

RESEARCH ARTICLE

Climate-resilient aquatic food systems require transformative change to address gender and intersectional inequalities

Rahma Adam^{1*}, Anamika Amani², Rob Kuijpers², Katrine Danielsen³, Esther Smits², Froukje Kruijssen⁴, Nicole Moran², Michelle Tigchelaar^{5,6}, Colette Wabnitz^{5,7}, Alexander Tilley⁸, Matteo Luzzi⁸, Rumana H. Peerzadi⁹, Anouk Ride¹⁰, Cristiano Rossignoli⁶, Edward H. Allison⁶, Steven Cole¹¹, Irene Zatti², Kevin Ouko¹, Cathy Rozel Farnworth¹²

1 WorldFish Kenya, C/O International Livestock Research Institute, Nairobi, Kenya, **2** KIT Royal Tropical Institute, Amsterdam, The Netherlands, **3** Mondiaal FNV, Amsterdam, The Netherlands, **4** Aquaculture Stewardship Council, Utrecht, The Netherlands, **5** Center for Ocean Solutions, Stanford University, Stanford, CA, United States of America, **6** WorldFish, Bayan Lepas, Pulau Pinang, Malaysia, **7** Institute for the Oceans and Fisheries, University of British Columbia, Vancouver, Canada, **8** Food and Agriculture Organization of the United Nations (FAO), Fisheries and Aquaculture Division, Rome, Italy, **9** WorldFish, Dhaka, Bangladesh, **10** WorldFish, Honiara, Solomon Islands, **11** The International Institute of Tropical Agriculture (IITA), Dar-Es-Salaam, Tanzania, **12** Pandia Consulting, Münster, Germany

* R.Adam@cgiar.org



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Abstract

The adverse impacts of climate change on aquatic food systems (AFS) and the people who depend on AFS for livelihood security are inequitably distributed between and within countries. People facing the highest risks and experiencing the severest impacts of climate change are those who already experience multidimensional inequalities in their lives, particularly because of their gender, class, age, indigeneity, ethnicity, caste, religion, and the physical and political conditions that can create additional vulnerabilities. In this paper, we conducted a scoping review of the literature that explores the links between climate change, gender, and other social identities, and AFS. The review was complemented by an analysis of representative data on women and men aquaculture farmers in Bangladesh from 2018 to 2019. We also analysed data from the 2019 Illuminating Hidden Harvest project. The study relied on the gendered agrifood system and aquatic food climate risk frameworks to guide on literature search, review, and data analyses. Our findings show that intersecting identities disadvantage certain AFS actors, particularly young women from minority ethnic groups, and create challenge for them to manage and adapt to climate shocks and stresses. Examples of gender-responsive and transformative interventions are highlighted from our review to showcase how such intersectional disadvantages can be addressed to increase women's empowerment and social and gender equality.

1. Introduction

An aquatic food system according to the WorldFish Centre is “the complex web of all the elements and activities that relate to foods from water, along with parts of the broader economic,

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social, and natural environments in which they are embedded. It encompasses the steps from production all the way to consumption, as well as outcomes related to nutrition, public health, food security, social and economic prosperity, and environmental sustainability". Aquatic foods are harvested from inland and marine fisheries or produced through aquaculture. They contribute to global food and nutrition security, poverty alleviation, and economic development [1]. Over the past decades, AFS have been experiencing unprecedented stresses from anthropogenic activities, including over-exploitation of resources, habitat destruction, pollution, and climate change [2,3]. Concerning the latter, rises in temperature, ocean acidification, and climate extremes [4–6], for example, can all have a negative impact on AFS. Under a high-emissions, no-mitigation scenario, lower-income countries in Africa, the Indo-Pacific, and South and Southeast Asia are projected to face high climate risks to nutrition and health, social, economic and environmental outcomes of AFS by 2100 [7,8]. The AFS of higher-income countries are projected to experience low to medium climate risk even though these countries are among the highest emitters of greenhouse gases [7].

Broadly, people who face the highest risks and experience the most severe impacts of climate change are those who already experience multidimensional inequalities [9]. It is particularly pertinent to view risks associated with climate change and people's abilities to (in) adequately respond to climate change challenges through a gender and intersectional lens due to the ways in which gender and social inequalities get produced and reproduced in AFS and disproportionately disadvantage women and marginalized groups [9,10]. Women are especially vulnerable to challenges created by climate change because of their higher dependence on natural resources [11,12]. Yet women experience limited coping and adaptive capacities to climate change challenges owing to their multiple, competing responsibilities carrying out productive, household, and care work compared to men [12–15]. Unequal gender norms and power relations sustain this status quo [16].

This article investigates how gender, and other social identities, influence the adaptive capacity of AFS in the face of climate change. It explores the abilities of AFS actors to manage climate change risks and build resilience in AFS in gender-equitable ways. This paper addresses the following research questions: (1) How do gender and other social identities impact livelihoods in AFS experiencing climate change challenges? and (2) What are the coping strategies and adaptation and mitigation measures used by women and men whose livelihoods depend on AFS to deal with climate change?

To help explore these questions we first developed a conceptual framework that maps how climate shocks and stresses interact with gender and other socio-economic variables to shape AFS outcomes. Guided by this conceptual framework, we conducted a literature search and review from 2017–2022 on empirical studies that examined the interactions between gender and other social identities, climate change, and AFS. This timeframe was chosen to include the most recent research on the topic, while generating a realistic amount of information to process within the scope of the review. The key findings from the review highlight how gender and other social identities shape people's capacities to respond and adapt to climate shocks and stresses in AFS. Finally, we assessed participation rates of women and men in AFS using a global dataset developed by the Illuminating Hidden Harvest project and examined the key factors that influence women's adaptive capacities and resilience in a major aquaculture-producing country (Bangladesh) as a case study.

The overall aim of this paper is to show what we know about women's participation and resilience in AFS. Good practices were reviewed, and recommendations made based on these good practices.

2. Conceptual framework

We drew on [17] gendered agrifood system and [7] aquatic food climate risk frameworks to guide our literature search and review and data analyses. Fig 1 depicts our conceptual framework. In the upper part, climate risk is a function of hazards, exposure, and vulnerability. Stresses and shocks caused by climate change affect AFS in multiple ways, through rising water temperatures and sea levels, ocean acidification [2], reduction in dissolved oxygen levels, increased hurricanes, and cyclones[2], alteration of fish migratory patterns[18], declines in the capture and production of aquatic foods [19], among many others. As AFS change, those dependent on aquatic foods for sustenance and livelihood security can be negatively impacted

