

How is gender investigated in African climate change research? A systematic review of the literature

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Abstract This systematic review analyzes all 260 studies published in the Web of Science on gender and climate change in Africa. While there is no strong methodological bias, comparative case studies and sex disaggregated analyses predominate from a limited set of countries. Many articles covered the agrarian sector by comparing women's and men's on-farm vulnerability to a changing climate based on their adaptation behaviours. Though this literature recognizes women's important conservation, farming, and food responsibilities, it oftentimes generalized these contributions without providing evidence. A number of themes were covered by a very limited number of articles, including coastal areas, conflict, education, energy, migration, urban areas, and water. Overall, more justice-oriented research is needed into the socioeconomic structures that intersect with social identities to make certain people, places, and institutions more vulnerable. Investigations into the power dynamics between (social) scientists and African institutions are also needed as most articles reviewed stem from North America and Europe and are locked beyond paywalls.

Keywords Africa · Climate change · Gender · Systematic review

INTRODUCTION

There is increasing recognition of the importance of conducting gendered analysis within climate change research. Africa features prominently in the literature on climate

change as people and governments across the continent are disproportionately vulnerable to its impacts, with limited capacity to mitigate and adapt to increasingly erratic rainfall, heat, drought, flooding and sea level rise. Women and men face unequal vulnerabilities to climate change because of differences in gendered norms, divisions of labour, resource access and power relations. This recognition is reflected in research funding agencies specifying gender as a focus in calls for proposals, such as those by the United Nations Framework Convention on Climate Change, the International Union for Conservation of Nature, the Consultative Group on International Agricultural Research (CGIAR) amongst many others, which have increased scholarly attention to gender in climate change research. Yet, it remains unclear the extent to which this research conducted about the African continent is building on wider gender and environment literature, how gender is being integrated methodologically, and what is being learned from this growing body of literature.

While research funding for and scholarship on gender and climate change in Africa has been steadily increasing over the past decade, statements of existing evidence and research gaps have been largely anecdotal and never comprehensively considered. This systematic search and review is the first that synthesizes and critically analyzes the emerging research on the intersection of gender and climate change conducted in Africa. We begin by contextualizing the literature search within the broader gender and environmental scholarship, and outlining the systematic search and review process broadly, before summarizing quantitatively and qualitatively the literature based on predominant sectors, geographic areas, theoretical framings and study designs. After discussing the predominant approaches and evidence, we point to the research gaps and

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biases of this literature and propose areas for further investigation.

CONTEXTUALIZING GENDER IN CLIMATE RESEARCH

The examination of gender has long been a part of broader environmental scholarship, evolving considerably over time. Since the 1970s, feminists have pushed back against male-biased knowledge of human-nature interactions that were problematically conceived as objective and neutral. Ecofeminists argue that women have essential knowledge of ecosystems and environmental protection that differs from men's knowledge because of their inherent connection to nature (Shiva 1988; Mies and Shiva 1993). The framing of women as being closer to nature than men by ecofeminists has also been widely challenged by other feminist scholars who have focused on gendered resource rights and labour roles (Agarwal 1992; Rocheleau et al. 1996). Differently, inequality in access to and control over resources and divisions of labour between women and men are thought to lead to differing perceptions of ecosystems. Ecological feminists and feminist political ecologists have argued that women tend to rely more on 'nature', common property and environmental resources compared to men because of their weaker material rights and disproportionate care responsibilities. These gendered differences translate to women having a greater interest in using natural resources more sustainably than men (Agarwal 1992; Rocheleau et al. 1996; Schroeder 1996). This systematic review assesses the extent to which discourses such as these are being integrated into studies on climate change in Africa. This review also considers the ways that African scholarship is complimenting, extending and countering these trends in the wider literature on gender and the environment.

Scholarship has also widely demonstrated how women are denied technologies and other assets provided by governments, markets, donors and NGOs that are needed to adapt to a changing climate, as well as given restricted access to and control over land, water, forests and other environmental resources (Moser 1993; Carney 1996). This gendered differentiation signals to women's greater vulnerability to environmental change, including climatic. The emphasis within gender and environmental studies more broadly, however, has largely remained focused on women. Feminist critiques have more recently pointed to the tendency in this literature to frame women in simplistic or contradictory ways—as either vulnerable victims of discriminatory social norms, or as agents of change, capable of saving the environment, and sometimes both (Leach 2007; Arora-Jonsson 2011). There is the continued danger

in scholarship on gender and the environment of reinforcing binary, static, homogenized notions of unpaid female care work and material subordination, or of emphasizing agency and making women 'responsible' for environmental improvements, adding to their existing work burdens (Nightingale 2006).

There is also a danger that gender and environmental theories, research questions, empirical methods and analysis developed by Western institutions, scholars and funders will heavily bias studies about the African continent. Decolonial scholarship in gender and environmental justice studies are contesting the status quo of knowledge production. Some of these critiques focus upon the power embedded within systems of knowledge production (e.g. Ndlovu-Gatsheni 2018), which have privileged male scholars based in the Euro-West (e.g. Medie and Kang 2018; Cochrane and Oloruntoba 2021; Tilley and Kalina 2021). Alternative approaches to scholarship that are being developed seek to decenter privileged voices and recenter those silenced and/or made invisible (drawing on the work of Ngugi wa Thiong'o) or call for a break from, or delinking with, the asymmetrical relationships that enable data extraction from the Global South to be owned and published in the Global North (via Frantz Fanon and Samir Amin). In addition to the power and relationships involved in data extraction and knowledge production, the epistemic, theoretical, and methodological biases regarding what is considered 'authentic' knowledge are increasingly being challenged (e.g. Afolayan et al. 2021), such that diverse ways of knowing, conceptualizing, and approaching can flourish.

Overall, gender and environmental scholarship, which includes a climate change subset, is shifting from being focused on 'women in/and environment' to 'gender and environment' and now to a 'gendering of' human-nature relations (Jerneck 2015). This evolution of thinking about ecosystems and environmental protection is about power relations and complex socioeconomic structures as opposed to simply individual subordination and agency. Gender is also further theorized as dynamic and negotiated through norms and values, intersecting with other social categories in different ways in different environments, and at varied moments in time (Nightingale 2006). These social identities can include gender, sexuality, class, race, ethnicity, religion, disability, nationality, life-course position, among others, which shape who does what, how, when, with what environmental resources and for what purposes (Mollet and Faria 2013; Sultana 2020). Given the lessons learned from other disciplines, and the interdisciplinary nature that climate change research demands, we would expect to see the climate change and gender literature in Africa drawing upon on these foundations. Building upon this evolution in thinking about gender and the environment, this systematic

review analyzes both the evidence from emerging research based in Africa and the methodologies employed. We also focus attention on how studies are engaging with the African continent to compliment, extend and counter these trends in the wider gender and environment scholarship.

