

Clark University

Clark Digital Commons

International Development, Community, and
Environment

Faculty Works by Department and/or School

1-2023

Climate Services and Transformational Adaptation

Edward Carr

EdCarr@clarku.edu

Follow this and additional works at: https://commons.clarku.edu/faculty_idce



Part of the [Sociology Commons](#)

Repository Citation

Carr, Edward, "Climate Services and Transformational Adaptation" (2023). *International Development, Community, and Environment*. 542.

https://commons.clarku.edu/faculty_idce/542

This Article is brought to you for free and open access by the Faculty Works by Department and/or School at Clark Digital Commons. It has been accepted for inclusion in International Development, Community, and Environment by an authorized administrator of Clark Digital Commons. For more information, please contact larobinson@clarku.edu, cstebbins@clarku.edu.

Article

Climate Services and Transformational Adaptation

Edward R. Carr ^{1,2} 

¹ International Development, Community, and Environment Department, Clark University, Worcester, MA 01610, USA; edcarr@clarku.edu

² Humanitarian Response and Development Lab, George Perkins Marsh Institute, Clark University, Worcester, MA 01610, USA

Abstract: The Working Group II contribution to the IPCC's Sixth Assessment Report states that effective adaptation to the changing climate will require transformational changes in how people live. This article explores the potential for climate services to catalyze and foster transformational adaptation. I argue that weather and climate information are not, in and of themselves, tools for transformation. When designed and delivered without careful identification of the intended users of the service and the needs that service addresses, they can fail to catalyze change amongst the users of that information. At worst, they can reinforce the status quo and drive maladaptive outcomes. For climate services to serve as agents of transformational adaptation, the climate services community will have to change how it understands the users of these services and their needs. Building climate services around contemporary understandings of how people make decisions about their lives and livelihoods offers designers and implementers of climate services opportunities to create services that catalyze transformational adaptation. These opportunities provide examples for the wider field of adaptation to consider in its efforts to contribute to climate resilient development.

Keywords: adaptation; transformation; climate services; maladaptation; climate resilient development; risk; vulnerability; resilience



Citation: Carr, E.R. Climate Services and Transformational Adaptation. *Sustainability* **2023**, *15*, 289. <https://doi.org/10.3390/su15010289>

Academic Editors: Charles Herrick, Jason Vogel and Glen Douglass Anderson

Received: 7 September 2022

Revised: 9 December 2022

Accepted: 12 December 2022

Published: 24 December 2022



Copyright: © 2022 by the author. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

The IPCC's Working Group II contribution to the Sixth Assessment Report offers a stark message: we have delayed action for too long for incremental changes in our systems and the ways we live in the world to deliver a just, sustainable future [1]. Pathways to a climate-resilient future require the transformation of how we live in the world.

This assessment changes the calculus of adaptation programs, projects, and interventions. Actions aimed at preserving the status quo or introducing incremental changes intended to weather coming changes in climate will, in the end, not meet the moment. Instead, these efforts must facilitate transformative changes that move people toward climate-resilient improvements in human well-being, or climate-resilient development (CRD) [1]. At the same time, a growing literature points to the very limited evidence for the efficacy of our prior adaptation efforts [2,3] and growing evidence of their maladaptive outcomes [4–8]. In short, we have not been very good at climate change adaptation when framed around preservation. To pivot adaptation toward sparking transformative changes in how people live introduces even greater uncertainties to this project.

Climate services are an interesting adaptation intervention from which to consider how to facilitate or catalyze transformative changes toward climate-resilient development. They are information that, in and of itself, is not prescriptive (though there are cases where climate services are bundled with more prescriptive interventions such as seed and fertilizer programs). Thus, the intended users of this information can choose how they use it—in part or in whole, for the purposes envisioned by the producers of the service or for completely different goals. This lack of prescriptive power is evident in a growing body of work around the outcomes and impacts of climate services programs. In the ways in which it reveals

how weather and climate information are taken up and used by their intended users, this work [9–16] sheds light on what in development studies [17] is a well-trodden critique: development and adaptation experts do not fully understand the current needs of their intended users, let alone the ways in which this information might facilitate transformative changes toward CRD.

There is much we still do not know about the users of climate services and their needs [18]. However, research on the dynamics of livelihoods in the context of development and adaptation interventions, economic change, and a changing environment points us toward what to look for as we consider the use of climate services as tools for transformative change toward CRD. Specifically, when we interrogate the resilience of socio-ecologies such as those that characterize agrarian communities in West Africa, we can see opportunities to catalyze (but not direct) transformative changes. At the broadest level, these opportunities exist in terms of the ability to reduce risk and vulnerability for agrarian populations. Doing so appears to create space for innovations in livelihoods practices and transformational shifts in the identities associated with those practices [19]. At the same time, delivering information in a manner that exacerbates risk and vulnerability, including the risk of changing the existing social order in a community, can result in decisions and actions that reinforce socio-ecologies against change. Over time, this renders them more vulnerable to catastrophic failures and costly transformations [20].