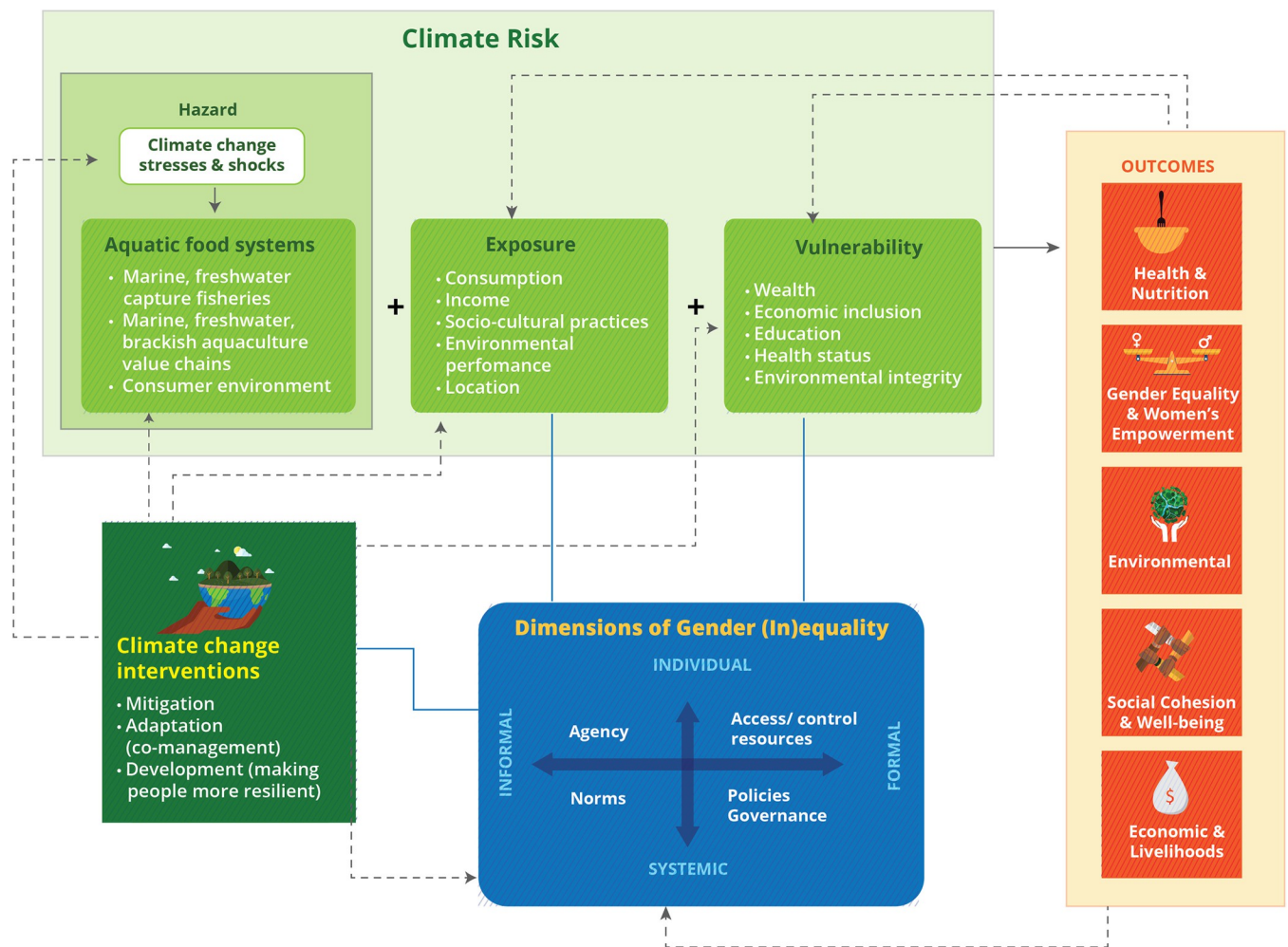


Fig 1. Conceptual diagram mapping the climate change-aquatic food systems-gender nexus. Reference to colors, lines' styles, directions, and sheds in Fig 1: Climate change poses a risk (solid arrow) to the different food system outcomes: Health and nutrition, gender equity & women's empowerment, environmental outcomes, social cohesion & well-being, and economic outcomes & livelihoods (red boxes). Climate risk (light green box) is a combination of climate hazards (climate change drivers impacting on different aquatic food systems), exposure (dependency on aquatic food systems for consumption, income, socio-cultural practices, and environmental protection, mediated by where aquatic food production is taking place), and vulnerability (constructed as a combination of sensitivity and adaptive capacity, as measured by indicators like wealth, economic inclusion, and education). Issues of agency, norms, access & resource control, and governance & policy (blue box) shape the dimensions of gender (in)equality in climate exposure, vulnerability, and interventions (blue lines). Climate change interventions (dark green box)—climate mitigation, climate adaptation, and actions to enhance the resilience of aquatic food-dependent communities—can target the different contributors to climate risk as well as dimensions of gender (in)equality (dashed arrows). The impacts of climate change on food system outcomes will further shape climate exposure, vulnerability, and gender (in)equalities (dotted arrows).

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by increases in aquatic food prices or income losses through reduced catch/production, and even by being forced out of AFS altogether [19,20].

People's exposure to the impacts of climatic stresses and shocks is determined by their relative dependence on AFS, species, and ecosystems [3]. Broadly speaking, the effects of stresses and shocks are felt more strongly for people with higher dependence on aquatic foods for food security and nutrition, income, and as part of socio-cultural practices [21–23]. The relative severity of the effects of climate change stresses and shocks clearly depends on the geographic location of people who depend on AFS [24]. Finally, disparities in climate risk arise from differentials in the vulnerabilities of men and women to the effects of climate stresses and shocks. Among social-economic factors such as health and economic status, the equity of AFS governance structures—particularly the ability of women and men to claim access to and control over the resources they need to participate effectively in AFS—contribute to how well they are able to manage and adapt to the adverse impacts of climate change [25].

In the lower parts of Fig 1, four interrelated dimensions of gender equality mediate AFS components and operate along two axes: (1) the formal/informal and (2) systemic/individual [26]. Importantly, the adaptive capacities of AFS actors are influenced by gendered and intersectional power dynamics at these levels. Intersectionality is premised upon the understanding that power inequalities arise from the ways in which multiple social identities, such as gender, age, marital status, religion, caste, indigeneity, ethnicity, and educational status interact to create unique experiences and advantages and disadvantages for individuals and communities [10,27–29] as they work to mitigate and adapt to the challenges they face. These interactions ultimately contribute to the differences we observe in AFS outcomes with respect to health and nutrition, gender equality and women's empowerment, the environment, social cohesion and well-being, and a range of economic and livelihood outcomes (right side of Fig 1). Fig 1 suggests that climate change interventions that address social and gender disparities in AFS outcomes must adopt approaches at the individual, systemic, formal, and informal levels to increase the agency and access to and control over resources of women and marginalized groups and transform unequal social and gender norms and discriminatory policies and governance structures. Table 1 presents definitions of key terms used in our conceptual framework.

3. Methodology

3.1 Scoping literature review

A scoping review framework was used to carry out the search and review. Scoping reviews identify the different evidence types (qualitative or quantitative) available on a particular topic and integrate this material through mapping or charting [40]. The process was divided into four steps: (1) identifying relevant studies, (2) screening and selecting relevant publications, (3) charting the data and information, and (4) assembling, summarizing, and reporting the results (Fig 2).

We limited our search to primary research articles in English published in peer-reviewed academic journals between January 2017 and October 2022. This timeframe was chosen to include the most recent research on the topic, while generating a realistic amount of information to process within the scope of the review. University of Amsterdam web library databases including Google Scholar, Clarivate Web of Science and Scopus were used. The search string was based on key components of the paper's conceptual framework: aquatic food (sub-) systems, gendered and intersectional inequalities, vulnerabilities, and adaptive capacities, as well as related outcomes and interventions.

Table 1. Definitions of key terms used in the conceptual framework that maps the climate change-aquatic food systems-gender nexus.

