



A Systematic Literature Review of Water-Migration-Gender Nexus Toward Integrated Governance Strategies for (Non) Migrants

Dilare Ecenur Irbik*

Independent Researcher, Ankara, Turkey

OPEN ACCESS

Edited by:

Ilse Ruysen,
Ghent University, Belgium

Reviewed by:

Alfred Owuor Opere,
University of Nairobi, Kenya
Lisa Thalheimer,
Princeton University, United States

*Correspondence:

Dilare Ecenur Irbik
ecenurirbik@hotmail.com

Specialty section:

This article was submitted to
Water and Human Systems,
a section of the journal
Frontiers in Water

Received: 15 April 2022

Accepted: 14 June 2022

Published: 07 July 2022

Citation:

Irbik DE (2022) A Systematic Literature Review of Water-Migration-Gender Nexus Toward Integrated Governance Strategies for (Non) Migrants. *Front. Water* 4:921459. doi: 10.3389/frwa.2022.921459

Water access and environmental migration are crucial global development issues to be examined from an interdisciplinary perspective. Although climate change and water-related dimensions of migration have been widely studied, a gendered lens on this topic is scarce in the current academic literature. To address this gap, I use insights from feminist political ecology and a water-migration-gender nexus to analyze the gender aspects in women's experiences, challenges, and opportunities due to climate change and water stressors. After conducting a systematic literature review, 67 articles were appraised for quality and included in the synthesis to review existing policies. In the discussion section, based on these existing policies, I propose integrated governance strategies that could synergically mitigate water-related problems and (non) migration challenges with a neglected gender focus so that women and girls can prepare to be more resilient to the social, economic, and environmental changes in everyday life. This paper engages with vulnerability, tolerance, and adaptation of women and girls to socio-ecological changes around the water discourse, and it proposes a conceptual framework for the integrated governance strategies to understand better the connection between water-related security risks and development problems resulting from climate change, (non) migration, and gender.

Keywords: climate change, migration, water, sustainable development, gender, integrated nexus approach, feminist political ecology

INTRODUCTION

Climate Change and Its Impacts on Water Resources

The environment is not static. It has been continuously changing at global, regional, and local levels. While some changes are driven by natural processes of biology, geomorphology, geology, or energy transfers, human activities such as deforestation, pollution, and greenhouse gas emissions also impact the environment (McLeman et al., 2016). Anthropocene is a term to describe a new epoch in which these human activities have become the central trigger in reshaping the environment (Steffen et al., 2007). The most far-reaching environmental challenge of the Anthropocene epoch is climate change which has been more a consequence of human activities than of natural processes, mainly due to the increased level of fossil energy consumption since the Industrial Revolution (Milán-García et al., 2021).

Climate change manifests itself as global warming and environmental changes (e.g., droughts, sea-level rise, floods, and hurricanes) that generate harmful environmental effects worsening the present water resources. Water problems due to climate change such as water scarcity and water stress relate to social and economic difficulties, political conflict, food security, legal concerns, and integrated water resources planning (Prívarová and Prívarová, 2019; Stoler et al., 2021). Therefore, the impact of climate change on water resources and freshwater ecosystems is a serious global challenge that many countries will have to cope with in the twenty-first century (Piao et al., 2010). Water scarcity could have adverse consequences on agricultural production (Piao et al., 2010). For example, rising sea levels in coastal regions may threaten the lives and livelihood of millions of people by causing higher economic costs, the risk of poverty, and hunger due to a decline in crop yield (Abbaspour et al., 2009). Furthermore, accessible drinking water sources contaminated by flood water may cause contagious diseases affecting people's health (Nagabhatla et al., 2020). The sustainable management of water resources in times of climate change may cause tension among countries or different social groups due to the unequal distribution of resources and power (Pahl-Wostl et al., 2010; Lynch, 2012). Water pollution and diversion of water can deepen the vulnerability of communities and ecosystems when equitable water governance is lacking. This may give rise to conflict about rights claims based on two fundamentally different views of how and by whom water should be governed, either by central and regional level authorities, or by vulnerable water users at the local level (Lynch, 2012).

Environmental (Non) Migration

Water problems due to climate change (e.g., floods, sea-level rise, and droughts) can be direct or indirect push factors for voluntary or forced internal and international migration. They may directly affect the wellbeing of people who live in territories dependent on agriculture, water resources, and fisheries. In turn, people are more likely to migrate away from these territories for a better life and access to natural resources (Black et al., 2011; Nagabhatla et al., 2020). Moreover, human conflict is exacerbated by water problems due to competition over scarce resources and instability in the countries with poor natural resource management; consequently, this leads to displacement and migration (Abel et al., 2019).