METHODOLOGY

We conducted a systematic search and review of the peer reviewed literature on gender and climate change in Africa to understand predominant and emerging theoretical conclusions based on evidence (Siddaway et al. 2019). A systematic search and review uses particular methods to gather and analyze all evidence under a set of specific criteria to answer research questions in ways that minimize bias (Moher et al. 2015). This type of study is both critical and comprehensive by addressing broad questions to develop a synthesis of the best evidence of what is known and to identify limitations or gaps (Grant and Booth 2009). Though systematic search and reviews are generally more exhaustive than other types of reviews, they are still susceptible to the methodology employed for identifying and analyzing articles (Grant and Booth 2009). To minimize bias in the identification, selection, synthesis and summary of literature, this study follows the checklist outlined by the Preferred Reporting Items for Systematic reviews and Meta-Analyses for Protocols 2015 (PRISMA) as much as possible, given that this is a review of social scientific studies and not strictly scientific ones as suggested by PRISMA and some other systematic review processes (Moher et al. 2015).

To search for literature, we utilize the Web of Science (WoS) platform, which indexes peer reviewed literature. Relying on the WoS platform and English language literature alone presents some limitations. Notably, it represents a limited segment of available research, such as by excluding doctoral theses or reports published at African universities that are not indexed by the WoS. The search process of the WoS, which relies upon limited aspects (title, keywords, abstract) also means that some articles may be missed (in contrast, Google Scholar conducts a full text search for keyword matches but results in a much higher rate of false positives). Given the large volume of literature already included in this study, the focus remains on the WoS only for the purposes of feasibility. We recommend a follow-up study focusing on grey literature to complement this work.

This systematic literature search was conducted on June 7, 2020, through searching keywords in the WoS search bar located in the WoS Core Collection- Editions: All, under the category of Documents. The three keywords, 'gender', 'climate change' and 'Africa' were each put in separate

search rows within quotations distinguished by 'and'. All three rows were categorized under 'All Fields' to keep the search broad. The search also included a date range cutoff date of December 31, 2019. The eligibility criteria and information sources for this search included all peer-reviewed, published articles in English focused on human-nature interactions in Africa and time periods up until and including 2019. Since WoS searches by year of publication, we decided to search up until 2019 instead of part way through a year to allow for others to replicate this study. Based on these keyword and time search parameters, a total of 276 articles published between 2004 and 2019 were identified and analyzed. All of these articles were downloaded onto a shared and secure OneDrive folder. A qualitative scan of the abstracts determined that a small number of articles (16 in total) were false positives, as they did not study human-nature interactions in Africa. Figure 1 summarizes the systematic search and review process undertaken.

All 260 articles were analyzed through both qualitative thematic coding and quantitative aggregation techniques. For the quantitative analysis, different aggregates were made, including those based on the types of study designs. The quantitative analysis also included a synthesis of articles published based on the criteria of year of publication, geographic area, open access and research funding agencies, which are outlined in the following sections. The aggregation of the studies pointed to a number of themes which then guided the qualitative analysis of the review (Fig. 2). The qualitative analysis or review was multi-staged, theoretically grounded and iterative, involving all of the authors. The major research questions guiding the qualitative review include, how are women's knowledge, experiences, labour roles, rights to environmental resources and other services considered in the literature on African climate change? To what extent do these studies move beyond individual categorical analysis of 'woman' and 'man' to include power and complex social relations that intersect with other place based, social categories beyond gender? Initially the articles were divided amongst all of the authors, with the first author reading more articles than the others. Each article was then read in entirety and summarized in a shared Google document by each author based on the research questions. Each article summary was classified according to the thematic research areas based on their main broad study focus that is summarized in Fig. 2. Articles were summarized according to these themes, with some articles being recategorized into multiple categories, as appropriate. These categories were selected based on an initial analysis of the abstracts, which were then added to as the wider reading, annotation and summarizing process took place. After all of the articles were summarized (resulting in a document of 112 pages), some categories with

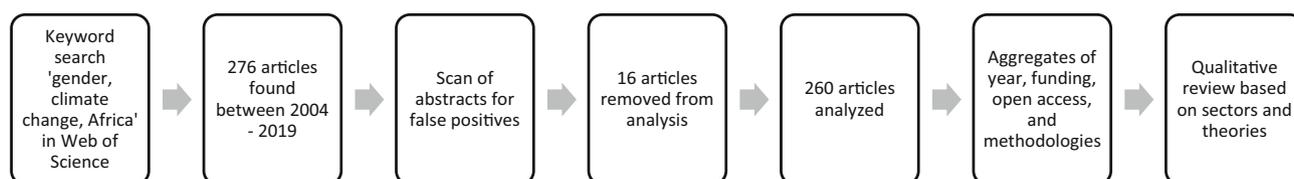


Fig. 1 Systematic search and review process undertaken

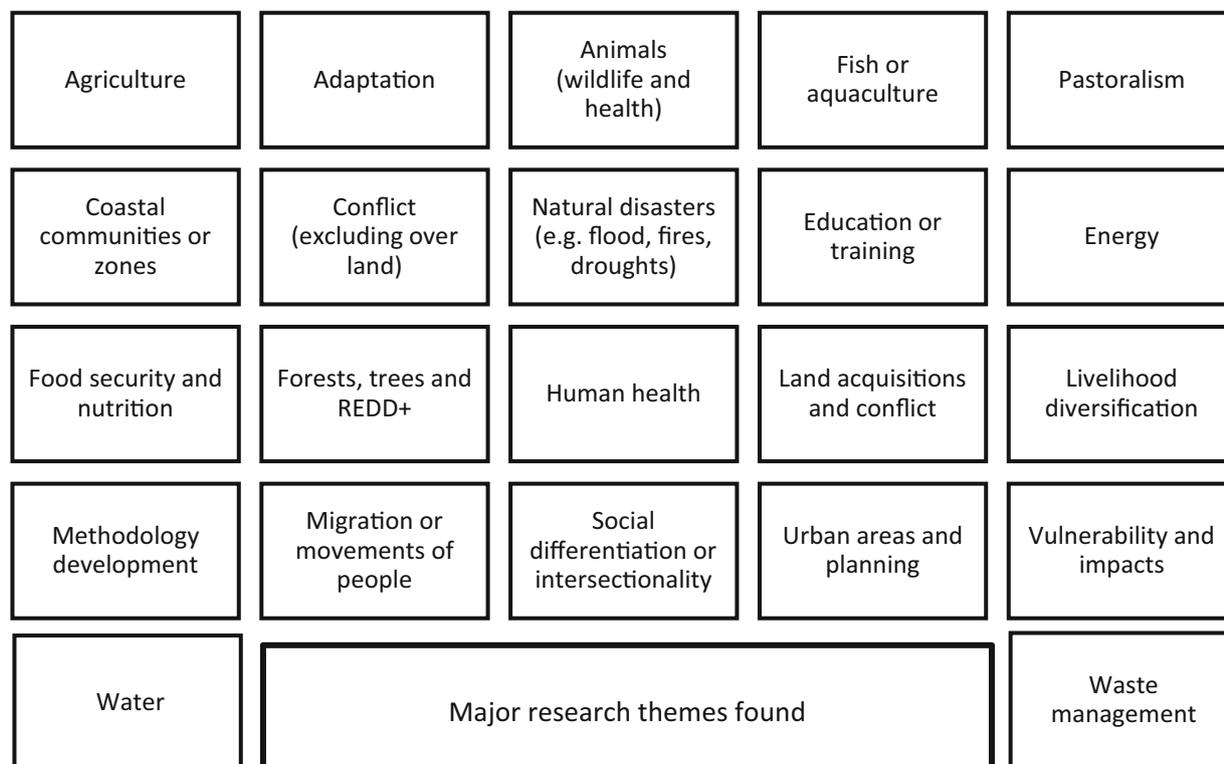


Fig. 2 Main broad thematic research areas found

very few articles were amalgamated under other themes, while others were disaggregated further because of the high number of articles.