Term	Definition	Source
Climate risk	The potential for AFS to fail to provide sufficient, appropriate, and accessible food to all, nutrition, and health benefits, or worsen the economic, social, and environmental outcomes. Climate risk is a function of hazard, exposure, and vulnerability.	[30–32]
Climate shocks	The instantaneous events caused by climate change that typically occur in a short period, whereas stresses refer to events caused by climate change that are often chronic and last for an extended duration.	[33,34]
Hazard	This includes processes that range from brief events, such as severe storms, to slow trends, such as multi-decade droughts or multi-century sea-level rise	[35]
Exposure	The fact or condition of being affected by the social, economic, and environmental implications of climate change in AFS.	[36]
Dependency	The state of relying on or being controlled by the social, economic, and environmental landscape of AFS.	[36]
Vulnerability	The propensity or predisposition to be adversely affected, and it carries several elements, including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.	[37]
Adaptation	Adjustments in ecological, social, or economic systems as a result of real or anticipated climate-related stresses and their impacts. It refers to changes in systems, methods, and structures to minimize possible harm or to take advantage of opportunities brought on by climate change.	[38]
Mitigation	Limiting the quantity of emissions released into the atmosphere and lowering the existing levels of carbon dioxide (CO ₂) by strengthening carbon sinks.	[38]
Gender equality	Refers to creating of, or the outcome of equal opportunities for women and men by removing formal barriers. This involves changing policies that exclude (primarily) women from equal access to fisheries jobs, markets, or other resources.	[39]
Gender equity	This is the process by which equality can be achieved by acknowledging the different positions of women and men in society and compensating for those differences. This includes capacity development aimed towards women, but also programs that incorporate elements of gender and power at several different levels.	[39]

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A total of 14,135 papers were obtained. The software package Cadima was used to identify and delete duplicates, resulting in a final sample of 1,966 original papers. Cadima was further used to screen article abstracts based on the inclusion criteria described below:

1. articles presenting primary qualitative or quantitative data through case studies, or evidence-based reviews.
2. articles with a clear focus on AFS and,
3. articles on gender and intersectional dimensions of climate change.

This process resulted in 32 articles for inclusion in our review. Nvivo was used to code the selected articles. They were categorized using the following classification: year of publication, country-specific risk profile [7], methodology, aquatic species focus, means of production (fisheries or aquaculture) (Table 2). Nine papers used quantitative research methods, 19 used qualitative research methods, and 4 used mixed methods. Most papers focus on a small subset of communities or a localised region in the world. The article set was complemented by a purposive literature review to help set the stage in the introduction, and to explain and reflect on the findings. This resulted in a final count of 125 publications.

3.2 Limitations of the scoping review methodology

There are a few limitations to the scoping review methodology we employed. First, we limited our search to journal articles in English. This may have had consequences for geographic scope: majority of the papers reviewed focused on Asia and Africa and with the remainder on

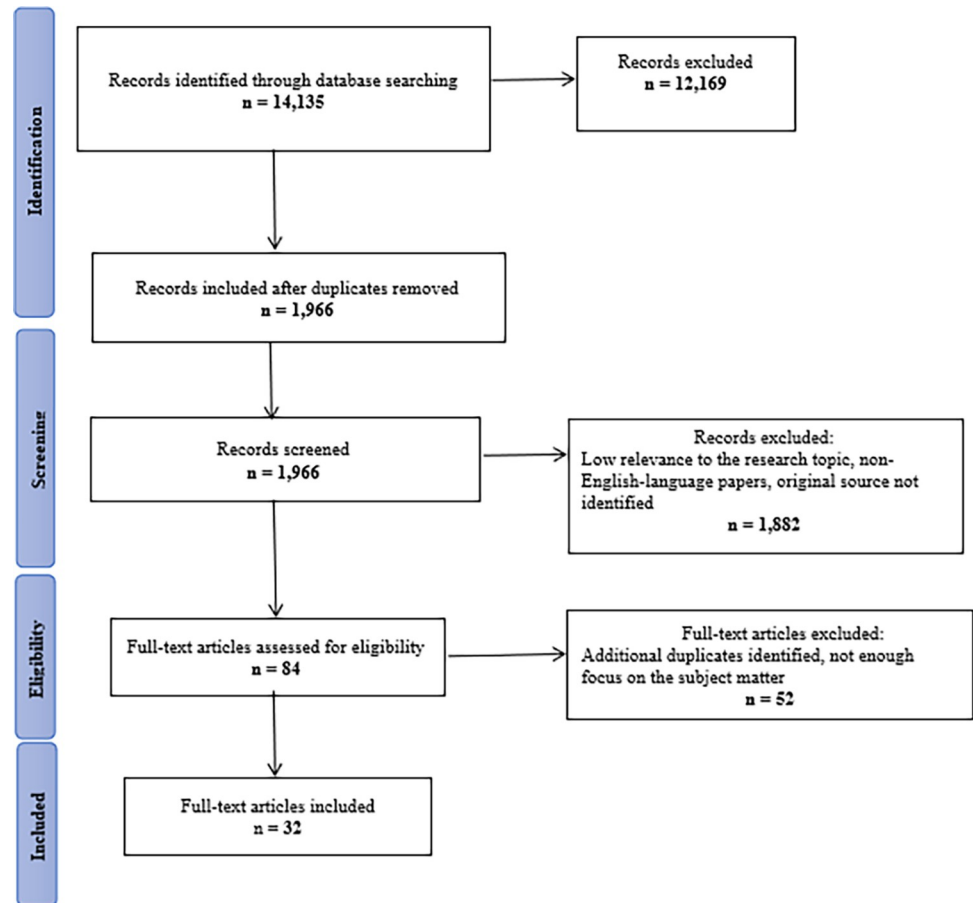


Fig 2. The PRISMA flow chart of the selection process for studies that examine climate-resilient aquatic food systems and gender and intersectional inequalities.

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Americas, the Caribbean, Europe, and Oceania. Second, since our literature search focused on academic peer reviewed journal articles, our paper may have failed to capture relevant information in grey literature. Third, the methodological focus of case studies in our literature review sample was mostly qualitative. This may pose limitations to drawing generic conclusions.

3.3 Data and methods for complementary data analysis

To complement the scoping literature review, we conducted an analysis of secondary data. First, we used a dataset developed by the Illuminating Hidden Harvests (IHH) project to assess the participation rates of women and men in small-scale fisheries globally ([S1 Data](#)). This included household income and expenditure surveys from 78 countries in the period 2008–2018. Data on aquaculture were not collected. The IHH dataset provides sex-disaggregated employment estimates for the pre-harvest, harvest, processing, and trading stages of the fishery value chain, and estimates the number of people involved in small-scale fisheries for subsistence. Regional estimates of employment and subsistence were then estimated by extrapolation from these 78 countries to the regional level using weighted regression analysis and validated through comparison with other global datasets (Additional information 2). We conducted an elaborate search to find representative and gender-disaggregated quantitative

Table 2. Distribution of included papers by year of publication, location, methodology and sample size.

Paper characteristics	Number of papers (%) Total (n) = 32
Year of publication	
2017–2020	15 (46.88%)
2020–2023	17(53.12%)
Risk Profile	
Cluster 1	14 (35.38%)
Cluster 2	10 (35.38%)
Mixed	2(6.25%)
Unspecified	6(18.75%)
Methodology	
Mixed Methods	4(12.5%)
Qualitative	19 (57.58%)
Quantitative	9 (28.12%)
Species Focus	
Unspecified	30 (93.75%)
Shrimp	1 (3.13%)
Hilsa	1 (3.13%)
Specific to fisheries	
Yes	27(84.38%)
No	5 (15.62%)
Specific to aquaculture	
Yes	5(15.62%)
No	0 (84.38%)

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data on either aquaculture farmers or small-scale fishers for complementary analyses on gender-based differences in resilience and adaptive capacity but found very limited datasets meeting these requirements.

Second, we analysed data collected by the 2019 Bangladesh Integrated Household Survey (BIHS) to explore the linkage between adaptive capacity and resilience of women and men aquaculture farmers. The use of the BIHS is motivated by the importance of Bangladesh as an aquaculture producer, the country-level representativeness of the dataset, and the detailed data related to adaptive capacity and resilience obtained through interviews with both men and women aquaculture farmers. For small-scale fisheries a representative and sex-disaggregated dataset was not available. After isolating households engaged in aquaculture (n = 2,279), we used data from the Women's Empowerment in Agriculture Index (WEAI) module to carry out our analysis. The WEAI module contained information on both male and female primary decision-makers. We calculated sex-disaggregated average values on variables that are believed to correlate with adaptive capacity and resilience, such as access to resources and information, influence in community decisions, group membership and the time available for non-reproductive work (Additional information 3). To assess whether the differences in means were statistically significant we used t-tests for continuous variables and two-proportion Z-tests for binary variables.

