks not only to the subsistence base of the household, but also opportunities for investment in non-farm activities. For men, the advisory services speak to a mix of crops uses, from subsistence to pure market sale. However, younger men focus the production of advisory-informed crops more on

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Table 5 All crops grown by farmers interviewed in GLAM villages in livelihoods Zone ML 10: 'Sorghum, millet, and cotton', by gender/seniority

GLAM Senior Man (n=20)

*Sorghum	100.00%	Eat all
*Cotton	80.00%	Sell all
*Maize	80.00%	Eat all
*Millet	75.00%	Eat all
*Peanut	45.00%	Eat more than sell
Rice	25.00%	Eat and sell equally
Cowpeas	15.00%	Eat all
Fonio	10.00%	Eat all

GLAM Junior Man (n=21)

*Maize	95.24%	Eat more than sell
*Millet	95.24%	Eat more than sell
*Sorghum	95.24%	Eat more than sell
*Cotton	85.71%	Sell all
*Peanut	61.90%	Eat and sell equally
Cowpeas	33.33%	Eat more than sell
Rice	28.57%	Eat more than sell
Fonio	14.29%	Sell more than eat
Okra	4.76%	

GLAM Senior Woman (n=14)

*Peanut	71.43%	Eat more than sell
*Sorghum	57.14%	Eat more than sell
Rice	28.57%	Eat more than sell
Tomato	28.57%	Sell more than eat
Onion	21.43%	Sell more than eat
Chili pepper	14.29%	Eat and sell equally
Cowpeas	14.29%	Eat more than sell
*Millet	14.29%	Eat all
Okra	14.29%	Eat more than sell
Banana	7.14%	
Cabbage	7.14%	
*Maize	7.14%	
Sesame	7.14%	

GLAM Junior Woman (n=20)

*Peanut	80.00%	Eat and sell equally
Okra	45.00%	Eat more than sell
Cowpeas	35.00%	Eat and sell equally
Onion	25.00%	Sell more than eat
*Millet	20.00%	Eat more than sell
Rice	20.00%	Eat more than sell
Lettuce	10.00%	Sell all
*Sorghum	10.00%	Eat all
Tomato	10.00%	Sell all
Chili pepper	5.00%	
Hibiscus	5.00%	
*Maize	5.00%	
Sesame	5.00%	

4.5–5	Sell all
3.5–4.49	Sell more than eat
2.5–3.49	Eat and sell equally
1.5–2.49	Eat more than sell
1–1.49	Eat all

Notes: The data is organized by the rate of cultivation. The shaded column indicates the average use for the crop mentioned by farmers. Crops marked with * are those for which advisory services are provided

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market sale than more senior men. As with women, this suggests that younger men see agricultural production more as a source of income than senior men. Thus, the advisory services speak to two different framings of livelihoods among men.

An intersectional epistemology of CSD users' identities works to inform the design of targeted advisories with greater salience, legitimacy and credibility than possible before. For example, advisory services aimed at younger men should likely consider not only the length of the growing season, but also the timing of markets to help farmers spread production across a long enough time to prevent market flooding. Merely identifying an optimal variety for season length might result in diminished market profits if the harvest coincides with all other harvests. This is likely also true of peanuts for younger women. Aside from peanuts, however, junior women have little use for the advisory services as currently delivered, because they rarely cultivate any other advisory crops. For senior women, advisory services need not consider market factors, because their production is normally consumed in the household and therefore maximising yield is the primary goal. Consequently, even in a relatively small area marked by a high degree of ethnic homogeneity, different users and user needs exist and can be addressed if we understand users in terms of their roles and responsibilities with regard to the climate-related decisions at hand.

Conclusion

Within CSD, a shift in the epistemology of vulnerability has taken hold. The literature is leaving behind exposure-led framings of vulnerability and is moving toward a widespread adoption of exposure/sensitivity/adaptive capacity framing. This shift clears a path to a new, less-considered epistemological challenge for CSD: interrogating and reframing CSD's epistemology of the end-user. The CSD literature has started to shift from an essentialist epistemology of identity that frames users in terms of individual, fixed identities and their associated roles and responsibilities. In its place, CSD is starting to embrace an intersectional epistemology of identity that sees these roles and responsibilities as situational and emerging at the intersection of many identities, each with their own roles and responsibilities in the context of the activities to which CSD are directed. In this article, we have empirically demonstrated that how we construct the end-users of climate services has significant ramifications for the services that we design, the utility of the information we deliver and the outcomes of existing programmes and projects. By taking an intersectional approach to the different identities, roles and responsibilities of target users, we can better understand the range of decisions being made in a given population, who is making these decisions and what information would speak to the needs of these decisionmakers.