For climate services to serve as agents of transformative adaptation, the climate services community will have to change the ways it understands the users of these services and their needs. After briefly describing the historical practice of climate service design, I discuss recent progress in efforts to identify climate services users and needs. I identify persistent knowledge gaps that will continue to challenge our ability to use climate services as tools for transformative adaptation. I then offer some examples of climate services that are creating space for transformative change, consider the ways in which climate services might catalyze more rapid changes toward CRD, and suggest lessons for other interventions seeking to promote transformational adaptation and CRD.

2. Designing Climate Services

The design of most climate services reflects an understanding of vulnerability as produced by exposure to the impacts of a variable and/or changing climate [15]. As a result, most early climate services were shaped by the availability of climate information and the ability to disseminate it [21,22]. Under this model, those with weather and climate information packaged and disseminated that information, allowing the recipients to do whatever they wanted with it. The design and dissemination of climate services often lacked careful consideration of who the intended users of the information were or what their needs might be.

While this was the dominant mode of climate service design until very recently, there were important exceptions, such as the initial design of Mali's Agrometeorological Advisory Program. The design of that program was shaped by Malians intimately familiar with agricultural production in the country, and who therefore understood who the users of this service were and what information they needed [23]. However, even this case of good initial design illustrates the challenges that the climate services community faced in identifying users and needs. As the drought that provided its initial impetus faded, the program was given new purposes and goals for which it had not been designed. Where once it had been well-targeted to specific users and needs, the expansion of program goals over the next two decades led to a situation where, by 2010, the program was making broad assumptions about its users and needs that were not borne out by examination [13,24,25].

More recently, a nuanced literature focused on the diversity of climate service end users and needs has emerged. Such work has lurked at the margins of the climate services community for two decades. In the early 2000s, Archer [26] and Roncoli [11,27] examined different users of climate services, whether farmers or in the forecast community. While this early work in this arena was slow to get traction, more recent development donor attention

to climate services has shifted the emphasis in their design. These organizations have increasingly looked to climate services as means to address important environmental and social challenges. Refocusing climate services on the achievement of goals requires attention to those who use the information, how they use it, and whether or not it helps them achieve their goals. Thus, the work of Roncoli and her co-authors [27] on the integration of scientific and indigenous understandings of precipitation forecasting set the stage for more recent work on how to overcome persistent misperceptions about end-users in the climate services community [28–30]. Work pointing to the differences among end-users and their ability to interact with forecasts [26,31] was foundational for more recent efforts seeking to identify the specific information needs of different end-users [32–36] and facilitated the emergence of gendered and feminist approaches to understanding end-user needs [15,37]. Today, engagement with the users of climate services is integral to conversations about their impact [38,39]. At the same time, it is not controversial to suggest that climate services, as a field, struggles with the effective identification of end users and their needs [40] and that substantial, systematic research on this subject is needed to move the field forward [18].

While users and their needs have become central to the design and implementation of many climate services over the past decade, one aspect of the framing of climate services has remained constant. Whether carefully considering users and needs or not, they are framed as defensive tools for the preservation of existing ways of living in the face of a changing climate, environment, and economy. Increased attention to users and needs allows us to think in more critical and nuanced ways about *whose* ways of living are preserved and protected by a particular service. However, at a time when the climate change community recognizes that transformational adaptation will be required to achieve CRD, interventions that preserve that which exists now risk becoming maladaptive. They can perpetuate practices that will become inviable over time or maintain social relations that act as barriers to significant changes in human well-being. Shifting the framing of climate services from defensive tools protecting people and livelihoods from the impacts of climate change to vehicles for the achievement of CRD requires more than just shifting the focus of climate services from the science of climate to the social and behavioral science of the intended end-user. It requires social science approaches that can identify opportunities for transformation that climate services might support or leverage.

Relatively little work in climate services has considered how they might contribute to transformational adaptation, or more broadly to CRD. Notable exceptions to this lie in work led by Hansen [38,41]. The approach in this work focuses on identifying broad relationships between the use of weather and climate information and the achievement of development goals. While this enables discussions of pathways by which climate services might, for example, address SDG 2 “Zero Hunger” [38], it does not unpack the very localized opportunities that such information leverages or the barriers that it overcomes to result in such impacts. To change climate services from efforts to hold off the bad effects of climate variability and change to vehicles for the sorts of transformation inherent to achieving development goals requires a different approach. I suggest that one productive means of understanding how climate services work as vehicles for transformational adaptation and the achievement of CRD is to understand how they intersect and interact with livelihoods, people’s ways of living in the world [42–44].

3. Using Livelihoods Analysis to Design Transformational Climate Services

A starting point for transformational climate services lies in understanding not only what the intended end-users of a given climate service want, but why they want it. This requires engagement with the perceptions of individuals and the social structures that give perceptions meaning. This sort of inquiry identifies two kinds of barriers and opportunities for climate services. The first are barriers to the uptake and use of different kinds of climate information. The second are barriers to and opportunities for such interventions to catalyze transformative adaptation that aligns CRD. This is not to suggest that climate science is

irrelevant to the development of transformational climate services, but that it should not be the starting point of the design and implementation of those services.