4. Findings

The findings from our scoping literature review and analyses of the two datasets are presented under three broad heading based on the synthesis of the conceptual framework (Fig 1): (i)

gender data in AFS, (ii) gender and resilience, and (iii) climate change and intersecting social identities.

4.1 Gender data in AFS

AFS data are insufficiently sex-disaggregated particularly with respect to formal national-level fisheries statistics. This appears to be for the following reasons. First, more effort has been directed to research (including boat-based, gear-driven, and finfish fishing among others) in capture fisheries, which men dominate [41,42]. Although women dominate near-shore and on-shore fishing and gleaning, and shell-fisheries, these fisheries remain understudied and thus overlooked despite their importance to the livelihood resilience of often marginalized peoples and the contributions of such activities to food security and nutrition [43]. Importantly, women's work in these aspects of fisheries tends to be relabelled, not as fishing, but rather as (for example) minor work "mussel collectors" and framed as complementary and supportive to that of men who engage in actual fishing [44]. Second, global and national fisheries statistics focus on men-dominated formal markets. Less research attention is paid to small-scale retail, and informal markets, where women mostly dominate [41,45]. Third, conceptual biases in statistical models frequently undervalue the unpaid labour women provide to AFS. This includes making and repairing fishing nets and traps, procuring bait, repairing, and maintaining their husband's clothing for their fisheries' work, cooking for family and deckhands, contributions in some cases to administrative running of fisheries enterprises, and fish processing. These tasks are widely taken for granted, seen as 'helping out' and not valorised [46–49].

The aforementioned conceptual biases are reinforced by, fourth, the assumption that the efficacy of fisheries management can be adequately optimized by studying catch and fishing efforts and that other dimensions of small-scale fisheries, such as nutrition security and the livelihood security and adaptability of the poorest to climate change are less important [50]. Fifth, an underlying conceptual bias can be detected. The framing of men as fisheries actors is global and cross-cultural and is reflected in the normative framing of fishers as fishermen, including in languages like Portuguese that have a feminine form—*peçadora* in this case—yet rarely use them [51]. Linguistic invisibilization at higher levels is reinforced by women, as well as men, in fishing households themselves. Women rarely identify themselves as fishers or fisherwomen, nor does the wider community [52] see also [53], on how people literally may not see women's work). Iterative processes develop which continually screen women's work in fisheries from view [43,54].

The IHH study (2023) is an attempt to correct gendered data biases. It confirms that sex-disaggregated fisheries data, particularly in formal national-level fisheries statistics, remain rare (Additional information 4). However, as represented in Fig 3 estimates that women comprise 50% of the trading and processing workforce, and that 45% of the fishers in small-scale, subsistence-oriented fisheries are women (Additional information 5). However, women comprise 15–19% of the actively employed (Additional information 6). These findings hold true for all world regions, including Asia and Africa, which have the largest populations dependent on fisheries for their food security, nutrition, and income (see S1 Fig).

4.2 Gender and resilience

Our review shows that sparse research on the gender-climate change-AFS nexus has been conducted. Several empirical studies reviewed for this study examine the adaptive responses of small-scale fishers and seafood-farming households and communities to stressors. They note that gender intersects with other socio-economic determinants of (in)equalities. The continual

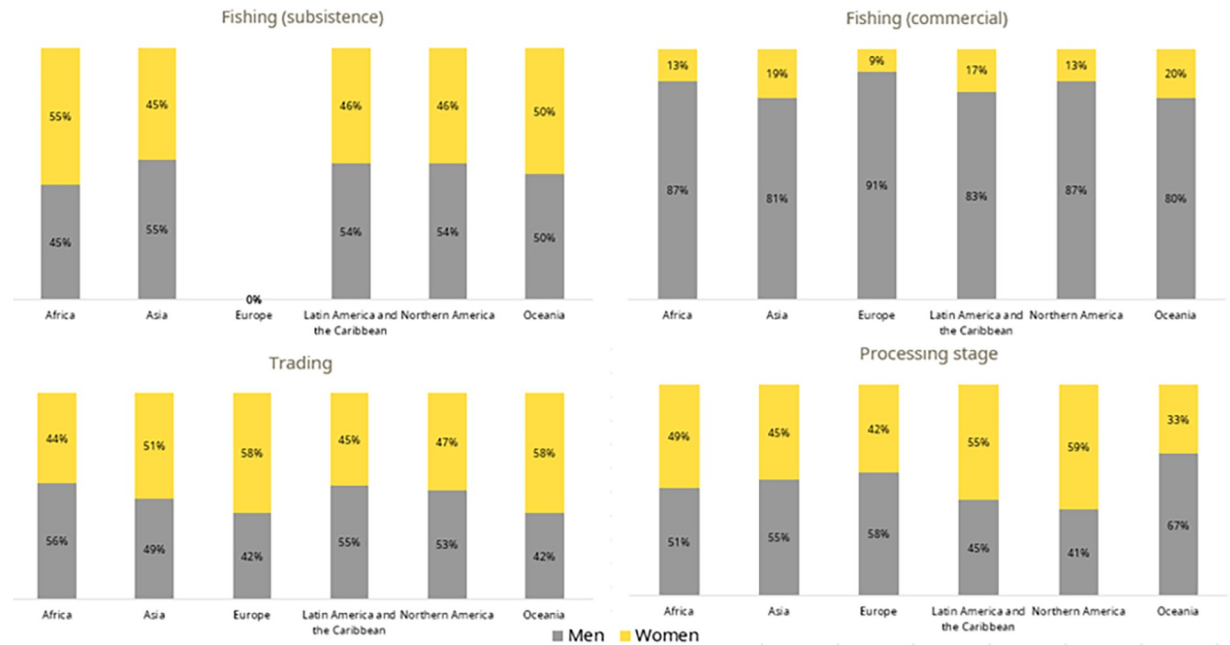


Fig 3. Percentage distribution of worldwide employment at the different stages of the fish value chain by men and women. Source: Analysis by the authors based on data from the Illuminating Hidden Harvests study (FAO, Duke University, WorldFish, 2022).

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interactions generated contribute to power and agency differentials between different population groups. However, intersectionality does not form an analytic criterion in most articles and thus the implications of how gender intersects with other social identities to influence adaptive responses are insufficiently analysed [55,56]. Focusing only on men and women as dichotomic actors—without delving deeper into how gender intersects with other social identities—makes it difficult to understand the advantages and disadvantages for certain actors in AFS to respond to climate change [57]. We present our findings on gender and resilience in four sub-categories namely, gender and agency, gendered access to and control over AFS resources and gender norms and gendered policies and governance.

4.2.1 Gender and agency. More than half of the literature review sample ($n = 17$) discussed individual and group agency in the context of climate change adaptation and risk management by AFS actors. Effective individual and group agency has the potential to facilitate individuals, households, and communities to cope with, forecast, and adapt to, extreme climate shocks and stresses over time [13,58–60]. Women and men from coastal fisher households in Bangladesh use gender-specific local knowledge on food and water provisioning, share experience from past climate shocks, and negotiate through religious and social networks, to create short-term survival strategies and move towards longer-term adaptation to climate change [58] Heiltsuk women in Canada's Pacific Coast are changing fisheries governance through developing measures to protect the herring stocks in their traditional territory—particularly through ensuring restored access to the spawn-on-kelp fishery. They are achieving this through extending the remit of their gendered roles and responsibilities in the community and ensuring that they are heard in national fisheries governance forums [61].