Many terms have been used to refer to individuals who moved or were displaced in connection with the environmental challenge (e.g., environmental migrant, climate refugee, displaced persons). There is no internationally defined terminology for individuals migrating for environmental reasons. The concept "climate refugee" is difficult to institutionalize at the international level since it would require challenging dominant conceptions of humanitarian and environmental distress, or the concept "displaced person" generally alludes to "internationally displaced persons" (Munoz, 2021). Yet, at the most generic level, environmental migrant refers to "persons or groups of persons who, for compelling reasons of sudden or progressive changes in the environment that adversely affect their lives or living conditions, are obliged to

leave their habitual homes or choose to do so, either temporarily or permanently, and who move either within their country or abroad" (IOM, 2007; para. 6).

Environmental migration induced by the water dimension of climate change link to sustainable development in multiple ways. As a strategy for adapting to water stress, safe and orderly migration can contribute to agricultural development, economic growth, food security, and rural livelihoods in home and host communities (Wrathall et al., 2018). Yet, negative results of involuntary, unsafe, and poorly managed environmental migration (e.g., lack of drinking water, poor sanitation, increased vulnerabilities, pressures on water resources, water infrastructure problems) cannot be ignored. For example, the ability to migrate is mainly based on personal characteristics such as age, gender, wealth, or disability of individuals. Therefore, in some cases, despite the environmental challenges, the most vulnerable and poor people have the least opportunities to migrate away from the risky environment and should stay in their territories and adapt to the changes (Nagabhatla et al., 2020).

Migration is a multidimensional process, and one of the vital challenges under migration is resource efficiency (Heinonen, 2006; Papadopoulou et al., 2020). Resource efficiency is strongly related to the sustainability of limited assets such as water availability and allocation, regulation of land uses, food security, and energy production (Papadopoulou et al., 2020). In the (non) migration context, increasing resource efficiency and sustainability of water resources management worldwide play a significant role in human security and the exploitation of natural resources because challenges of environmental migration and water stressors do not only affect people's access to fresh water. It also has direct/indirect impacts on many sectors heavily dependent on water, social, economic, political, and health influencing standards and quality of life.

Relevance of the Water, (Non) Migration, and Gender Nexus

There is a connection between migration and sustainable water management, which leads to vulnerability worldwide due to societal and structural forms of inequality and discrimination that create the uneven enjoyment of rights and levels of power. For example, water-related infections due to water-driven disasters may potentially increase in the areas where public health care infrastructures are minimal (e.g., rural areas) and the availability of fresh water is constrained (Haines et al., 2006). Consequently, the importance of managing natural resources and water resource governance has been increasingly discussed in the migration debate and various international, regional, and national policy frameworks (Tignino and Mach, 2018). The nexus between the water governance and migration patterns scenarios is crucial as it reveals how the connections of water and migration challenges exacerbate the effects of climate change. For instance, change in water availability in the home country is a factor in the decision to migrate, or an increase in the proportion of migration flows may increase the scarcity of water resources in the host country. Additionally, the nexus between water and migration unveils multi-layered results of climate

change, interacting with social, economic, and political processes by taking into account all social groups and social factors to protect the rights of migrants displaced by water scarcity. For example, poor people are more vulnerable to rainfall variability and migrate as a risk management strategy in response to the threats to livelihoods associated with hydrological risk (Warner and Afifi, 2013). Or in stark contrast, the poorest and most food-insecure people cannot migrate, and are forced to stay, and adapt to climate change since people's social and economic capitals, capability, and social networks structure their migration opportunities (Etzold et al., 2016). Even though people migrate for a better life, they may face several problems in urban areas since they are more likely to live in squatter's houses with a lack of water infrastructure. These urban poor spend time collecting household water or managing limited available quantities. This may reduce their labor force participation and further impact their physical and psychological health (Stoler et al., 2021). All these examples show that the growing dependence of the vulnerable people on the water resources requires a critical and holistic analysis since migration and water governance are inherently interlinked policy fields. However, scholars generally propose individual solutions to challenges from a water resources management or migration policy perspective, and the number of studies examining the nexus between water and migration is scarce. Studies mainly focus on migration as an income-generating or adaptation strategy to climate change (Schmidt, 2016) rather than giving insights about water sustainability that might alleviate the water-related problems and meet the needs of underrepresented social groups and environmental (non) migrants. Moreover, dimensions such as government policies, land and water tenure guidelines, inequality, wealth and power dynamics, market mechanisms, and customary norms have been frequently discussed in the migration literature as driving factors of human mobility. However, they are underreported alongside spatial and temporal dynamics of land and water resources (Nagabhatla and Brahmhatt, 2020).