Since systematic reviews are not objective nor neutral and are greatly influenced by the authors' interpretation of the broader literature, research questions, significance and gaps in studies considered, we briefly present the authors' positionality, which is an important feminist analytical method used for pointing to bias risks at the study analysis and outcome level. Dr. Siera Vercillo is a human geographer who investigates gender relations, agricultural development and household food security in West Africa. She is a social scientist who uses a mixture of mainly qualitative methodologies based in feminist geography and political ecology scholarship. She is less familiar with ecologically based, strictly scientific types of studies. Dr. Chris Huggins has a background in environmental studies and geography

and has conducted his research primarily in Central and East Africa. He uses largely qualitative methods in his own research and is inspired by critical political ecology. Dr. Logan Cochrane comes from a practitioner background, having worked with intergovernmental, non-governmental and governmental agencies, before transitioning to teaching and research. Much of Dr. Logan Cochrane's experience comes from East Africa, where he has been involved in qualitative, quantitative and mixed methods research projects. Overall, the authors' positionality is leaning towards critical, qualitative study, which translates to a focus on questions and interpretation of studies based on social relations and power dynamics. Though each author has been largely based in Western institutions, each has been working closely with universities and communities on the African continent for over a decade. As critical scholarship and feminist methodology suggests, the authors'

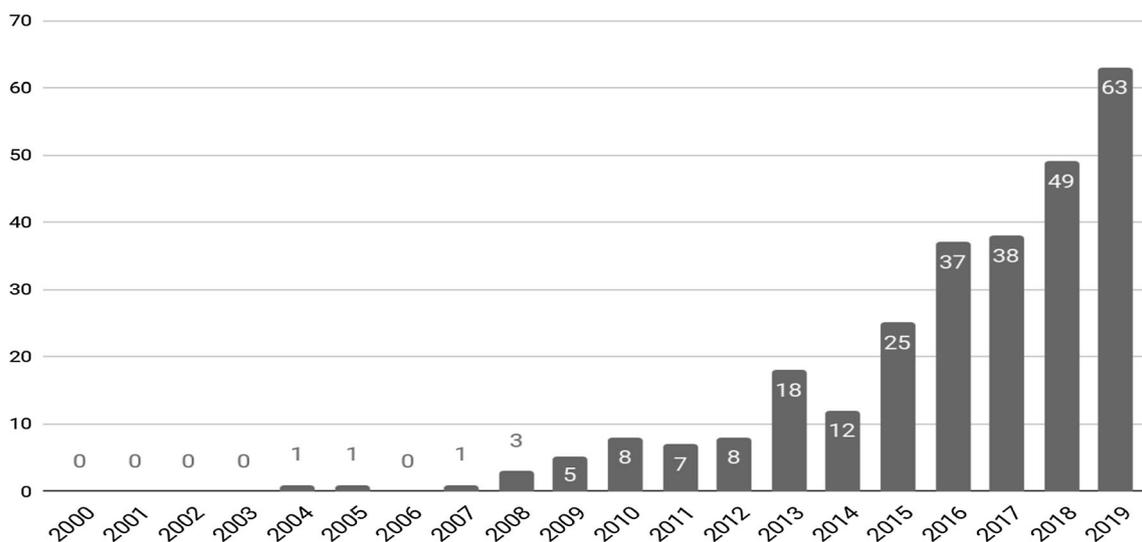


Fig. 3 Knowledge production over time (of selected literature)

analysis also seriously considers the way African institutions and people's perspectives are involved in studies in gender and climate change.

LANDSCAPE OF LITERATURE

Based on our aggregate analysis, we discovered that between 2000 and 2019 there has been a substantial rise of literature that considers the interconnections and interrelations between gender and climate change in Africa (see Fig. 3). However, the increase of available evidence is not necessarily equally available to all, particularly those beyond the university walls, as well as those working in academic institutions that do not have access to literature due to barriers of expensive journal subscriptions. In this data set, less than half (41%, 113 of 275) of the relevant publications were available as Open Access publications.

Alongside issues of inequality of access, this data set also identifies inequalities of research across the continent detailed in Fig. 4. The geography of research reflects some of the trends identified in previous studies, such as by Cochrane and Thornton (2018) and Hendrix (2017), who identified accessibility, population, language and relationships as key factors affecting where research is conducted. Of the most populous countries that are missing, four (Egypt, Algeria, Sudan, Morocco) could be explained by language (French, Arabic) and limitations of this study (the search focuses on 'Africa' when countries in North Africa may not have as frequently used this as keyword). This disparity of research also shows that many of the countries that most need research to support evidence-based decision making are under-researched. This includes countries like Chad, Somalia, Central African Republic, Eritrea, D.

R. Congo and Guinea-Bissau, which the ND-GAIN Index ranks as being the most vulnerable to climate change and having the least capacity to respond to it.

In addition to limitations of accessibility and disparities of research based on geography, we sought to assess if there were methodological biases in the literature on gender and climate change in Africa. While surveys were the most commonly utilized method, qualitative methods (interviews, focus group discussions) also had a significant place in the literature, as well as reviews (Table 1). Therefore, we did not find a strong methodological bias. However, the scale of studies were predominantly at the local level (63%), and of those local studies, comparative case studies were the most common. Scales that were researched less frequently included studies that focused on the global, continental, regional and national scales (respectively: 11%, 9%, 6%, 11%).

Knowledge production processes are also important to consider as funding agencies and affiliations have their own set of research interests and epistemologies that can predominate in the literature, leading to gaps and biases. Out of all the articles listed with funding organizations, 105 out of 131 articles (80%) were funded by agencies based in the Global North. The top 10 funders of the research sample are outlined in Table 2. Notably, all of the major research funders are based in the Global North (and specifically North America and Europe), with only one intergovernmental/international (IFAD).