Yet the agency of local communities is often frustrated by gender-blind, top-down policies, research frameworks and interventions, which fail to invest sufficiently in understanding local dynamics and needs. In the wake of Hurricane Maria (2017) in Dominica, many young people took advantage of the National Employment Programme to move out of fisheries. However,

the intervention unintentionally undermined community resilience and local adaptive capacity because it ignored community support strategies. Young farmers and fishers relocated away from their communities, resulting in weakened family and community ties, additional financial pressure on families already in crisis, and negative outcomes for community food security, household incomes and social networks [60].

4.2.2 Gendered access to and control over AFS resources. About 75 percent of the literature review sample ($n = 24$) discussed access to resources as central to climate change adaptation and risk management. Of these, all discussed access to material resources including land, equipment, housing and infrastructure, and formal and informal credit. A subset of 37 additionally discussed resources such as knowledge, skills, and social networks. Our review shows that gender is one important determinant of access to resources such as credit, fishing boats and gear, fish processing tools and technical trainings, and the node of fishery value chains that they can access. However, social identities such as marital status, health status, education status, geographic location, and economic class, intersect with gender to influence the ability of specific categories of individuals and social groups to access and control resources [62–64]. In Egypt, where both women and men are involved in fish trading, the educational level and number of dependents in the household affect which women and men participate more actively in their businesses and generate more profits [64]. In Malawi, widowed and divorced women fish traders participate and benefit from market access more extensively than their married counterparts. This is because they do not need to obtain permission from their husbands [65]. In Ghana, poor male fishermen involved in primary harvesting of fish are strongly affected by declining fish catch due to a combination of climate and non-climatic pressures. Wealthier women, who are gear owners or involved in fish trading, tend to be less impacted because they have alternative fishers to work with [66]. A government relocation program in Fiji for indigenous i-Taukei communities impacted by coastal erosion recognized that all women in the targeted communities play a key role in subsistence fishing for their households with men working in agriculture and other jobs further inland and created a fish farming (aquaculture) invention to help create an alternative form of income generation. However, program planners failed to recognize that women were differentially affected by age, health, and income status. One unintended project outcome was that elderly and sick women lost access to fishing as a consequence of being relocated further away from the shore. At the same time, these women did not have disposable income to buy the farmed fish sold by the younger women participating in the intervention. Overall, they lost access to food and status [67].

A noteworthy finding from the review is that small-scale fisheries in some countries are under increasing pressure from economically wealthier and better-connected new entrants to fisheries from other sectors such as agriculture, which face negative consequences from climate change. In Malawi and Ethiopia, for example, declining crop productivity due to climate stress and shocks has led to state interventions encouraging farmers to engage in mixed farming-fishing livelihoods or in seasonal fishing [68,69]. In Thailand declining prices for certain commodity crops such as rubber and oil palm has meant that an increasing number of rubber and oil palm farmers are shifting to fishing and competing for catch in the sea [70]. On the southwest coast of Bangladesh, increasing salinity intrusion into coastal lands is resulting in a decline of rice farming, paving the way for an expansion of shrimp farming for export [71]. In some cases, new entrants are more powerful than existing fisher communities. They may have more and better assets (motorized boats, new technology, investment), and wider and more influential social networks and education, than artisanal fisherwomen and men. This results in the latter being pushed out to the base of the fishery value chain and facing further decline in their agency, income, and wellbeing [70–72].

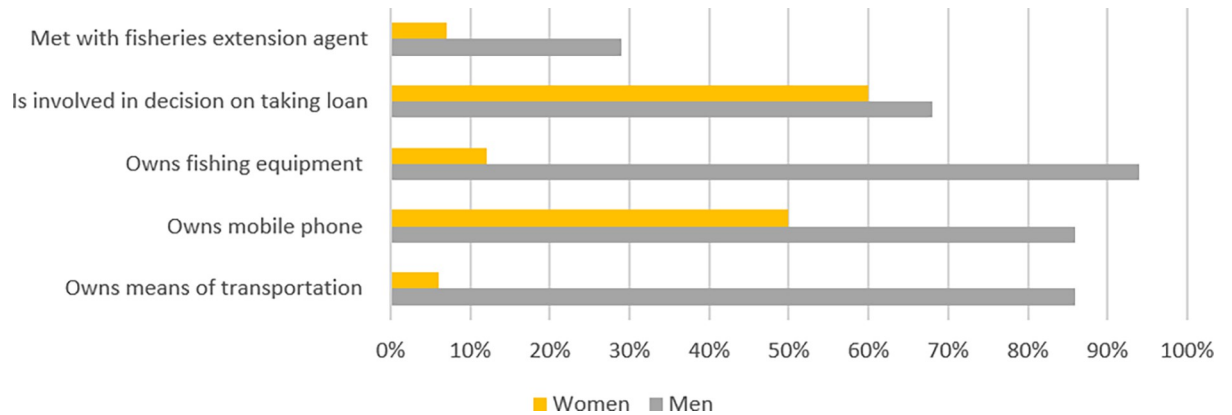


Fig 4. Percentage access to resources for women and men aquaculture farmers in Bangladesh. All differences are statistically significant with a p-value smaller than 0.01. Source: Analysis by the authors based on the Bangladesh Integrated Household survey (2020).

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In Bangladesh, our analysis of the 2018–2019 BIHS data (See [S1 Table](#)) shows that, compared to their male counterparts, women aquaculture farmers experience weaker access to the extension services, credit, and other productive capitals they need in order to be able to adapt to climate change and achieve resilience. Bangladeshi women aquaculture farmers are much less likely than men to own means of transportation, a mobile phone (for contacting customers), and fishing equipment. Only 7% of the women have interacted with an extension agent compared to 29% of men ([Fig 4](#)).

Men's interactions with extension agents are more intensive because widely prevailing religious and socio-cultural norms discourage women's mobility and interactions with non-family men. In terms of decision-making, women are less likely to be involved in decision-making around whether to take credit and how to use it.

4.2.3 Gender norms. About 65 percent of the literature review sample ($n = 21$) discuss how gender norms influence AFS actor climate change adaptation and risk management strategies. However, only a few studies explore the dynamic nature of gender norms and how, and why, they change in particular contexts and differentially among groups of women and men with various social identities. Limited research attention has been paid to how formal actors and institutions influence processes of normative change. Indeed, the gender analysis in most of the reviewed literature is largely focused on women and men roles, responsibilities and to some extent benefits, rather than on gender dynamics and agency.

The review highlights that gender norms are context-specific, and that they strongly influence the work women and men do within fisheries and aquaculture, the spaces they work in, how their work is recognised and valued, and the coping strategies that women and men develop, and adopt, for climate change and climate shocks. The most universal gender norm is that women are broadly responsible for conducting household and care work within the household. This includes looking after and educating children, caring for elderly or sick people, cooking, obtaining water if relevant, cleaning, and a range of other tasks which vary according to locale. In Bangladesh, the 2018–2019 BIHS dataset suggests that women spend significantly more time on such tasks than men with men engaged more strongly on productive work, particularly paid work (see [Fig 5](#)). Notably, during the data collection, men and women were asked (separately from each other) about their daily time investment (in minutes) in specific tasks, such as farming, fishing, reproductive work, productive work, and communal activities. However, it is important to note that Bangladeshi women conduct many productive tasks at home or in the vicinity, for example post-harvest processing, livestock care, tending