The epistemological tensions in CSD are specific manifestations of wider questions in climate change adaptation: how can we identify who is vulnerable and to what impacts of climate variability and change? Much in CSD and climate change adaptation work on vulnerability tends to focus on aggregated populations (Carr and Thompson 2014). Only a relatively small literature on climate change adaptation has engaged with gender as a significant identity shaping adaptation outcomes, and an even smaller, emerging literature within climate change adaptation understands 'the vulnerable' through intersectional epistemologies of identity. This literature, however, demonstrates that studies founded on an intersectional epistemology of identity better reveal the distinct and differentiated vulnerabilities to climate variability and change that exist within communities and households, at the scale where most adaptation decisions are made. As a specific case of this epistemological challenge on climate change adaptation, CSD's ways of knowing the end-users represents a focused opportunity to make the case for refining this epistemology for climate change adaptation more generally.

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Note

1 It is worth noting that while age is critical to the determination of social rank among the Bambara, it is often bound up in a broader framing of seniority for which there is no firm age cut-off. Instead, other factors such as wealth and marital status can subtly influence community perceptions of an individual's seniority, making this aspect of identity locally specific. Therefore, we are using seniority here as a somewhat broader, but locally appropriate, proxy for age.

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References

Akeredolu M, Asinobi C O and Ilesanmi I 2007 Gender and trends in production constraints among the Bambara people of Mali in *Proceedings of the 23rd annual meeting of the Association for International Agricultural and Extension Education* Polson, Montana 1–13

Akponikpè P B I, Johnston P and Agbossou E K 2010 Farmers' perception of climate change and adaptation strategies in Sub-Saharan West-Africa in *ICID +18: 2nd international conference: climate, sustainability and development in semi-arid regions* Fortaleza, Brazil

Becker L C 1990 The collapse of the family farm in West Africa? Evidence from Mali *The Geographical Journal* 156 313–22

Bone C, Alessa L, Altaweel M, Kliskey A and Lammers R 2011 Assessing the impacts of local knowledge and technology on climate change vulnerability in remote communities *International Journal of Environmental Research and Public Health* 8 733–61

Carr E R 2013 Livelihoods as intimate government: reframing the logic of livelihoods for development *Third World Quarterly* 34 77–108

Carr E R ed 2014 *Assessing Mali's Direction Nationale de la Meterologie Agrometeorological Advisory Program: preliminary report on the climate science and farmer use* United States Agency for International Development, Washington DC

Carr E R and Thompson M C 2014 Gender and climate change adaptation in agrarian settings: current thinking, new directions, and research frontiers *Geography Compass* 8 182–97

Cash D W, Clark W C, Alcock F, Dickson N M, Eckley N, Guston D H, Jäger J and Mitchell R B 2003 Knowledge systems for sustainable development *Proceedings of the National Academy of Sciences of the United States of America* 100 8086–91

Diarra D and Kangah P D 2007 Agriculture in Mali in **Hellmuth M E, Moorhead A, Thomson M C and Williams J** eds *Climate risk management in Africa: learning from practice* International Research Institute for Climate and Society (IRI), Columbia University, New York 59–74

Dixon S and Holt J 2010 *Livelihood zoning and profiling report: Mali* United States Agency for International Development, Washington DC

Green D and Raygorodetsky G 2010 Indigenous knowledge of a changing climate *Climatic Change* 100 239–42

Grigsby W J 1996 Women, descent, and tenure succession among the Bambara of West Africa: a changing landscape *Human Organization* 55 93–8

Grigsby W J 2004 The gendered nature of subsistence and its effect on customary land tenure *Society and Natural Resources* 17 207–22

Hansen J W 2005 Integrating seasonal climate prediction and agricultural models for insights into agricultural practice *Philosophical Transactions of the Royal Society London B: Biological Sciences* 360 2037–47

Hansen J W, Mason S J, Sun L and Tall A 2011 Review of seasonal climate forecasting for agriculture in Sub-Saharan Africa *Experimental Agriculture* 47 205–40

Hansen J W, Mishra A, Rao K P C, Indeje M and Ngugi R K 2009 Potential value of GCM-based seasonal rainfall forecasts for maize management in semi-arid Kenya *Agricultural Systems* 101 80–90