Using livelihoods to understand how climate services work is not entirely new. In an effort to strengthen drought-preparedness efforts, Roncoli and her co-authors [45] examined the livelihoods implications of a severe drought in Burkina Faso. Using the predominant framing of livelihoods at that time, one focused on material means of making a living [46–48], they examined how farmers' perceptions shaped their evaluations of and predictions for agricultural seasons. Through this work, they convincingly demonstrated that the farmers in their study were not helpless victims of drought, but agents worthy of engagement when planning forecasts, famine warnings, and other forms of weather and climate service. However, this early work differs from the question at hand in two important ways.

First, what Roncoli and her co-authors were studying was coping, rather than adaptation. Their goal was to demonstrate that farmers held stores of knowledge and practice for managing shocks like drought, and that what farmers know and do should be part of conversations that had, to that point, often been limited to development, humanitarian, and meteorological organizations. They did not examine the adaptive or transformational potential of the farmers in their study because that was not their aim.

Second, their framing of livelihoods and the ways in which farmers shifted them in the context of a drought was descriptive and material in its focus. Because the aim of the research was to demonstrate the value of farmer knowledge and practice to forecasting and early warning, there was little need for discussion of the social context within which farmer perceptions could be translated into decisions and actions. This work did not engage with the ways in which making a living is inextricably intertwined with making meaning of the world and how to live in it [42–44,49,50]. However, as the Working Group II contribution to the IPCC's Sixth Assessment Report recognizes, meaning, power, and agency are critical aspects of transformation and the achievement of CRD [1].

More recent work in livelihoods studies builds on the idea that livelihoods are always both about making a living and making sense of the world. This work creates opportunities for examining issues of meaning and value central to livelihoods decisions and practices, and therefore critical to the identification of opportunities for transformative change and CRD. Livelihoods research has developed a range of theoretical approaches to the making of meaning first articulated by Bebbington [44]. These include approaches that draw on Ortner's model of "serious games" [49], Bourdieu's theory of practice [50], and Foucault's concept of governmentality [43,51]. In this article, I draw from studies that employed the latter, in the form of the Livelihoods as Intimate Government approach. These illustrate how contemporary livelihoods approaches focused on meaning *and* materiality allow for the identification of barriers to the transformational use of climate services and opportunities for weather and climate information to catalyze such transformation.

3.1. Understanding the Transformative Potential of Climate Services through Livelihoods: LIG

The Humanitarian Response and Development Lab (HURDL) at Clark University has employed the Livelihoods as Intimate Government approach to both evaluate the impact of climate services in sub-Saharan Africa and to inform the design of new services. Through this work, HURDL has identified nuanced reasons for the limited uptake of weather and climate services tied to social structures, power relations, and meaning [13,15,25]. At the same time, it has also identified spaces where transformational change might take root and flourish if properly supported by targeted weather and climate information [19,20].

As an approach, LIG focuses on the different understandings and experiences of the vulnerability context expressed by individuals in the same community or household. These differences speak to the understanding of different stressors, activities, and identities, providing a point of entry into the construction of meaning through livelihoods in a given place. Broadly speaking, LIG treats meaning as emerging at the intersection of three things: (1) discourses of livelihoods, which reflect local understandings of the "correct" activities to undertake and the correct way to undertake them given the challenges of the context, (2) the

ways in which those discourses and understandings mobilize identity as they speak to who should conduct what activities and how they should be conducted, and (3) tools of coercion, locally-appropriate means of disciplining people to ensure they align with expectations of their identity and the discourses of livelihoods [43,51]. Methodologically, LIG employs rapid ethnographic methods, including participant observation and semi-structured interviewing. Typically, fieldwork is conducted by teams of two or more researchers, spending eight to ten weeks in a community [51].

3.2. Climate Services as Barriers to Transformation

A LIG analysis of the uptake and use of climate information provided by Mali's Agrometeorological Advisory Program speaks to how a well-targeted climate service might address short-term livelihoods and food security needs but over the long term hold back the sorts of transformation needed for successful adaptation. An initial assessment of the impact of the program commissioned by USAID [24] more than three decades after its launch found that the uptake of the advisories was very low and skewed toward men. Further investigation employed the LIG approach to explain this pattern of use [25]. The assessment found that the project was, on one hand, extremely well-designed for its stated purpose: addressing food availability challenges in the late 1970s and early 1980s. The advisories targeted key staple crops over which men had decision-making authority. Further, the nature of the advisories (such as providing farmers with constantly-updated information on when to plant, and what varieties to plant) meant that only the wealthiest fraction of men, those who owned both farm equipment and animal traction, could use the advisories. These, of course, were the men who would produce the most staple crop, and therefore be the audience that this program most needed to reach [13]. The assessment found that even in 2014, these men were still following the advisories [24,25].