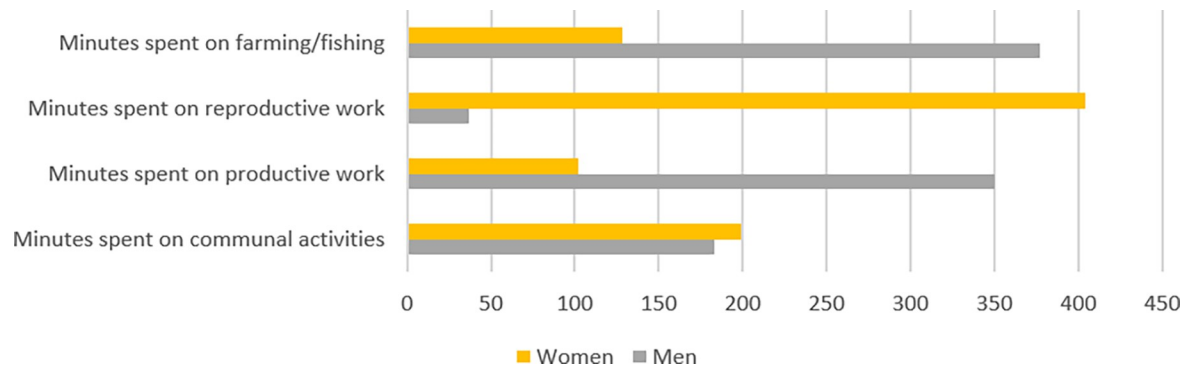


Fig 5. Time spent (in minutes) on different activities by women and men aquaculture farmers in Bangladesh. All differences are statistically significant with a p-value smaller than 0.01. Source: Analysis by the authors based on the Bangladesh Integrated Household survey (2020).

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vegetable gardens, etc. These are frequently ignored because many survey schedules assign such work to the reproductive domain [73,74].

An important characteristic of small-scale fisheries is the gendered division of space, whereby men fish in the open sea/large lakes using boats and fishing gears. In contrast, women's work is mostly shore- and land-based using little equipment. This gendered division of space affects the location of women and men within small-scale fisheries value chains. Men are involved in primary harvesting and larger scale marketing whilst women work in shore- and land-based fishing, processing, and trading activities [47]. When external interventions by state and other development actors do not take this gendered division of work and space into account, they can end up reinforcing gender norms that limit women's resilience and adaptive capacity. Coping strategies to climate shocks such as male outmigration can worsen income and livelihood options for women since they are left with more household and community responsibilities, and still face gendered challenges accessing resources at community level and participation in community forums [75,76]. In coastal fisher communities in Bangladesh, for instance, the ability of households to respond to and adapt to climate shocks, and to increased salinity, can be limited by institutional targeting. The long-term out-migration of male household heads is a coping strategy, but support services are often slow to react the reality of changes in population dynamics, decision-making, and who does what in the home. Women, although they may have become *de facto* household heads, may be completely overlooked for weather warning systems, or by extension agents. This hampers the abilities of such households to achieve resilience and undermines the efficacy of men's coping strategies for household well-being [75,77,78]. A study of 20 livelihood development projects implemented in coastal Indonesia found that projects that do not consider women's household, caregiving and community responsibilities often increase women's time burdens without suitable compensation and will likely be abandoned once the project ends [79]. In small-scale fisheries in the Western Indian Ocean the temporary migration of women traders to more distant fish trading sites due to reduced local fish catch is becoming more common because their earnings are increasing critical to household income [59].

4.2.4 Gendered policies and governance. About 40 percent of the literature review sample (n = 13) discussed how policies and governance interact influence the climate change adaptation and risk management strategies of AFS actors. Most articles were constructed around a dichotomous (women: men) rather than a gendered approach to understanding gender dynamics. At the formal-systemic level, the review shows that the lack of representative sex-disaggregated data in the fisheries sector and the low recognition of women's work and

contributions is a major factor driving the lack of attention to women's needs and benefits in fisheries management [80,81]. Broadly, the review shows that although some gender-equality policies and funds exist at national level, these often do not inform fisheries policies due to lack of interdepartmental coordination and lack of resources to translate gender policies into practice [82–84].

In terms of staffing, women are under-represented in fisheries management and policy development globally. Very few women occupy senior management and decision-making positions [85,86]. For example, in Canada, the expertise of Inuit women, who occupy a prominent role in Inuit society, though they have achieved some success in relation to salmon, remains marginal to mainstream climate change policy and strategy. Indigenous forms of leadership and consultation processes are not visible, or incorporated, into formal and institutional levels of governance [87]. Inadequate research and consultation with local communities can lead to projects which harm rather than help [60,70,71]. VaTonga Communities in Binga District, Zimbabwe, are unable to exercise their full fishing rights in the Zambezi catchment, although everyone wishes to do so. This is because local authorities fail to involve these communities in fisheries planning and management design. This is accompanied by lack of transparency around access rights; and people's exclusion is reinforced by their lack of knowledge and poverty [25].

With respect to community level decision-making processes, the review shows that women are widely underrepresented in fisher producer groups and in community-level leadership structures. Turning to Bangladesh, the findings show that women aquaculture farmers are significantly less likely to be involved in aquaculture producer groups (17% of men versus 6% of women) and are less likely to occupy leadership roles (see Fig 6) (2018–2019 BIHS data). The benefits, including developing social networks, derived from producer group membership are thus less accessible to women. However, in credit or microfinance groups we see an inverse pattern: Bangladeshi women are more likely than men to participate in these groups (47% of women versus 16% of men) and it is also more likely for women to be leaders of these groups. The same data set indicates that a large proportion of women are uncomfortable speaking in public settings regarding their opinion on infrastructure-related matters or high capital investments (Fig 6). Intriguingly, though, women aquaculture farmers do not rate their influence in

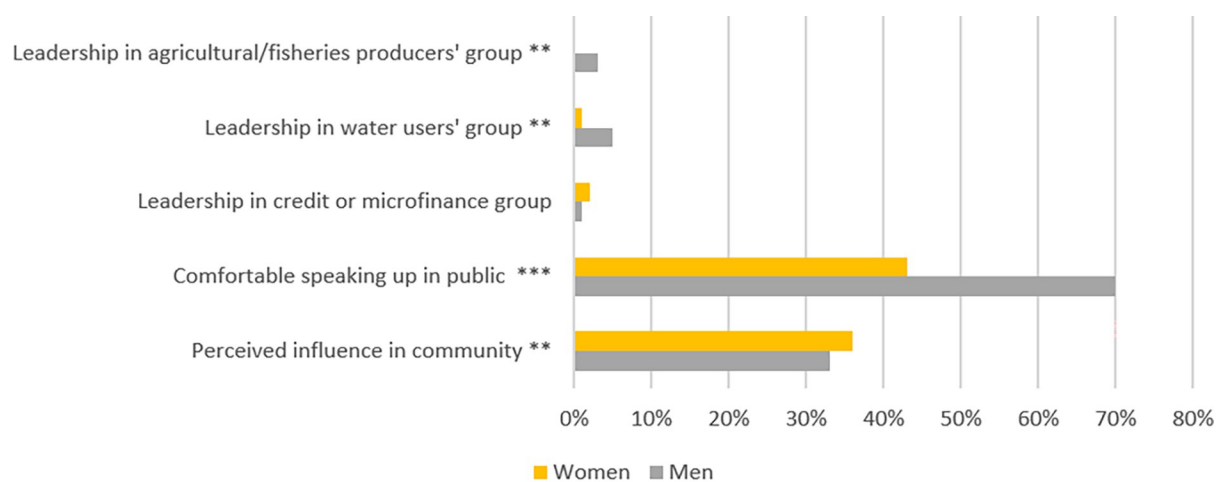


Fig 6. Percentage influence on community decision-making by women and men aquaculture farmers in Bangladesh. All differences are statistically significant with a p-value smaller than 0.01. Source: Analysis by the authors based on the Bangladesh Integrated Household survey (2020).

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the community lower than men aquaculture farmers. This might be because women compensate for the lack of formal/public influence through exerting informal influence on other women, their spouses, or other household members.