In addition to the low number of studies examining the water-migration nexus, this nexus has been neglected within the gender aspect. Previous research on climate change adaptation has underreported how women and men are affected differently by climate change and have not revealed how their adaptation strategies are dissimilar. Understanding the impacts of and vulnerabilities to climate change requires analyzing social relations and power structures to determine case-specific and functional adaptation strategies for particular contexts. In this sense, gender is a critical factor since the perception and response of women and men toward climate change are different, implying that adaptation is gendered (Ylipaa et al., 2019). Gender is shaped by political, economic, cultural, and symbolic processes, and any discursive dimension about climate change practice and policy will have gendered implications (Lama et al., 2021). Climate change exacerbates water availability, access, scarcity, and security globally, with significant gender inequality consequences within and outside the home (Enarson and Fordham, 2001; Cannon, 2002). For example, a decrease in water volume due to climate change, compounded with the geographical proximity of water sources, determines the workload of women regarding

distance covered, time spent, and frequency of water collection (Sugden et al., 2014). Safe water scarcity affects the health and wellbeing of all members of households. This may strain the reproductive and caregiving roles of women (Sultana, 2018). Water insecurity is particularly burdensome to women during the vulnerable periods of pregnancy and postpartum since their psychosocial or physical health is affected by, for example, lack of nutrition (Collins et al., 2019). The most vulnerable groups such as the poor, women, indigenous, elderly, and children in rural and coastal communities are at risk of being marginalized in terms of inclusion and social equity in climate change adaptation measures and planning (Dulal et al., 2009). Low-income women in agricultural communities and highly dependent on natural resources (e.g., water, farming) are among the world's poorest and vulnerable to the harmful impacts of climate change (Buechler, 2009). However, male out-migration is more common than women related to climate change and water-related hazards (e.g., floods, tsunamis, droughts, glacial melts, and riverbank erosion). This leads to a double burden on women since they have to handle both household responsibilities (e.g., water fetching from long distances, child-rearing, etc.) and men's previous responsibilities (e.g., agricultural activities to generate income) (Jobbins et al., 2018). Climate change and water stressors inevitably bring some psychological and social implications. Property rights in land and resources reduce vulnerability and feelings of desperation and anxiety to the next natural disaster and enhance coping and adaptation strategies regarding water stressors. Yet, women often do not own land or cannot inherit land in many South Asian societies, and this may further compound gender marginalization (Sultana, 2018). Moreover, given women's limited or absent participation in water management, although they do not own land, male out-migration jeopardizes the sustainability and functionality of local water management institutions (Djoudi and Brockhaus, 2011), which increases the limits on land use for the women who are left behind. Once environmental migrants arrive in the host country, inclusion in the job market is experienced differently by women and men (Piper, 2008). Those imply that men and women experience, understand, and adapt to climate change and water-related problems differently. The interactions of nexus issues, combined with the lack of sustainable water resources management, exacerbate a risk threatening social, economic, political, and health consequences, which can be worsened and amplified by trying to resolve only one aspect of the nexus (Mohtar and Daher, 2012). Therefore, gender as a justice variable should be involved in climate change and water management policy design and implementation. Sustainable development can be achieved in the long term only if academic debates and policymakers develop multi-scalar, critical, and intersectional analyses of the water crisis, migration challenges, and gendered vulnerabilities to hazards and socio-ecological changes.

After identifying a research gap in the water-migration-gender nexus in the literature, this study aims to shed light on the implications of this nexus on climate change adaptation in the water sector and women's resilience. Addressing this gap is important because only one perspective of either water or migration alone would neglect to solve the social,

economic, health, and political problems of women and girls since all these aspects are multi-faceted and interconnected. Through this nexus, the sustainability of water resources can be preserved, and the environment-based problems of vulnerable environmental (non) migrants can be alleviated. In that sense, my research question is as follows: “*To what extent can integrated governance strategies be used to reduce the water-related problems of the environmental (non) migrants, considering the gender dimension?*” I aim to create a narrative of the causes, results, and solutions to propose integrated governance strategies that could synergically mitigate water-related problems and (non) migration challenges with a specific focus on the underestimated gender perspective. Following the main research question of the paper, three broad sub-questions are:

- i How can responses to climate change be integrated into water policy to reduce/control environment-induced (non) migration?
- ii In what ways can a perspective on the vulnerability of women bolster water policy that aims to reduce/control environment-induced (non) migration?
- iii How can one structure vulnerability-centered responses to such a crisis in the context of environment-induced (non) migration?