THEMATIC AREAS

The following section summarizes the literature according to the main themes (see Fig. 4), as well as some of the

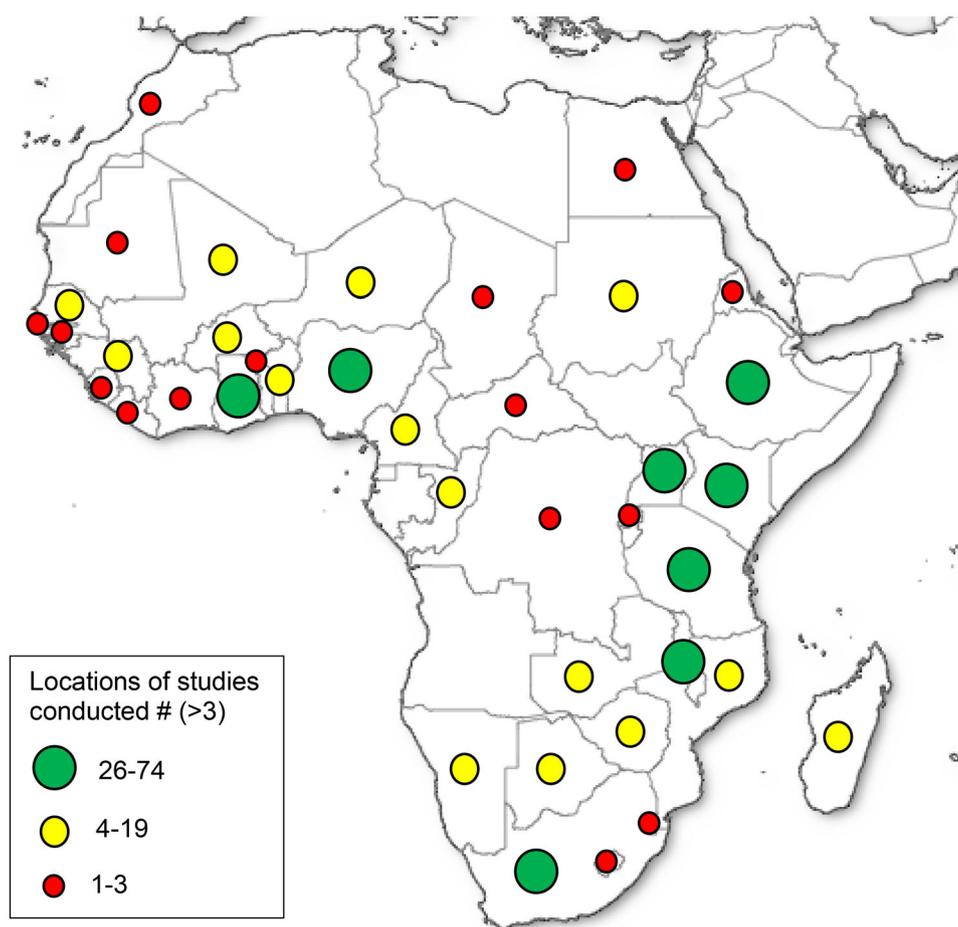


Fig. 4 Predominant locations of studies. *There are a number of limitations with this quantitative approach. For example, countries listed in affiliation appear as results, as do countries listed in titles within bibliographies. As a result, we have only counted the publications that have more than three mentions. Although this is arbitrary, it suggests something more substantial than an affiliation and/or bibliographic mention

Table 1 Most commonly utilized methodologies utilized in dataset

Methodology	Times employed	Percent of overall (%)
Ethnography	24	4.5
Qualitative and quantitative mixed methods	42	7.9
Other	43	8.1
Review	71	13.4
Focus group discussions	84	15.8
Individual interviews	96	18.1
Surveys	133	25.1
All others	41	7.1

*The number of methodologies used does not match the total publications included because many studies employ multiple methodologies, all of which were counted in this assessment

aggregates collected about the study designs employed. Based on the thematic analysis, categories with very few articles were amalgamated under other themes related to their links, while other themes or categories were disaggregated further because of the high number of articles. Table 3 summarizes the main findings and gaps of the studies categorized by the major themes. The last grouping includes an amalgamation of themes with fewer articles but were nonetheless present.

Agriculture

One main finding of our systematic review is that a large proportion of studies related to gender and climate change in Africa were focused on evaluating the practices supported by donor and state projects that women and men use in agriculture to adapt to a changing climate in order to discern gender differences in resilience. Little attention is given to locally specific or indigenous knowledge that does not reflect a particularly 'modernist' idea of capitalist,

Table 2 The top funding agencies (by record count)

Research Funding Agency	# of Articles Funded
United States Agency for International Development	12
European Union	9
Federal Ministry of Education Research (BMBF) (German)	7
National Science Foundation (USA)	7
Economic Social Research Council (UK)	6
Department for International Development (UK)	4
European Commission Joint Research Centre	4
International Development Research Centre Canada	4
International Fund for Agricultural Development	4

commercial development. Further investigations into how micro-level case studies on adaptation practices link to meso- and macro-level institutions and processes are needed, as they have their own implicit gender and Western biases.

52 studies were categorized under ‘agriculture’, which means that this category represents more than 20% of the sample. Of the 52 articles, about half were primarily quantitative and about half were qualitative, though six papers use both qualitative and quantitative methods. Within this category, 10 studies look at ‘adaptation’, 5 look at climate-smart agriculture, and there are several other less common sub-themes including conservation agriculture, climate change resilience, and postharvest storage. A total of 36 (67%) of these articles substantively incorporated gender dimensions into the conceptual framework, with the remainder of the papers simply providing sex-aggregated data or treating gender issues only tangentially. More than a quarter of all these studies focused on evaluation of projects, strategies, or technologies (e.g. a particular crop). There is a risk that agricultural risk management strategies might be abstracted from their particular context, reduced to ‘technologies’ which can be easily transferred, rather than understood as existing at the nexus of particular forms of local and/or indigenous knowledge, agro-ecological conditions, market demand, etc. In terms of gender theories, one article observes that in many cases, ‘studies have used binary household headship as their level of gender data disaggregation and eschewed more in-depth respondent analysis’ (Tavener et al. 2019, p. 2) which is reflected in our sample.

While most of the studies reinforce the narrative that women play significant labour roles in African farming systems but lack sufficient control over resources and decision-making power (particularly at intrahousehold level), several warn against over-generalization and

sweeping statements about ‘African women’, noting variations across contexts. For example, the studies that demonstrate differences in women’s and men’s crop production or land access as a way to discern vulnerability and resilience to a changing climate, tend to make claims about the gendered use of these crops (for subsistence or cash) based on generalizations, oftentimes about women’s production as being more subsistence-oriented than men’s, without providing evidence of this. One insightful paper paid attention to the gender inequalities embedded in agricultural policies and donor agendas which typically promote commercial crops, and economic forms of value, to the detriment of other goals that might be prioritized by women (Eriksen et al. 2019).

Adaptation

A total of 57 papers (about 22% of the total sample) were categorized as primarily addressing adaptation. About a quarter of the studies on agriculture used surveys and other methods to develop lists of adaptation strategies, which were sometimes combined with other variables such as perceptions of climate change. In this literature there is very little discussion of indigenous farming practices and knowledge of their environments (e.g. Lunt et al. 2018), despite the focus on farmers’ perceptions of a changing climate. These studies also rarely embed the adaptation strategies within detailed analysis of gender roles, gendered control over assets, or gender dimensions of agricultural policies. Due to the limited context, some of these studies were unable to explain gendered differences in adaptation strategies through empirical data and instead put forward suggestions based on literature or supposition.