4.3 Climate change and intersecting social identities

In our literature review, articles discussed outcomes and impact of climate change in relation to income and livelihoods ($n = 31$) and health and nutrition ($n = 26$). Several articles discussed the implications for gender equality and empowerment of actors ($n = 23$), and the social well-being of communities ($n = 17$). The environmental effects of small-scale fisheries and aquaculture under pressure of climate change was weakly addressed in the reviewed articles, with only 6 articles briefly discussing this.

4.3.1 Economic and livelihood outcomes. Declines in species distribution, increasing seasonal variability, sea-level rise, and increasing frequency of extreme events such as floods, high temperatures, and tidal surges are having a significant negative impact on fishing economies, livelihoods, and incomes at local and global levels [7,54,71,88]. Women and men who already lack material assets such as land, equipment, savings and immaterial ones such as education and skills are typically the hardest hit [7,89].

4.3.2 Nutrition and health. Studies show that the impact of short-term coping strategies in the immediate aftermath of climate shocks, as well as longer-term climate-adaptation strategies on the health and diet of different AFS actors are greatly influenced by gender and other intersecting inequalities [71,90,91]. Pregnant women from indigenous communities living in rural Uganda are generally more strongly impacted by weather variability than non-indigenous women. Compared to non-indigenous women, the overall health of mothers and children among Batwa indigenous women worsened when there was significant food insecurity—despite investments in their access to prenatal care. Underlying ethnic and gender inequitable norms and practices help to explain these findings. Indigenous Batwa tend to farm lower quality land and have less access to off-farm income generation opportunities due to ethnic biases against them. The marginalization of these communities, and particularly women, make it more difficult for them to develop effective strategies to adapt to climate change [92].

Transgender, intersex, and non-binary people face increased health risks during and after natural disasters due to unequal access to emergency relief and shelters as a direct consequence of discriminatory exclusion [93]. This is especially true for queer people who can face social prejudice, discrimination, stigma, and violence [94,95].

More broadly, inadequate access to assets and resources often leads to short-term coping strategies among the most marginalized groups which fail to progress into adaptive resilience. This can have long-term implications for the health and well-being of the entire household though women's health and well-being can be worse affected. For example, women in economically poor fisher households in Bangladesh and among poor lower castes in India, have been shown to deprive themselves through reducing or foregoing meals and personal health-care as a household coping strategy during periods of climate shock [58,71,96].

4.3.3 Social cohesion and well-being. The impact of the climate crisis on AFS can lead to adverse impacts on the social cohesion and well-being of coastal and fisher communities. The breakdown of social networks is mostly felt by the poorest: they suffer through livelihood loss, resource scarcity, conflict, and migration [58,71,72].

Several studies on social cohesion and well-being in coastal and fishing communities document increased Gender Based Violence (GBV) as a consequence of climate change [63,65,81,97–99]. GBV can limit women's participation in fish value-chain activities, and women also run the risk of GBV when trying to defend their access to fishing grounds (ibid.).

As aquatic resource scarcity grows in the communities hit most by the climate crisis, the level of violence against women is likely to increase [100,101]. The loss of livelihoods and resources that the most at-risk communities are facing result in conflicts between different categories of fishers, based on their wealth status and ownership of assets such as mechanised boats, as well as within communities and within families [72,102].

Transactional sex is another facet of GBV. ‘Fish for sex’ or sex for resources is common in some fishing communities [65,69,102]. As the impacts of the climate crisis continue to devastate livelihoods and create resource scarcity, there is likely to be more pressure on women to engage in transactional sex to obtain the resources they need. In the countries around Lake Victoria, where eutrophication due to excessive nitrogen loading is increasing, fish catches are declining significantly. This is promoting the ‘fish for sex’ economy, because women traders can acquire favoured access to fish through engaging in transactional sex. Due to shortages of fish women traders are travelling increasing distances to obtain fish. At the same time, male fishers are similarly travelling further to capture fish and use a variety of landing beaches and they also maintain a wide range of sex for fish relationships with women traders. These practices are leading to an increase in HIV/AIDs and leading to the loss of women and men in their prime years [103–105].

4.3.4 Environmental outcomes. The literature review revealed that some aquaculture and fishing practices which aim to promote climate-adaptation can contribute to environmental degradation. Shrimp farming, which thrives in brackish water and is promoted by the Bangladesh government as a climate-adaptation strategy, further salinizes water and reduces drinking-water supplies. Women often have to travel further to obtain potable family drinking water, have reduced income to buy nutritious food, and face health problems, including birth and pregnancy complications, due to increased exposure to salinity [75]. Inland fisheries in Africa’s Great Lakes region are recognized for the contribution they can make to climate adaptation due to their significantly lower land, water, and feed resource use footprint compared to aquaculture, livestock and livestock production [106]. However, some inland fisheries techniques raise environmental concerns. These include chemical water pollution (e.g. use of chemicals for fishing), surface water pollution (e.g. oil spills from fishing vessels and suspended matter such as fragments of plastic, rubber or other fishing materials), and carbon emissions from trawlers [107,108]. Non-fisheries sources of pollution also raise considerable health concerns. In India, children exposed to higher concentrations of agro-chemicals in water during the first month after conception experience poorer health outcomes on a variety of measures including higher mortality and morbidity, and reduced height-for-age and weight-for-age in infants under five years [109]. In districts with higher shares of surface water in Vietnam, the share of fish consumption is higher, and the share of meat consumption is lower than in districts with less surface water. Households in water-rich areas may have a higher probability of being exposed to toxic chemicals—caused by run off of farm chemicals and industrial plants—due to higher fish consumption [110]. Overall, though, aquatic foods have a lower carbon footprint than many other animal-based foods [111].

5. Discussion

The findings from our scoping literature review and secondary data analyses indicate that women are central yet underrecognized actors in small-scale fishing and aquaculture economies. There is still a very long way to go to realize SDG Goal 14 on *Life Below Water: Conserve and sustainably use the oceans, seas, and marine resources for sustainable development* in ways that strengthen the economies of small-scale AFS actors, and in particular that strengthen the livelihoods, resilience and agency of women in these systems.

In response to the widespread perception that state actors and institutions are failing to respond effectively to the decline of the fisheries sector globally, women-led NGOs and fisher organisations are advocating and implementing bottom-up fisheries management tools and policies in countries as diverse as South Africa, Chile, and Mexico [80,112]. Existing gender-responsive policy guidelines such as FAO Voluntary Guidelines on Small-Scale Fisheries, the IHH 2023 report, and the gender integration and intersectionality in food systems research for development guidance note by the CGIAR Research Program on Fish Agri-Food Systems (FISH) [113] are helpful to legitimize such efforts from the actors who are most actively involved in AFS value chains as well as most directly impacted by the impact of climate change. Ensuring women's freedom to participate actively in meetings on the same terms as men in governance structures must be a strong programmatic objective [114–117].

Looking to the future, gender-responsive and sex-disaggregated macro-level models and projections forecasting the future impacts of climate change on AFS at global and country levels will help to guide global policy and funding priorities. Gender-responsive and sex-disaggregated approach would include balancing involvement of marginalized women and men in maintaining their livelihoods through diversification with adequate financial compensation, and labor-saving and productivity enhancing technologies, improving their resilience to climate change, and securing nutritious food for themselves and their families are important while considering sex, age and other social markers.

The review further shows that gender and social inclusion approaches in small-scale AFS are frequently limited to ensuring women participate or gain access to resources to increase their productivity or income. It is rarer for the underlying structural factors that continually reproduce unequal gender norms and relations that marginalise women to be challenged or transformed [12,79,118,119]. Our analysis suggests that AFS interventions and policies need to be more systemic in addressing gender and power inequalities at individual, systemic, informal, and formal dimensions. Some valuable initiatives show what is possible. For instance, several governments have adopted climate-adaptation and mitigation strategies to help manage depleted ecosystem resources and support the most marginalized groups, including women. Studies of oyster fisheries in Ghana and Gambia illustrate how collaboration between government, research organizations, and civil society organizations under the Sustainable Fisheries Management Project boosted coastal oyster fisheries co-management and increased the capacity of poor women and youth oyster harvesters by giving them formal user rights to the protected fisheries area, and recognizing their contribution in maintaining the resources [120,121].