However, the assessment also found that these advisories reinforced existing livelihoods—both their meaning and their material practices [25]. For example, by providing information that only the wealthiest, most senior men could use, the advisories reinforced the authority of these men over their households and extended families. As part of their role, these senior men are expected to make agricultural decisions for the fields of their families, most commonly the shared fields of the family. Such decisions also have implications for the fields of individual households in the concession because junior men do not want to contradict senior men. This can result in the loss of access to land and other agricultural resources. A senior man's power is not absolute. If he fails to successfully feed his family through his agricultural decisions and staple crop production, he can have his authority and status questioned or even stripped. Interestingly, the skill of these advisories, and thus their ability to productively inform on-farm decisions, has been questioned [52]. However, their accuracy might be beside the point. By providing something men could blame for faulty decisions, the advisories gave senior men a means of deflecting criticism of their decisions and therefore reduced their accountability to their households. Reduced accountability for those with the greatest authority increases the durability of existing social structures, even under conditions of environmental stress. These structures limit women's authority and autonomy, and thus circumscribe one of the most well-understood pathways to transformative change and climate-resilient development: empowering women.

3.3. Climate Services as Catalysts of Transformational Adaptation

Livelihoods analysis can help us identify situations where climate services reinforce the structural causes behind observed inequities in situations where transformational change is needed. It also can help identify opportunities for climate services to catalyze transformational change. I use the term catalyze advisedly here. As noted by Schipper and her co-authors [1], CRD pathways are not prescriptive steps that one takes toward a climate resilient future. Instead, these pathways emerge from formal and informal decisions taken by individuals, households, communities, and countries. More than 80 years of formal development practice have demonstrated that prescriptive transformations tend to reflect

the desires and beliefs of the “developed”, who are the wealthy and powerful, and thus those with the most invested in existing economic, political, and social structures. In short, this echoes an observation about livelihoods enabled by LIG, but at much larger scales. Just as in a household livelihoods decision, a transformation of international or global structures whose means and goals are managed by the wealthiest and most powerful is unlikely to challenge the structures that grant the powerful their privileges [43]. Seen from the perspective of the powerful, transformations are likely to be transformation for others, but status quo for the wealthy and powerful. Further, many decades of development have shown us that the transformations desired by “the developed” are often not those that “the developing” would select for themselves [17], resulting in many development projects and interventions with low rates of uptake and limited impact.

If we shift our thinking from the management of transformation to the catalysis of transformation, we shift our understanding of agency and outcomes in this process. While those with resources and authority are still able to invest in certain catalysts of change, they are not able to determine the final outcome of that which they start. Catalyzing change means creating opportunities for actors to make new decisions, take up new activities, and redefine how they live in the world in terms that make sense to them. Often the outcome is not far from the goals of formal development practice. For example, where we have seen women’s empowerment around the world, it has come less from donor-funded gender sensitization programs than from women who understand how to identify and leverage opportunities in their specific contexts. Numerous studies of reversals of environmental degradation have demonstrated that local knowledge of the environment often has much more to do with effective outcomes than outside technical knowledge.

If climate services are to be catalysts of transformational adaptation, they must clearly identify opportunities for weather and climate information to create the conditions within which people can act in new ways without reinforcing existing structures that act as barriers to transformational change. One example lies in a broad observation that has emerged across HURDL’s work on livelihoods. A broad synthesis of livelihoods data [19] spanning more than a thousand interviews and a dozen livelihoods zones across West Africa suggests that as individuals, households, and communities experience greater security from uncertainty and locally-specific drivers of vulnerability, spaces open for transformational change. For example, in Mali and Senegal, the most food and income secure households are also the places where one is most likely to find women taking on activities or roles that do not align with expectations, such as farming a “man’s crop.” In the most stressed and challenged households, we see no deviation from expectations.

This difference in attitude toward innovation and potential transformation lies in the ways stressors that challenge sources of income and assets present two threats. The first is material, which in the most stressed households can manifest as existential threats. Under such circumstances, insisting that all members of the household play their roles is justified as a pathway to safety and security in a context of vulnerability. At the same time, these stressors also threaten the existing social order. In these households, men are often failing to feed their families adequately. They therefore risk loss of status and authority each season. Allowing other members of the household to take on new tasks, or to take on tasks and responsibilities that belong to men, risks demonstrating that these men and their decisions need not be at the center of livelihoods. Thus, men have an incentive to carefully enforce roles and responsibilities in their households to ward off challenges to their authority. In situations where material and social stresses converge, livelihoods can become rigid to the point of brittleness. This puts households and communities at risk of catastrophic transformations where existing livelihoods (both activities and the meanings and order behind them) are pushed past thresholds of sustainability [20]. On the other hand, in households where production, and therefore the status of the man in charge of the household, is secure, a woman farming a man’s crop presents neither a material nor a social threat and is tolerated. Over time, such spaces of deviation and innovation can

quietly redefine what is seen as acceptable behavior for women, junior men, or others in society, creating a pathway toward CRD.