Of the 57 articles, about 35 are primarily quantitative and 28 are qualitative, though 8 papers are both. Only 28 articles include gender dimensions in a fundamental way, with others mentioning them briefly or treating them outside of any gendered conceptual framework. Mubaya et al. (2017, p. 495) criticize what they see as a dominant trope of women as ‘vulnerable’, and provide empirical evidence from Zimbabwe to show that, women ‘emerge as victors and successful by adopting diverse household resource-use strategies to cope with food deficit situations, especially during lean seasons and natural disasters’. In addition to aggregated information from focus group discussions, this paper also provides short vignettes of individual women’s struggles and strategies, in order to emphasize their agency. Rao (2019) use a unique research design drawing on 25 comparative cases from Africa and Asia, explicitly focused on women’s agency. Importantly, the study identifies environmental stresses, changes in mobility of household members, and women’s working conditions as common factors which constrain women’s agency. Another paper

Table 3 Summary of the main trends found in literature and analytical gaps

Major theme	Number of studies	Main findings	Main gaps
Agriculture	52 articles	<p>Recognizes that women's farm labour is significant for subsistence;</p> <p>Acknowledges that women lack control over resources and decision-making power over farming activities compared to men;</p> <p>Distinguishes and evaluates farming practices and technology adopted by women and men;</p> <p>Climate smart or conservation agriculture is a major focus for evaluations;</p> <p>'Modernist' capitalist, commercial development is the basis for assessing men's and women's farming.</p>	<p>Local gendered knowledge and indigenous farming practices;</p> <p>Linking micro adaptation practices with wider political economic scales.</p>
Adaptation	57 articles	<p>Lists adaptation strategies, mostly in farming by women and men;</p> <p>Compares perceptions of climate change between women and men;</p> <p>Women's voice and agency for adapting to climate change is recognized often.</p>	<p>Embedding women and men's adaptation strategies within wider contexts, gendered roles, control over assets and agricultural policies.</p>
Animals (wildlife & animal health)	13 articles	<p>Women's engagement with animals, particularly as a livelihood.</p>	<p>Gender relations around animals, resource access, labour roles and wider political economic dynamics.</p>
Disasters (natural), including flooding, fires, droughts	6 articles	<p>Tallies women's and men's assets and roles in disaster management, which differ substantially by context.</p>	<p>Explain women's and men's assets and roles with baseline data;</p> <p>Gender disaggregation.</p>
Fish or aquaculture	8 articles	<p>Compare aquaculture livelihoods between women and men;</p> <p>Men focus more on fishing;</p> <p>Women focus more on fish processing and marketing.</p>	<p>Ways that climate change could affect livelihoods, gender relations and power dynamics;</p> <p>Differentiate between the impacts of climate change and other challenges such as over-fishing and water pollution.</p>
Food security, nutrition & human health	34 articles	<p>Female headed households are more food insecure than male headed households;</p> <p>Food and nutrition practices investigated in association with climate change adaptation;</p> <p>Recognizes women as major food producers for household consumption;</p> <p>Social differences and intersections, such as migratory status, place, education and group participation, which make some households more or less vulnerable to stunting and/or HIV.</p>	<p>Investigates the linkages between these themes.</p>
Livelihood diversification	9 articles	<p>Recognizes the gender differences in livelihood diversification choices that shape resiliency or vulnerability to a changing climate;</p> <p>Gendered productivity gaps are exacerbated by a changing climate.</p>	<p>Livelihood decisions made within constraints associated with wider political economic dynamics;</p> <p>Broader patterns experienced across social classes or sub-groups.</p>
Vulnerability to climate change	12 articles	<p>Examines how women and men perceive of and are differentially impacted by climate change;</p> <p>Gender differences in responsibilities related to food and the farm, as well as access to resources, education and training.</p>	<p>Inclusion and exclusion of women in decision-making and the challenging of cultural beliefs by various actors and institutions;</p> <p>Beyond gender to also understand class, racial politics, marital status and other social positions within the domestic sphere; Intersectional vulnerabilities.</p>

Table 3 continued

Major theme	Number of studies	Main findings	Main gaps
Forests and trees	20 articles	<p>Whether the effects of climate change on forests and trees differed for women and men;</p> <p>Differences in forest management and knowledge between women and men, recognizing women as important conservationists;</p> <p>REDD + and other forest management programming remains largely gender blind;</p> <p>Recognizes that gender is rendered 'technical' or largely about economics and divorced from power;</p> <p>Warned against the instrumentalization of women in programs for efficiency in practice.</p>	Frame women as either victims of discriminatory social norms, or as agents of change, capable of saving the environment.
Social differentiation and intersectionality	15 articles	<p>Demonstrates how gender roles, responsibilities and negotiations within different types of households shift in relation to a changing climate;</p> <p>Poorer households tend to have more rigid gender roles and also tend to struggle disproportionately with drought;</p> <p>Intersection of gender with ethnicity, generation, HIV status and/or those who were single, married, divorced, and widowed to understand vulnerability to climate change and adaptation;</p>	
Methodological development	11 articles	<p>Calls for integration of race, ethnicity, gender, class and politics into historical studies of climate;</p> <p>Scientific research can act as a form of coloniality.</p>	Did not adequately incorporate gendered dynamics into arguments.

expands the common definition of 'knowledge for adaptation' by placing emphasis on 'women's strategies to build social networks, access resources, and gain access to formal institutions' which, 'reflect equally important aspects of local knowledge' as more technical or agro-ecological aspects (Smucker et al. 2016, p. S277). In celebrating women's local knowledge/practices, the paper recognizes that these are also constrained by gendered inequalities. Another article which stands out in this group is Ngigi et al. (2018), which uses interview data from Kenya to conclude that men and women adapted to climate change due to similar motivations (desire for independence, happiness, comfortable life and good health). This paper is an example of successful combination of quantitative and qualitative methods and the feasibility of combining adaptation strategies with gendered agency, motivation, and the collective actions that might be possible as a result.

Animals, including wildlife, animal health (excluding fish/aquaculture) and pastoralism

Thirteen publications were grouped under this theme, representing a wide range of sub-themes that discuss women's engagement with animals, though with little consideration for gender relations, resource access, labour roles and dynamics. Most articles used qualitative methods,

though some used both qualitative and quantitative approaches. Only three articles focus on gender theory in a fundamental way. One of these, Balehey et al. (2018), examines gender roles, inheritance practices, intra-household decision-making practices, participation in community activities, and other dimensions, differentiating between livelihood strategies (agrarian, pastoral, and agro-pastoral) as well as men and women's roles. Grillos (2018) notes that there is relatively little rigorous work assessing the impacts of women's participation in environmental management institutions. Archambault (2016) notes that gender roles in Maasai households, seen as products of 'culture', have also resulted from external interventions that often narrowed the scope of women's decision-making. Maasai women's roles are changing rapidly, and their social and family networks, as well as small-scale business activities, are increasingly important to livelihood diversification in the face of climate change and other stressors. These types of changes to gendered relations should be considered further in other contexts.