The objectives of this systematic literature review are as follows:

Objective 1: To examine the challenges of environmental (non) migration due to climate change and water stressors.

Objective 2: To determine in which social areas there is a scientific gap of how nexus approaches require including migration and gender aspects interconnected to water issues.

Objective 3: To analyze the water-migration-gender nexus in migration and non-migration settings.

Objective 4: To propose possible solutions for integrated water resources governance to respond to the needs of vulnerable environmental (non) migrants, to provide sustainability, and to better understand water and sustainability issues from a nexus perspective that goes deeper, with a specific focus on the underestimated gender perspective.

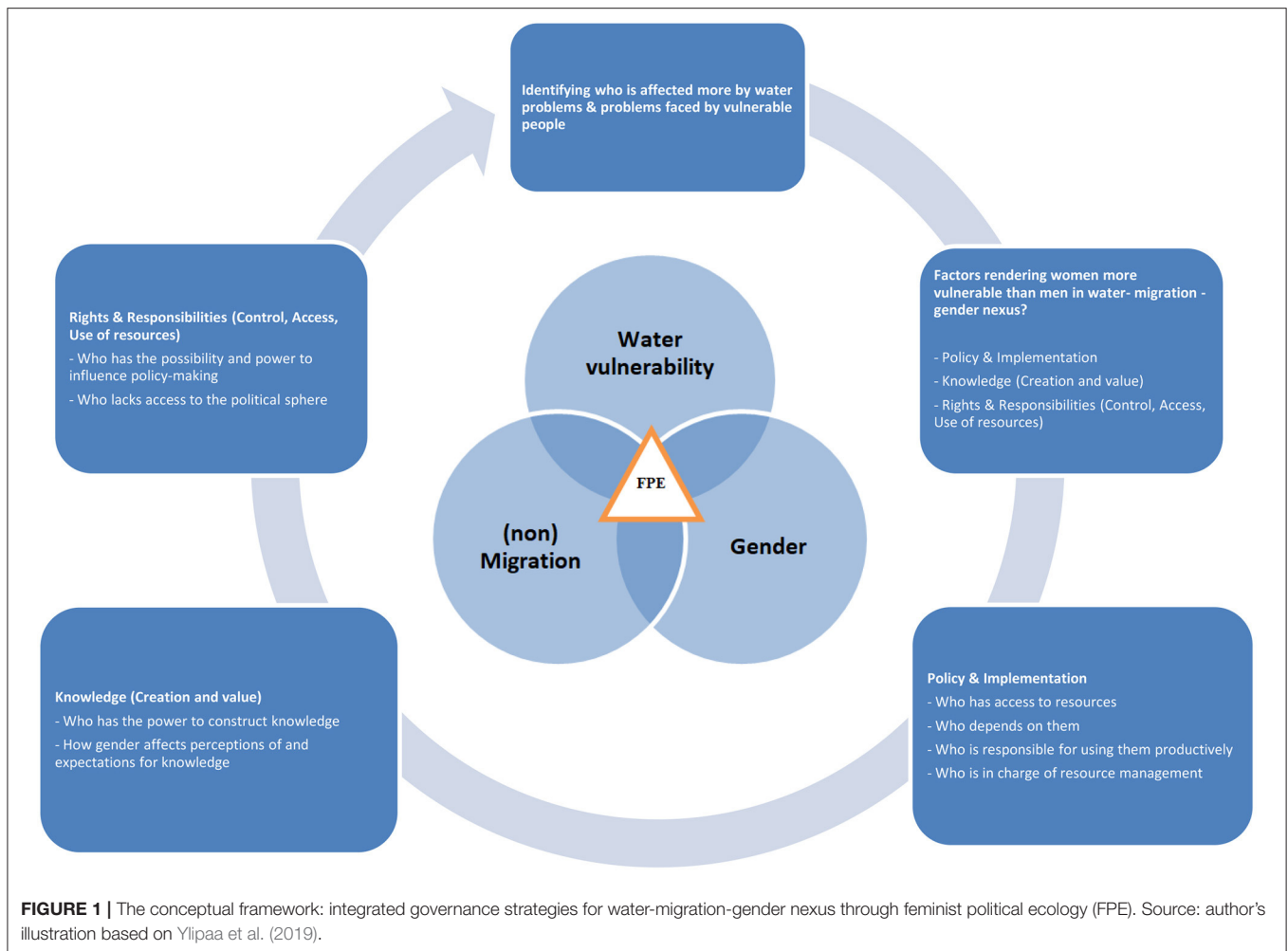
Toward an Integrated Approach—Feminist Political Ecology and Water-Migration-Gender Nexus