This suggests that one way that climate services can promote transformational adaptation and pathways toward CRD is by focusing on vulnerability reduction. This is not the same thing as risk reduction. Risk requires understanding the likelihood of a hazard's occurrence. Vulnerability, on the other hand, demands we understand how that hazard impacts a person's way of living in the world. By providing information that can lower the vulnerability associated with different livelihoods, climate services can create the sorts of security and safety that allow for the sorts of innovation and transgression that can result in transformation. Such outcomes might come through increased production during average years as climate services reduce the need for inefficient hedging. Perhaps forecasts can facilitate livelihoods planning to address the impacts of excessively wet, dry, or hot years. There are any number of possible contributions climate services might make to transformational adaptation and CRD. Like the observation about vulnerability reduction above, such contributions should be identified through nuanced understandings of the current structure of activities and society and be targeted toward explicit sites where change can be catalyzed. Following this line of thinking moves us past a framing of climate services as solutions for adaptation and development challenges in and of themselves. Instead, it presents climate services as locally appropriate facilitators of transformation to CRD.

4. Conclusions

The remaining pathways toward increased CRD are transformational in character [3]. The climate change community of practice is pivoting toward CRD as a framing for climate action that moves us past the preservation of current systems, structures, and levels of well-being. For climate services to contribute to this changing understanding of climate action and its goals, we must rethink their purpose. Where once climate services were also implicitly defensive tools for the preservation of current practices and structures in the face of growing threats, today climate services should be viewed as potential catalysts of CRD. How we might do this for climate services illustrates broader principles for transformational adaptation that can be applied to all manner of adaptation interventions.

The pivot to transformational adaptation makes the ongoing attention to users and needs central not only to the long-term relevance of climate services, but also to any adaptation intervention with transformational aspirations. The climate change community requires an expansion of inquiry into the users of adaptation interventions and their needs to fill the substantial gaps in our knowledge. However, this work must not fall into the trap of an exclusive focus on understanding and preserving what currently exists in the face of change. Inquiry into the opportunities for transformation in existing systems and situations is the foundation for transformational adaptation.

A pivot toward users and needs emphasizes the potential value and importance of co-produced adaptation interventions. However, it also highlights that such co-production itself must be built on a deep understanding of users [39,53–55]. In its discussion of the structures behind observed livelihoods decisions and uses of weather and climate services, this article highlights the need for deep engagement with users of adaptation interventions that will not emerge in a single workshop, but through extended engagement and learning through the design, implementation, and monitoring of adaptation in action. The identification of transformational opportunities is fraught with micro-politics and competing interests, making everything from who participates in co-production to the means of eliciting ideas and understandings critical to the transformational potential of such activities. Co-production is not, by itself, a means of making adaptation interventions effective catalysts of CRD. The character of co-production is critical.

Finally, aligning climate services with CRD highlights the need to coordinate adaptation interventions with other efforts to create opportunities for transformational change that speak to development challenges. While an effective seasonal forecast might tell farmers what they need to plant to avoid negative outcomes, without access to seeds and

appropriate farming equipment that information will not be translated into the safety and security that creates spaces of transgression and transformation. Further, even in situations where an adaptation intervention does contribute to increased safety and security, those seeking to transgress will need access to opportunity. While the women in wealthy, secure households described above *can* farm men's crops and avoid sanction or even attention, they cannot do so without access to seed, land, and farming equipment. It is only through deep engagement with the users of adaptation interventions that we will learn what opportunities they are seeking, what opportunities we can create, and the limits of different adaptation interventions on our path to CRD.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Acknowledgments: Any time one attempts to write a piece with a broad agenda, it stands on more shoulders than can be named in an acknowledgements section. This article benefited from more than a decade of conversations about adaptation and climate services with many colleagues, including John Furlow, Sheila Onzere, Helen Rosko, Kwame Owusu-Daaku, Daniel Abrahams, Tshibangu Kalala, Jim Hansen, Cathy Vaughan, Simon Mason, Glen Anderson, Steve Zebiak, Zack Guido, Jim Buizer, Janae Davis, and Rob Goble. My thinking on adaptation was also greatly influenced by my co-authors in Chapter 18 of the Working Group II contribution to the IPCC's Sixth Assessment report, including Lisa Schipper, Siri Eriksen, Aromar Revi, Ben Preston, Luis Fernández-Carril, Bruce Glavovic, Nathalie J.M. Hilmi, Debbie Ley, Rupa Mukerji, Silvia Muylaert de Araujo, Rosa Perez, Steve Rose and Pramod Singh.

Conflicts of Interest: The author declares no conflict of interest.