Disasters (natural), including flooding, fires, droughts

The articles in this category are notable for using both qualitative and quantitative approaches, yet they largely

focus on oversimplifying explanations of adaptation strategies to disasters by tallying women's and men's asset access and roles. Of the six articles, four use mixed methods. Only one article in this category substantially focuses on gender roles: using the asset-based vulnerability and adaptation (AVA) framework, Afriyie et al. (2018, p. 271) conclude that in the Northern Region of Ghana, livelihood diversification as part of adaptation strategies, 'seem to reproduce existing gender based and age-related roles differentiations'. Importantly, this study observes that asset adaptation strategies, 'may not be easily observable to the outsider because of the multidimensional and small scale at which they occur' (Afriyie et al. 2018, p. 272). Another article (Bahta et al., 2016) is notable for its emphasis on the psychological impacts of exposure to risk (revealing mental health as an often overlooked variable). Bahta et al. (2016) also recognize that while women are typically less able to respond adaptively to disaster due to household power relations, a minority consider women's resiliency due partly to their motivation to protect and nurture their children. Several papers in this category appear to be problematic, either due to lack of explanation of key information, lack of baseline data, lack of substantial gender disaggregation, or over-simplifications of gender roles (e.g., identifying activities exclusively as 'men's' or 'women's' responsibilities without recognizing the negotiated nature of labour or changing gender roles).

Fish or aquaculture

This category included eight articles, which generally compare the different aquaculture livelihoods between women and men, with men focusing more on fishing and women focusing more on processing and marketing of fish, mentioning only in brief the ways climate change could affect these livelihoods, gender relations and power dynamics. Only two articles address gender through strong conceptual frameworks. Weeratunge et al. (2010) emphasize the importance of understanding the gendered dynamics of fisheries governance institutions, rather than only household-level decision-making processes and gender roles (though these need more research as well). Musinguzi et al. (2018, p. 567) acknowledge that women, "have substantial potential to increase household adaptive capacity" but overall, emphasize women's vulnerability much more than their agency. The majority (three) of the articles are purely qualitative; three articles are both qualitative and quantitative. Several of these articles observe that although fishing is often seen primarily as a male livelihood strategy, women and girls play important roles not only in marketing and processing of fish (well-

known roles) but also in less visible support activities such as making and repairing fishing gear, and subsistence forms of fishing and aquaculture. The involvement of women and girls in the fisheries sector may often be underestimated. Some of the studies mention climate change as a threat to the sustainability of fishing but do not adequately differentiate between the impacts of climate change and other challenges such as over-fishing and water pollution. It appears that the impacts of climate change on fisheries are not yet well understood (Cowx and Ogutu-Owhayo 2019), at least in literature paying attention to gender.

Food security, nutrition and human health

One of the largest themes discerned from the systematic search and review is related to investigating how climate change impacts on human health are gendered, including those related to food and nutrition (34 articles out of 260, or greater than 7%). A typical study design in this thematic area included household surveys and analysis that compare male headed (MHH) and female headed households (FHH) food security status, finding that FHH are more food insecure than MHH (e.g. Mabuza et al. 2016). These sex disaggregated studies also investigated food and nutrition practices associated with climate change adaptation (e.g. Ajaero 2017). However, we find that a large proportion of these articles (11 articles out of 34, or 33%) did not adequately investigate the linkages between these themes. For example, seven of these articles mentioned gender only in passing and four did not engage with climate change substantially. There are no primarily qualitative and ethnographic types of studies. Hernandez et al. (2019) is the only study in this category that utilized more open-ended methods, but still relied heavily on aggregate analysis of themes raised in focus groups.

A subset of studies in this category (8 articles out of 34, or 24%) have a more nuanced analysis of gender than presenting sex disaggregated data. These studies considered the effects of climate change on gender relations and broader social differences and intersections, such as migratory status, place, education and group participation, which made some households more or less vulnerable to stunting and/or HIV (e.g., Chersich et al. 2018; McKune et al. 2018). Some of these studies examined how gendered relations impacted climate adaptation and household food security and vice versa. For example, Bezner Kerr et al. (2019) found that households where farming adaptation was discussed between spouses were 2.4 times more likely to be food secure and have diverse diets than those that did not. Kpienbaareh and Luginaah (2019) also found that gendered power relations negatively influenced the

negotiation of environmental resources needed for adapting to increased wildfires, such as between women and herders, or women and those who process their crops, which shaped their food outcomes. Vibert (2016) is one of the few studies that considered broader issues of gender identity within community cooperation for food security and health practices that strengthened their resilience to climate change.

Livelihood diversification

While agriculture, climate adaptation and food security are major themes found in the systematic search and review, there were a number of articles that focused on livelihood diversification (9 articles out of 260, or 3%), which generally extended the findings from articles published on these other themes. These studies generally concluded that sex-disaggregated data show differences in livelihood diversification choices (e.g. Ajaero 2017) or that gendered productivity gaps are exacerbated by changing climate variables (e.g. Adzawla et al. 2020). These livelihood strategies are presented largely as a set of individual choices that shape resiliency or vulnerability due to a changing climate. Virtually all of the literature on gender, livelihood diversification and climate change are quantitative, and even those articles that conducted focus groups rely on more quantitative oriented analytical techniques of women's and men's individual livelihood choices, such as pairwise ranking (e.g. Kimaro et al. 2017).

There is, however, a subset of studies that conducted detailed gendered analyses which demonstrated the potential to produce important, explanatory and nuanced findings. For example, Tiwari et al. (2019) pointed to how women's greater financial autonomy and social networks, stemming from livelihood diversification, improved their authority over expenditure within the household. While livelihood diversification is discussed in the literature sample as a common household coping strategy, and the African countryside is sometimes characterized as undergoing multiple transformations, these discussions are not always fully contextualized. As theorized by various scholars (see review in de Haan and Zoomers 2005) livelihood pathways are influenced by multiple factors including 'technology, ecology and socio-economic differentiation' (Scoones and Wolmer 2002, p. 27). Carr's (2014) study stands out as both a critique and alternative to the framing of livelihoods as simply individual choices in other studies. He offered an alternative framework to understand how varied social groups perceived their wider vulnerability context; why disparities in these perceptions existed; and how they shaped individual livelihood decisions. Uniquely, he advocated for participant observation, which is a method largely missing from this literature category and downplayed in the wider literature overall.

Vulnerability to climate change

A surprisingly limited number of articles found in the systematic search and review focused primarily on investigating the gendered dimensions of vulnerability to climate change (12 articles out of 260, or less than 5%). The lower number of studies in this category is surprising given how widely the concept of vulnerability is mentioned across the articles in the broader search and review with 124 articles mentioning 'vulnerability' five times or more, and 154 mentioning 'vulnerability' three or more times. About half of these articles were primarily quantitative in nature (5 articles out of 12, or 42%) and often focused on providing sex disaggregated analysis only, typically of how women and men perceived of, and were differentially impacted by climate change (8 articles out of 12, or under 67%).

While there are no primarily qualitative studies in this category and only two mixed method studies, four of the articles took a more nuanced approach to conceptualizing and providing evidence about gender relations related to climate change vulnerability than sex disaggregated statistics. Differences in responsibilities related to food and the farm, as well as access to resources, education and training were also commonly disaggregated to discern gendered vulnerability to climate change (e.g. Randell and Gray 2016). However, Rao (2019) emphasized the importance of moving beyond the counting of men and women in the literature to investigating the nuances of inclusion and exclusion in decision-making and challenging cultural beliefs to understand the causes of vulnerability to climate change. Otherwise, there is the risk of homogenizing women's experiences in line with 'victimhood', negating their agency and perpetuating gender inequities. Iniesta-Arandia et al. (2016) demonstrated the value of work that goes beyond gender to also understand the way class, racial politics, marital status and other social positions within the domestic sphere intersected or deepened vulnerabilities and inequities. Advocating for ethnographic research, these studies point to how in-depth, qualitative research can demonstrate how people adapt dynamically to climate change in ways that sex disaggregated statistics cannot.