Knowledge development in association with strengthening women's agency is an important aspect of enhancing the agency of women in general, and marginalized groups of women and men to engage in positive adaptation measures [62]. As part of this, promoting strong women role models through facilitating their transgression of the traditional gender division of labour can be valuable. With support and training, women can successfully take on typically male responsibilities and play an active role in coastal and marine conservation. A women-led NGO in Mexico increased agency and awareness among local fisherwomen and men on marine conservation and provided enabling opportunities for local women to transgress their traditional gender roles through learning new skills such as diving. Women gained respect and decision-making power in their families and in local and regional fisheries forums [117]. In Vietnam, a project which provided well-directed training and support reduced gender biases in fisheries and improved women's income and active participation. This was facilitated through the involvement of local male leaders and women's husbands in gender training ([62,97]. Similarly, in Myanmar, government initiatives that supported women's participation in household decision-making were significantly and positively correlated to improved technical efficiency

of aquaculture farms and increased productivity due to the improved ability of households to allocate and organize productive resources optimally [114]. Further examples of successful strategies include training women in improving dried fish production [122], strengthening the co-management of fragile coastal mangrove ecosystem for oyster fisheries [120], developing participatory community-based marine conservation management plans [112], providing loans and training to women fish retailers for value addition in fish products [63,65], and promoting inland fish farming to women and men [62]. For example, in Bangladesh WorldFish promoted women's ability to manage their ponds using novel learning approaches. This resulted in significantly higher fish productivity, fish diversity, and income generation, as well as improvements in women's control over income and assets, though wider determinants of women's empowerment were unaffected [123,124].

Promoting opportunities for fisherwomen to diversify their income beyond fisheries can be valuable. This has been promoted in Bangladesh [125] and in the United Kingdom. Here, women's work outside fisheries often provides stable income for small-scale fisher households that are increasingly threatened by climate irregularities [88].

We conclude that further evidence-based—and action-orientated—research is needed to inform targeted and place-based climate interventions that address existing power inequalities and work to change social relations towards more equity and inclusion.

6. Conclusion

Based on the literature review and the supplementary datasets from Bangladesh and IHH we propose below some key action pathways for research, interventions, and policy to enable and contribute to gender-transformative and climate-resilient AFS.

First, policy, research and interventions must address multi-dimensional power inequalities. At the research and intervention levels, it is important to engage both women and men to complement gains in income, food security and livelihood diversification, with increased decision-making power of women on resource allocation and income. Household-based approaches that involve men as well as women are important to strengthen intra-household collaboration on productive and household and care tasks, and to strengthen jointness in decision-making in all domains. At an institutional level, it is important to commit resources and funding for gender sensitisation at community level, and in government and research agencies. This can help to reduce gender inequality in staffing and pay and change attitudes and practices that restrict women's mobility and active participation in public meetings, consultations, and forums. These are the first steps in creating a transformative change by addressing key normative barriers for gender equality. At the policy level, climate adaptation policy must be informed by women's contribution to small-scale and subsistence fisheries and aquaculture, the different needs of women and men, improving commercial returns to women and the specific constraints they experience (due to gender, socio-cultural and religious norms, access to and control over resources and labour, and time constraints). Mitigation strategies must be gender-responsive, including balancing the increasing involvement of marginalised women and men in livelihood diversification with adequate financial compensation, and labour-saving and productivity-enhancing technologies.

Second, women's work throughout aquatic food value chains must be recognised, documented, and valued. At intervention/project level, this can be done by integrating gender and intersectionality within the theory of change and collecting—and analysing—sex- and gender-disaggregated data for effective monitoring, evaluation, and learning. At the research level, there is a need for more mixed-methods approaches, value-chain analyses and large-scale quantitative studies on women's work across the fisheries and aquaculture value chain (pre-

production, post-harvest processing and trade), including women's contribution to subsistence fisheries and to the informal markets. At the policy level, funding and resources should be earmarked for systematic collection of quantitative as well as qualitative data on women's contributions in aquatic food value chains in order to formulate evidence-based, gender-responsive policies that recognise and utilise the agency and knowledge of marginalised actors. This will facilitate more sustainable and custodial management of aquatic food resources.

Third, research on climate change and small-scale fisheries and aquaculture, with a gender and intersectional lens, is critical to determine heterogeneity and agency in the adaptive capacities of AFS actors, and to catalyse activism. This approach opens avenues for interventions and policy that integrate local AFS actors as part of the solution, rather than as the problem, thus bolstering sustainable, equitable and resilient AFS. There should be a specific focus on two factors. The first one is closer interdisciplinary engagement between socio-ecological resilience analysis and gender analysis in research on climate change and AFS. This should combine ongoing efforts to increase and improve the collection of sex-disaggregated data in small-scale fisheries and aquaculture systems research together with developing high-quality gender analysis on socio-ecological dynamics in small-scale fisheries. Second, studies should go beyond a household and gender-dichotomous focus in qualitative and quantitative research for a better understanding of climate change-driven adaptive choices by women and men on livelihood diversification in different contexts. Studies that link gender and AFS research to the fisheries and global political economy through a feminist political economy research agenda could also support women's activism. This is because women, including indigenous women, have a significant role to play in articulation of climate action strategies.

Supporting information

S1 Checklist. The Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement, guides the reader on where they can find information on what was done, why it was done, what was done and what was found.

(XLSX)

S2 Checklist. This provides detailed information of the 32 research articles that contributed to this paper. The information included are the lead authors of the article, region, country, risk profile, methodology, species, system, scale and value chain.

(DOC)

S1 Fig. Population fully and partially dependent on fisheries globally. Source: Analysis by the authors based on data from the illuminating hidden harvests study (FAO, Duke University, WorldFish 2022).

(TIF)

S1 Data. Illuminating Hidden Harvest datasets. These are datasets from 58 countries, which encompasses the pre-harvest, harvest and post-harvest sectors of inland and marine fisheries, with a focus on local and global contexts.

(XLS)

S1 Table. Comparative analysis between women and men aquaculture farmers in Bangladesh based on the BIHS (2020) data.

(DOCX)

S1 File. Additional information.

(DOCX)

S2 File. This is the confidentiality disclaimer of the Illuminating Hidden Harvest datasets. (DOCX)

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Author Contributions

Conceptualization: Rahma Adam, Katrine Danielsen, Froukje Kruijssen, Michelle Tigchelaar, Colette Wabnitz, Matteo Luzzi, Rumana H. Peerzadi, Anouk Ride, Edward H. Allison, Steven Cole.

Data curation: Rob Kuijpers, Esther Smits, Nicole Moran, Alexander Tilley, Cristiano Rosignoli, Irene Zatti.

Formal analysis: Rob Kuijpers, Esther Smits, Nicole Moran, Irene Zatti.

Funding acquisition: Rahma Adam.

Investigation: Rahma Adam.

Methodology: Rahma Adam, Anamika Amani, Rob Kuijpers, Irene Zatti, Kevin Ouko.

Project administration: Rahma Adam.

Supervision: Rahma Adam.

Validation: Rahma Adam.

Writing – original draft: Rahma Adam, Anamika Amani, Rob Kuijpers, Esther Smits, Irene Zatti.

Writing – review & editing: Rahma Adam, Anamika Amani, Michelle Tigchelaar, Colette Wabnitz, Kevin Ouko, Cathy Rozel Farnworth.

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