References

1. Schipper, E.L.F.; Revi, A.; Preston, B.L.; Carr, E.R.; Eriksen, S.H.; Fernandez-Carril, L.R.; Glavovic, B.; Hilmi, N.J.M.; Ley, D.; Mukerji, R.; et al. Climate Resilient Development Pathways. In *Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*; Pörtner, H.-O., Roberts, D.C., Tignor, M., Poloczanska, E.S., Mintenbeck, K., Alegria, A., Craig, M., Langsdorf, S., Löschke, S., Möller, V., et al., Eds.; Cambridge University Press: Cambridge, UK, 2022; pp. 2655–2807. ISBN 9781009325844.
2. Sitati, A.; Joe, E.; Pentz, B.; Grayson, C.; Jaime, C.; Gilmore, E.; Galappaththi, E.; Hudson, A.; Alverio, G.N.; Mach, K.J.; et al. Climate Change Adaptation in Conflict-Affected Countries: A Systematic Assessment of Evidence. *Discov. Sustain.* **2021**, *2*, 42. [[CrossRef](#)] [[PubMed](#)]
3. IPCC. *Summary for Policymakers*; Pörtner, H.-O., Roberts, D.C., Tignor, M., Poloczanska, E.S., Mintenbeck, K., Alegria, A., Craig, M., Langsdorf, S., Löschke, S., Möller, V., et al., Eds.; Cambridge University Press: Cambridge, UK, 2022; ISBN 9781139177245.
4. Eriksen, S.; Schipper, E.L.F.; Scoville-Simonds, M.; Vincent, K.; Adam, H.N.; Brooks, N.; Harding, B.; Khatri, D.; Lenaerts, L.; Liverman, D.; et al. Adaptation Interventions and Their Effect on Vulnerability in Developing Countries: Help, Hindrance or Irrelevance? *World Dev.* **2021**, *141*, 105383. [[CrossRef](#)]
5. Atteridge, A.; Remling, E. Is Adaptation Reducing Vulnerability or Redistributing It? *Wiley Interdiscip. Rev. Clim. Change* **2018**, *9*, e500. [[CrossRef](#)]
6. Magnan, A.K.; Schipper, E.L.F.; Burkett, M.; Bharwani, S.; Burton, I.; Eriksen, S.; Gemenne, F.; Schaar, J.; Ziervogel, G. Addressing the Risk of Maladaptation to Climate Change. *Wiley Interdiscip. Rev. Clim. Change* **2016**, *7*, 646–665. [[CrossRef](#)]
7. Schipper, E.L.F. Maladaptation: When Adaptation to Climate Change Goes Very Wrong. *One Earth* **2020**, *3*, 409–414. [[CrossRef](#)]
8. Eriksen, S.H.; Nightingale, A.J.; Eakin, H. Reframing Adaptation: The Political Nature of Climate Change Adaptation. *Glob. Environ. Change* **2015**, *35*, 523–533. [[CrossRef](#)]
9. Roncoli, C. Ethnographic and Participatory Approaches to Research on Farmers' Responses to Climate Predictions. *Clim. Res.* **2006**, *33*, 81–99. [[CrossRef](#)]
10. Peterson, N.D.; Broad, K.; Orlove, B.S.; Roncoli, C.; Taddei, R.; Velez, M.-A. Participatory Processes and Climate Forecast Use: Socio-Cultural Context, Discussion, and Consensus. *Clim. Dev.* **2010**, *2*, 14–29. [[CrossRef](#)]
11. Roncoli, C.; Ingram, K.T.; Kirshen, P.; Jost, C. Burkina Faso: Integrating Indigenous and Scientific Rainfall Forecasting. *IK Notes* **2001**, *39*, 1–4.
12. Rader, M.; Kirshen, P.; Asce, M.; Roncoli, C.; Hoogenboom, G.; Ouattara, F. Agricultural Risk Decision Support System for Resource-Poor Farmers in Burkina Faso, West Africa. *J. Water Resour. Plan. Manag.* **2009**, *135*, 323–333. [[CrossRef](#)]
13. Carr, E.R.; Onzere, S.N. Really Effective (for 15% of the Men): Lessons in Understanding and Addressing User Needs in Climate Services from Mali. *Clim. Risk Manag.* **2018**, *22*, 82–95. [[CrossRef](#)]