Forests and trees

Another group of studies found in the systematic search and review focused on assessing the effects of climate change on forests and trees and vice versa (20 articles of 260, or less than 8%). These articles included a well distributed mixture of primarily quantitative (6 articles), primarily qualitative (5 articles) and review (7 articles) types of studies. However, most of these studies had little if any engagement with gender or women, and those that did

investigated whether women and men perceived climate change differently and/or were affected by it differently (e.g., Sanogo et al. 2017; Wagner et al. 2019). Whereas other studies examined differences in forest management and knowledge between women and men, there was little discussion of how this was impacted by climate change (e.g. Gram et al. 2018).

One major theme found in the literature that examined gendered norms, relations and power dynamics within forest adaptation to climate change is related to programming intended to conserve forests. Larson et al. (2015) and Westholm and Arora-Jonsson (2015) found that while women were expected to participate in this programming, they were largely underrepresented in its design. As a result, REDD + programming, for example, remained largely gender blind. Gender seemed to be more of a 'bureaucratic obligation' of conservation oriented programming, rendered 'technical' or largely about economics and divorced from power. Ruth Meinzen-Dick et al. (2014) cautioned against overgeneralizations about women as conservationists in the literature. Jerneck (2015), Bee and Basnett (2017), and Struckmann (2018) further warned against the instrumentalization of women in these programs for efficiency in practice based on the evidence available.

Social differentiation and intersectionality

While many articles in our systematic search considered aspects of social differentiation, there were 15 that had this as their primary focus (out of 260 or under 6%). The articles primarily focused on social differentiation crosscut the other themes mentioned, such as livelihoods (Lau and Scales 2016; Quandt 2019), health (Githinji and Crane 2014), food security (Ajaero 2017), forests (Ofoegbu and Chirwa 2019), energy (Denton 2004). What is most striking about these articles is their primary engagement with gender as a socially constructed, and relational power-laden identity, situated in different places and often intersecting with other identities to shape vulnerability and resilience to a changing climate (9 articles out of 15, or 60%). A high percentage of these articles demonstrated how gender roles, responsibilities and negotiations within different types of households shifted in relation to a changing climate (e.g. Rao 2019). Anbacha and Kjosavik (2019) found that poorer households which tended to have more rigid gender roles, also tended to struggle disproportionately with drought. Quandt (2019), Githinji and Crane (2014), Iniesta-Arandia et al. (2016) and Van Aelst and Holvoet (2016) examined the intersection of gender with ethnicity, generation, HIV status and/or those who were single, married, divorced, and widowed to understand vulnerability to climate change and adaptation.

Methodological development

There were also a number of articles that focused primarily on contributing to a rethinking of how we can more comprehensively investigate and think about gender and climate change issues in Africa (11 articles out of 260, or 4%). Some of these articles proposed a rethinking of more quantitative methodologies (Bakker et al. 2018; Knippenberg et al. 2019), whereas others were primarily qualitative (Jagustovic et al. 2019), and some advocated for a mixture of both (Mwongera et al. 2017; Farnworth et al. 2018). Three articles reviewed literature to point to how to rethink certain theoretical frameworks. For example, Carey (2012) called for an integration of race, ethnicity, gender, class and politics into historical studies of climate. One study by Connell et al. (2018) in particular stood out as it reviewed the politics of knowledge in relation to climate change. They argued that because the natural sciences are founded on the principles of generalizable scientific laws, research can act as a form of coloniality. Climate researchers get their modelling frameworks from the metropole which is highly biased. These studies focused on methodological development however largely did not adequately incorporate gendered dynamics into their arguments.

Under-researched thematic areas

The thematic areas analyzed above were identified based on the data set and emerging trends. Several additional themes were identified, for which very little research emerged in the literature (10 articles of 260, or less than 4%). These under-researched thematic areas are discussed briefly here, in alphabetical order. Given that many densely populated regions are in coastal areas and that anticipated climate change impacts include sea level rise and increased flooding, it was assumed this would be an area of significant research. Outside of our dataset, this is a topic of significant study, often of technically oriented research, however studies that incorporate gender were very few. In fact, only one study examined the impacts and adaptation measures, a household survey in coastal Cameroon (Molua 2009). No research integrated aspects of climate, gender and conflict. In the education theme, Randell and Gray (2016) show the long-term impacts of climate variability on education, suggesting that educational outcomes and attainment will be negatively affected.

Under the energy thematic area research continues to seek cleaner and healthier alternatives for energy use at the household level (e.g. Jerneck and Olsson, 2013) and macro scale (e.g. Chirambo 2018). Yet, emerging solutions (e.g., biogas, solar, cookstoves) were not always suitable nor did they necessarily reduce gendered burdens, in some instances these increased time and work demands of

women (Marshall et al. 2017). Particularly given scholarly attention to the global land rush in the last decade (see e.g. Cochrane and Andrews 2021), we anticipated some research to explore intersections of climate, land appropriation and gender, but this was almost entirely absent, with the exception of Vaz-Jones (2018), who used feminist political ecology to contest conceptualizations of displacement.

A surprisingly limited number of articles (only 2) engaged primarily with the gendered dimensions of migration or the movement of people due to climate change. The relatively few studies under this theme is surprising given the popular narratives of climate migrants. Sow et al. (2014) in particular stands out as an interdisciplinary and in-depth qualitative study that examined the complexity of gender relations understood within wider contexts of political, economic and ecological transformations that shape people's movements. Greiner and Sakdapolrak (2013) finds that there are positive and negative effects of rural out-migration via remittances and loss of agricultural labour. Akin to the coastal studies, although urban areas and urban planning were of significant study, the intersection of that with gender and climate were minimal (e.g. Tacoli and Satterthwaite 2013). A significant contribution in this thematic area, however, was a special issue edited by Simon and Leck (2015), which included papers on Ghana, Mozambique, Senegal and Tanzania (although gender analyses remained peripheral). Some papers implicitly or explicitly signal the importance of urban markets when discussing livelihood diversification and off-farm occupations, but relatively few take account of 'circular migration', and broader urban livelihood networks within which 'rural' households might be partially embedded. More obviously, as pointed out in a recent paper, 'the majority of research in gender and climate change adaptation has focused on rural communities to the detriment of their poor urban counterparts' (Owusu et al. 2019, p. 13). The last under-researched thematic area was water, with notable contributions of a critical assessment of Ghana's water policy (Monney and Ocloo 2017) and Coulter et al.'s (2019) work on gendered decision making in Kenya from an institutional perspective of local associations. What all of these eight under-researched thematic areas highlight is that while significant advances are being made in a wide range of fields considering climate change, very few are also addressing questions of gender.

DISCUSSION

Major themes that emerge from this systematic search and review of literature on gender and climate change in Africa also point to research gaps and biases. This discussion

highlights (1) the prevalence of individual level, sex disaggregated analysis; and (2) limited decolonial and intersectional studies. We propose research areas and modes for further investigation based on a discussion of the potential consequences of the major biases and research gaps underlying these themes.