Ingram K, Roncoli C and Kirshen P 2002 Opportunities and constraints for farmers of west Africa to use seasonal precipitation forecasts with Burkina Faso as a case study *Agricultural Systems* 74 331–49

Konare K 2012 *Personal conversation with the author* Dakar, Senegal

Leclerc C, Mwongera C, Camberlin P and Boyard-Micheau J 2013 Indigenous past climate knowledge as cultural built-in object and its accuracy *Ecology and Society* 18 22–34

Luseno W K, McPeak J G, Barrett C B, Little P D and Gebru G 2003 Assessing the value of climate forecast information for pastoralists: evidence from Southern Ethiopia and Northern Kenya *World Development* 31 1477–94

Millner A and Washington R 2011 What determines perceived value of seasonal climate forecasts? A theoretical analysis *Global Environmental Change* 21 209–18

O'Brien K, Leichenko R, Kelkar U, Venema H, Aandahl G, Tompkins H, Javed A, Bhadwal S, Barg S, Nygaard L and West J 2004 Mapping vulnerability to multiple stressors: climate change and globalization in India *Global Environmental Change* 14 303–13

Orlove B, Roncoli C, Kabugo M and Majugu A 2010 Indigenous climate knowledge in southern Uganda: the multiple components of a dynamic regional system *Climatic Change* 100 243–65

Patt A, Suarez P and Gwata C 2005 Effects of seasonal climate forecasts and participatory workshops among subsistence farmers in Zimbabwe *Proceedings of the National Academy of Sciences of the United States of America* 102 12623–8

Peterson N D, Broad K, Orlove B S, Roncoli C, Taddei R and Velez M-A 2010 Participatory processes and climate forecast use: socio-cultural context, discussion, and consensus *Climate and Development* 2 14–29

Phillips J, Deane D, Unganai L and Chimeli A 2002 Implications of farm-level response to seasonal climate forecasts for aggregate grain production in Zimbabwe *Agricultural Systems* 74 351–69

Roncoli C 2006 Ethnographic and participatory approaches to research on farmers' responses to climate predictions *Climate Research* 33 81–99

Roncoli C, Ingram K and Kirshen P 2001 The costs and risks of coping with drought: livelihood impacts and farmers' responses in Burkina Faso *Climate Research* 19 119–32

Roncoli C, Ingram K and Kirshen P 2002 Reading the rains: local knowledge and rainfall forecasting in Burkina Faso *Society and Natural Resources* 15 409–27

Roncoli C, Jost C, Kirshen P, Sanon M, Ingram K T, Woodin M, Somé L, Ouattara F, Sanfo B J, Sia C, Yaka P and Hoogenboom G 2009 From accessing to assessing forecasts: an end-to-end study of participatory climate forecast dissemination in Burkina Faso (West Africa) *Climatic Change* 92 433–60

Roncoli C, Orlove B S, Kabugo M R and Waiswa M M 2011 Cultural styles of participation in farmers' discussions of seasonal climate forecasts in Uganda *Agriculture and Human Values* 28 123–38

Roudier P, Sultan B, Quirion P, Baron C, Alhassane A, Traoré S B and Muller B 2012 An ex-ante evaluation of the use of

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seasonal climate forecasts for millet growers in SW Niger *International Journal of Climatology* 32 759–71

Shankar K R, Nagasree K, Venkateswarlu B and Maraty P 2011 Constraints and suggestions in adopting seasonal climate forecasts by farmers in South India *The Journal of Agricultural Education and Extension* 17 153–63

Silvestri S, Bryan E, Ringler C, Herrero M and Okoba B 2012 Climate change perception and adaptation of agro-pastoral communities in Kenya *Regional Environmental Change* 12 791–802

Tschakert P 2007 Views from the vulnerable: understanding climatic and other stressors in the Sahel *Global Environmental Change* 17 381–96

Tschakert P, Sagoe R, Ofori-Darko G and Codjoe S N 2010 Floods in the Sahel: an analysis of anomalies, memory and anticipatory learning *Climatic Change* 103 471–502

Waiswa M, Mulamba P and Isabirye P 2007 Climate information for food security: responding to user's climate information needs in **Sivakumar M V K and Hansen J** eds *Climate prediction and agriculture* Springer, Berlin 225–48

Ziervogel G 2004 Targeting seasonal climate forecasts for integration into household level decisions: the case of smallholder farmers in Lesotho *The Geographical Journal* 170 6–21

Ziervogel G, Bharwani S and Downing T E 2006 Adapting to climate variability: pumpkins, people and policy *Natural Resources Forum* 30 294–305

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