14. Carr, E.R.; Fleming, G.; Kalala, T. *Assessing Climate Service Needs in Kaffrine, Senegal: Livelihoods, Identity, and Vulnerability to Climate Variability and Change*; USAID: Washington, DC, USA, 2015.
15. Carr, E.R.; Owusu-Daaku, K.N. The Shifting Epistemologies of Vulnerability in Climate Services for Development: The Case of Mali's Agrometeorological Advisory Programme. *Area* **2016**, *48*, 7–17. [\[CrossRef\]](#)
16. Owusu-Daaku, K.N. (Mal)Adaptation Opportunism: When Other Interests Take over Stated or Intended Climate Change Adaptation Objectives (and Their Unintended Effects). *Local Environ.* **2018**, *23*, 934–951. [\[CrossRef\]](#)
17. Chambers, R. *Whose Reality Counts?: Putting the First Last*; Intermediate Technology: London, UK, 1997.
18. Carr, E.R.; Goble, R.; Rosko, H.M.; Vaughan, C.; Hansen, J. Identifying Climate Information Services Users and Their Needs in Sub-Saharan Africa: A Review and Learning Agenda. *Clim. Dev.* **2020**, *12*, 23–41. [\[CrossRef\]](#)
19. Carr, E.R. Properties and Projects: Reconciling Resilience and Transformation for Adaptation and Development. *World Dev.* **2019**, *122*, 70–84. [\[CrossRef\]](#)
20. Carr, E.R. Resilient Livelihoods in an Era of Global Transformation. *Glob. Environ. Change* **2020**, *64*, 102155. [\[CrossRef\]](#)
21. Hansen, J.W. Integrating Seasonal Climate Prediction and Agricultural Models for Insights into Agricultural Practice. *Philos. Trans. R. Soc. London. Ser. B Biol. Sci.* **2005**, *360*, 2037–2047. [\[CrossRef\]](#)
22. Hansen, J.W.; Mishra, A.; Rao, K.P.C.; Indeje, M.; Ngugi, R.K. Potential Value of GCM-Based Seasonal Rainfall Forecasts for Maize Management in Semi-Arid Kenya. *Agric. Syst.* **2009**, *101*, 80–90. [\[CrossRef\]](#)
23. Moussa, A.; Traore, K. Background and Function of the Agrometeorological Advisory Program. In *Assessing Mali's Direction National de la Meteorologie Agrometeorological Advisory Program: Preliminary Report on the Climate Science and Farmer Use*; Carr, E.R., Ed.; United States Agency for International Development: Washington, DC, USA, 2014; pp. 12–18.
24. Carr, E.; Dinku, T.; Giannini, A.; Kupfer, J.; Mason, S.; Moussa, A. *Assessing Mali's Direction National de La Meteorologie Agrometeorological Advisory Program: Preliminary Report on the Climate Science and Farmer Use*; Carr, E.R., Ed.; United States Agency for International Development: Washington, DC, USA, 2014.
25. Carr, E.R.; Onzere, S.; Kalala, T.; Owusu-Daaku, K.N.; Rosko, H. *Assessing Mali's l'Agence Nationale de La Météorologie's (Mali Meteo) Agrometeorological Advisory Program: Final Report on the Farmer Use of Advisories and the Implications for Climate Service Design*; United States Agency for International Development: Washington, DC, USA, 2015.
26. Archer, E.R.M. Identifying Underserved End-User Groups in the Provision of Climate Information. *Bull. Am. Meteorol. Soc.* **2003**, *84*, 1525–1532. [\[CrossRef\]](#)
27. Roncoli, C.; Ingram, K.; Kirshen, P. Can Farmers of Burkina Faso Use Seasonal Rainfall Forecasts? *Pract. Anthropol.* **2000**, *22*, 24–28. [\[CrossRef\]](#)
28. Nidumolu, U.; Lim-Camacho, L.; Gaillard, E.; Hayman, P.; Howden, M. Linking Climate Forecasts to Rural Livelihoods: Mapping Decisions, Information Networks and Value Chains. *Weather Clim. Extrem.* **2018**, *27*, 100174. [\[CrossRef\]](#)
29. Loboguerrero, A.M.; Boshell, F.; León, G.; Martinez-Baron, D.; Giraldo, D.; Recaman Mejía, L.; Díaz, E.; Cock, J. Bridging the Gap between Climate Science and Farmers in Colombia. *Clim. Risk Manag.* **2018**, *22*, 67–81. [\[CrossRef\]](#)
30. Guido, Z.; Zimmer, A.; Lopus, S.; Hannah, C.; Gower, D.; Waldman, K.; Krell, N.; Sheffield, J.; Caylor, K.; Evans, T. Farmer Forecasts: Impacts of Seasonal Rainfall Expectations on Agricultural Decision-Making in Sub-Saharan Africa. *Clim. Risk Manag.* **2020**, *30*, 100247. [\[CrossRef\]](#)
31. Roncoli, C.; Orlove, B.S.; Kabugo, M.R.; Waiswa, M.M. Cultural Styles of Participation in Farmers' Discussions of Seasonal Climate Forecasts in Uganda. *Agric. Hum. Values* **2011**, *28*, 123–138. [\[CrossRef\]](#)
32. Nkiaka, E.; Taylor, A.L.; Dougill, A.; Antwi-Agyei, P.; Fournier, N.; Bosire, E.N.; Konte, O.; Lawal, K.A.; Mutai, B.; Mwangi, E.; et al. Identifying User Needs for Weather and Climate Services to Enhance Resilience to Climate Shocks in Sub-Saharan Africa. *Environ. Res. Lett.* **2019**, *14*, 123003. [\[CrossRef\]](#)
33. Carr, E.R.; Abrahams, D.; De la Poterie, A.T.; Suarez, P.; Koelle, B. Vulnerability Assessments, Identity and Spatial Scale Challenges in Disaster-Risk Reduction. *Jambá J. Disaster Risk Stud.* **2015**, *7*, a201. [\[CrossRef\]](#)
34. Henriksson, R.; Vincent, K.; Archer, E.; Jewitt, G. Understanding Gender Differences in Availability, Accessibility and Use of Climate Information among Smallholder Farmers in Malawi. *Clim. Dev.* **2021**, *13*, 503–514. [\[CrossRef\]](#)
35. Diouf, N.S.; Ouedraogo, I.; Zougmore, R.B.; Ouedraogo, M.; Partey, S.T.; Gumucio, T. Factors Influencing Gendered Access to Climate Information Services for Farming in Senegal. *Gend. Technol. Dev.* **2019**, *23*, 93–110. [\[CrossRef\]](#)
36. Buckland, S.F.; Campbell, D. An Assessment of Factors Influencing Awareness, Access and Use of Agro-Climate Services among Farmers in Clarendon, Jamaica. *Geoforum* **2021**, *126*, 171–191. [\[CrossRef\]](#)
37. Carr, E.R.; Fleming, G.; Kalala, T. Understanding Women's Needs for Weather and Climate Information in Agrarian Settings: The Case of Ngetou Maleck, Senegal. *Weather Clim. Soc.* **2016**, *8*, 247–264. [\[CrossRef\]](#)
38. Hansen, J.; List, G.; Downs, S.; Carr, E.R.; Diro, R.; Baethgen, W.; Kruczkiewicz, A.; Braun, M.; Furlow, J.; Walsh, K.; et al. Impact Pathways from Climate Services to SDG2 ("Zero Hunger"): A Synthesis of Evidence. *Clim. Risk Manag.* **2022**, *35*, 100399. [\[CrossRef\]](#)
39. Vincent, K.; Archer, E.; Henriksson, R.; Pardoe, J.; Mittal, N. Reflections on a Key Component of Co-Producing Climate Services: Defining Climate Metrics from User Needs. *Clim. Serv.* **2020**, *20*, 100204. [\[CrossRef\]](#)
40. Porter, J.J.; Dessai, S. Mini-Me: Why Do Climate Scientists' Misunderstand Users and Their Needs? *Environ. Sci. Policy* **2017**, *77*, 9–14. [\[CrossRef\]](#)