Individual level, sex disaggregated analysis

The vast majority of empirical articles in our systematic search and review are primarily sex-disaggregated studies focused on examining individual perceptions of their environments (e.g. Habtemariam et al. 2016). The inclusion of women's knowledge in relation to climate change in Africa compliments the wider gender and environmental scholarship that recognizes women's experiences as different from men's, critical for including a more comprehensive, unbiased study. Since sex disaggregated analyses, particularly those comparing male and female headed households' vulnerability and adaptation to climate change predominate in the literature (e.g. Kumasi et al. 2019), there is a limited conceptualization of gender as a socially constructed, nuanced and context specific reality, intimately associated with the environment and climate change.

There are a few studies that demonstrate the more gendered nature of human-environmental relations associated with climate change as recommended in the wider gender and environmental scholarship theorized by ecofeminists, feminist political ecologists, feminist geographers, among others, such as related to resource entitlement rights, decision making and labour burdens (e.g. Mubaya et al. 2017) and others that utilized creative methodologies like participatory mapping that go beyond sex disaggregation (De Giusti et al. 2019). A few studies should be commended for considering more collective actions around adaptation and resilience, rather than just individual/household-level actions (e.g., Vibert 2016; Nyantakyi-Frimpong 2019). While gender is increasingly theorized as dynamic and negotiated through norms and values, political and economic structures in the broader gender and environmental scholarship on human-nature interactions, the literature on gender and climate change in Africa generally targets individual women and men.

Stereotypical narratives or overgeneralizations pertaining to social norms, gendered roles, resource access and control to explain resiliency or vulnerability to climate change and potential pathways for adaptation are often reinforced in the literature on gender and climate change in Africa because of the limited scope of research designs focused on individual perceptions. Many studies compared women's adaptation activities, assets or livelihoods with men's, utilizing only secondary sources to explain these

findings, oftentimes calling it resiliency or vulnerability depending on the magnitude of similarity or difference (e.g., Wrigley-Asante et al. 2019; Adzawla et al. 2020). Explanations of gender differences frequently focus on discriminatory socio cultural norms and divisions of labour that tend to limit women's movements and resource use. Many studies gloss over wider political economic dynamics by putting blame narrowly on cultures or use other empirical studies to explain the differences in their particular case study, as opposed to conducting this research themselves. These generalizations, however, can lead to a reconfiguration of gender relations and divisions of labour through policy and practice in unexpected ways, oftentimes making the situation worse not better for women, such as by increasing their work burdens or causing a backlash, often violence against any support targeting women (Nightingale 2006; Vercillo 2020). Bee and Basnett (2017) warned against policy and practice that relied on using women to reduce poverty and achieve sustainability because it focuses on those who are often disproportionately vulnerable to overcome the barriers that constrained them. More in-depth, qualitative research that investigates the diversity and complexity of the causes of vulnerability and resiliency to climate change are needed to inform scholarship, policy and practice.

Limited decolonial and intersectional investigations

One striking pattern in the gender and climate change literature based in Africa is the limited decolonial and transnational feminist approaches (e.g., Jerneck 2015; Struckmann 2018). These approaches are useful to reorient research on gendered phenomena to those based in the Global South, thereby redefining human-nature interactions based on differing context-specific, political and social terms. Reorienting this research through a decolonial and feminist perspective can reconfigure policy formation and practice in ways that re-center marginalized voices at the global, national and local scales for long-term, sustainable change. The importance of feminist and decolonial research also reinforces the claims made by Connell et al. (2018) who argued that climate change research in Africa can act as a form of coloniality if governed by a subset of scholars and funding organizations. The aggregates of research funders that are found in this systematic review as predominating from North America and Europe, as well as the fact that less than half of articles are open access, also substantiate these critiques.

This orientation has also seemingly led to the absence of important questions, including investigations into the responsibility of the state and companies for gender equality, environmental protection and sustainability.

Literature in this systematic search and review tended to target and implicate climate change resilience and adaptation as the responsibility of individuals and households, which is in line with the tenets of neoliberalism. Marxist feminists have long argued that integrating women into environmental scholarship can serve to sustain existing exploitative structures globally, including the Global South's dependence on the Global North if the scholarship does not question underlying political, economic and social constraints (Struckmann 2018). Women are understood as one of the many exploited classes, alongside racialized and ethnic minorities part of a wider systemic process of accumulation and dispossession driven by Western markets that exploit the environment. Another radical shift is the focus on restricting wealth and riches, and less on the vulnerable and poor (Jerneck 2015). These theoretical perspectives situate research for redistributive justice of the harms caused in the Global South by the Global North related to industrialization. It can also shift the blame, and therefore research questions to the Global North, placing responsibility for the excessive carbon emissions less on individuals on the African continent and more on institutions, particularly those from outside the continent who are disproportionately deepening the climate crisis. This systematic review cautions against future research on gender and climate change in Africa that focuses on the individual, which can imply that the work needed of 'disrupting' gender norms be left to individual women, who are likely to face backlash from wider society.

Researchers need to be responsible for conducting inclusive, equitable investigations driven by those on the African continent, or else it is deepening inequalities in climate vulnerabilities. Bezner Kerr et al. (2019) found that smallholders in Malawi were responsible for < 1% of global greenhouse gas emissions, yet farmers blamed their own rural communities for changes in deforestation and rainfall patterns. This systematic review supports their claim for researchers to consider power dynamics between scientists and communities, which has been largely absent from the scholarship considered here.

Another important theoretical development emerging as an essential field in gender and environmental scholarship that is largely missing in this systematic search is the focus on intersectional disparities. There are a few studies, which demonstrated intersectional vulnerabilities related to gender with ethnicity, generation, HIV status and/or those who are single, married, divorced, and widowed to understand vulnerability to climate change and adaptation. Without considering the question of 'which women' are included in and excluded from research, existing knowledge may fail to be inclusive of certain groups.

CONCLUSION

This systematic search and review is the first that synthesizes and critically analyzes the emerging research on the nexus of gender and climate change conducted in Africa. We find that there are predominant sectoral areas of focus for investigation, particularly in agriculture, food security/health and rural livelihoods, which are concentrated in a limited number of countries. The vast majority of empirical articles in this systematic search and review offer sex disaggregated findings focused on individual perceptions of their environments, which generally suggests that climate change resilience and adaptation is the responsibility of individuals and households. There is also a limited conceptualization of gender as a socially constructed, nuanced and context specific reality, intimately associated with climate change, with very few papers conducting gender and intersectional analysis. Relatedly, the orientation of focusing on individual level studies has also seemingly led to the absence of important justice oriented and intersectional analyses, which miss important questions around the role of the state, corporations and the diversity of groups of people, potentially failing to reach those who are most vulnerable. Overall, more in-depth, qualitative research that investigates the diversity and complexity of the causes of vulnerability and resiliency to climate change are needed to inform scholarship, policy and practice that move beyond the individual towards socioeconomic and political and economic structures. Further research that considers power dynamics between (social) scientists and communities are needed due to the fact that the vast majority of funding for this research stems from agencies in North America and Europe, and more than half of studies remain inaccessible, locked beyond paywalls restricting access to evidence for those who likely most need it.

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