41. Hansen, J.; Hellin, J.; Rosenstock, T.; Fisher, E.; Cairns, J.; Stirling, C.; Lamanna, C.; van Etten, J.; Rose, A.; Campbell, B. Climate Risk Management and Rural Poverty Reduction. *Agric. Syst.* **2019**, *172*, 28–46. [[CrossRef](#)]
42. Scoones, I. Livelihoods Perspectives and Rural Development. *J. Peasant Stud.* **2009**, *36*, 171–196. [[CrossRef](#)]
43. Carr, E.R. Livelihoods as Intimate Government: Reframing the Logic of Livelihoods for Development. *Third World Q.* **2013**, *34*, 77–108. [[CrossRef](#)]
44. Bebbington, A. Capitals and Capabilities: A Framework for Analyzing Peasant Viability, Rural Livelihoods and Poverty. *World Dev.* **1999**, *27*, 2021–2044. [[CrossRef](#)]
45. Roncoli, C.; Ingram, K.; Kirshen, P. The Costs and Risks of Coping with Drought: Livelihood Impacts and Farmers' Responses in Burkina Faso. *Clim. Res.* **2001**, *19*, 119–132. [[CrossRef](#)]
46. Chambers, R.; Conway, G. *Sustainable Rural Livelihoods: Practical Concepts for the 21st Century*; Institute of Development Studies: Sussex, UK, 1992.
47. Farrington, J.; Carney, D.; Ashley, C.; Turton, C. Sustainable Livelihoods in Practice: Early Applications of Concepts in Rural Areas. In *Natural Resource Perspectives*; ODI: London, UK, 1999.
48. Carney, D. Implementing the Sustainable Livelihoods Approach. In *Sustainable Rural Livelihoods: What Contribution Can We Make?* Department for International Development: London, UK, 1998; ISBN 9781861920829.
49. Jakimow, T. Serious Games in Livelihood Analysis: Reflections from the Case of Agricultural Wage Labourers in Andhra Pradesh. *J. Dev. Stud.* **2012**, *48*, 1274–1287. [[CrossRef](#)]
50. Sakdapolrak, P. Livelihoods as Social Practices—Re-Energising Livelihoods Research with Bourdieu's Theory of Practice. *Geogr. Helv.* **2014**, *69*, 19–28. [[CrossRef](#)]
51. Carr, E.R. From Description to Explanation: Using the Livelihoods as Intimate Government (LIG) Approach. *Appl. Geogr.* **2014**, *52*, 110–122. [[CrossRef](#)]
52. Mason, S.J.; Giannini, A.; Dinku, T. Assessment of Climate Science Used by Direction Nationale de La Météorologie Du Mali for Provision of Agrometeorological Information to the Rural Community. In *Assessing Mali's Direction Nationale de la Météorologie Agrometeorological Advisory Program: Preliminary Report on the Climate Science and Farmer Use of Advisories*; USAID: Washington, DC, USA, 2014; pp. 19–34.
53. Vincent, K. Development Geography I: Co-Production. *Prog. Hum. Geogr.* **2022**, *46*, 890–897. [[CrossRef](#)]
54. Vincent, K.; Daly, M.; Scannell, C.; Leathes, B. What Can Climate Services Learn from Theory and Practice of Co-Production? *Clim. Serv.* **2018**, *12*, 48–58. [[CrossRef](#)]
55. Bremer, S.; Wardekker, A.; Dessai, S.; Sobolowski, S.; Slaattelid, R.; van der Sluijs, J. Toward a Multi-Faceted Conception of Co-Production of Climate Services. *Clim. Serv.* **2019**, *13*, 42–50. [[CrossRef](#)]

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.