The United Nations member states adopted the 2030 Agenda for Sustainable Development (UN General Assembly resolution 70/1) in September 2015, including the 17 Sustainable Development Goals and 169 targets “to realize the human rights of all, and to achieve gender equality and the empowerment of all women and girls.” These goals and targets are integrated and indivisible. They balance the economic, social, and environmental dimensions of sustainable development (The United Nations, 2015). This implies that complex global challenges (e.g., climate change and water crisis) should be handled by adapting systematic and holistic solutions involving all the sectors within a justice system to leave no one behind. Moreover, sustainable development is only possible if “women and girls must enjoy equal access to quality education,

economic resources, and political participation as well as equal opportunities with men and boys for employment, leadership, and decision-making at all levels” (The United Nations, 2015: p. 6).

This complex and multi-layered nature of sustainable development brings several debates on how governments could deal with complex problems. A novel and relevant approach that targets sustainable development and water resource efficiency is the nexus approach, which interlinkages the top-down and bottom-up approaches and includes selective stakeholders to develop and implement integrated policies (Schreier et al., 2014; Biggs et al., 2015; Papadopoulou et al., 2020). Nexus approach is a prominent, cross-sectoral, and multi-level approach in academic and policy circles, widely used among water science researchers to deal with complex sustainability challenges at the intersection of natural and human systems, supporting the sustainable use of natural resources (e.g., land, water, and energy) under conditions of global change such as climate change, urbanization, and population growth (Hoff, 2011; Hoff et al., 2019; Papadopoulou et al., 2020). It suggests a practice-oriented integrated solution and policy decisions for multifaceted interdependencies and relations of management and governance across different sectors (e.g., water, energy, food) in order to frame sustainability issues by providing a deeper understanding of sector interactions (Hoff, 2011; Smajgl et al., 2016; Hoff et al., 2019; Papadopoulou et al., 2020). Although the nexus approach uses a sustainability lens to develop resource securities to protect society from future risks, it mainly focuses on resource-efficient and technological solutions with a short-term perspective. Moreover, it commonly fails to identify interconnections between water resource management with social issues at the livelihood level (Biggs et al., 2015). This means that problematizing sustainability of water resource management may result in long-term societal justice problems that are less considered and underreported since it does not cover the human needs, vulnerability, resilience, and capability (Thaller de Zarate, 2020). Furthermore, the operationalization of the nexus approach in policy making and its implementation on the ground is constrained by several factors (e.g., insufficient incentives for integrated planning and policy-making at all levels, limited vision, knowledge, and practical experience to guide successful implementation) (Hoff et al., 2019). Therefore, we should understand the underlying implications of water sustainability within the social contexts such as social, political, economic, and administrative systems through more inclusive and integrative institutional arrangements and governance to enhance water security for the benefit of humans and nature (Pahl-Wostl et al., 2013).

Given the complexity of the intersections of natural and social processes, dynamics, and relations on a local to a global scale, there is not a simple or singular policy that can sufficiently decrease the water problems in the area of environment and social justice. To analyze and find solutions to alleviate the social injustices related to environmental change, the dynamic processes and power relations that render the sight of vulnerable groups should be revealed, rather than a descriptive account of who is poor, female, and where (Ackerly, 2016). Feminist political ecology examines the nexus among gender, politics, and ecology



that theorizes that gender is an essential variable in how a person interacts with and understands the natural environment in which they live (Andrew and Agu, 2022). The central idea of the feminist political ecology is that men and women have different experiences, responsibilities, and interests concerning nature due to gender differences in human-nature interactions. These gender differences are constructed socially, not biologically, resulting in divergence in culture, class, race, and place, and variation with the changing conditions of individuals and societies (Rocheleau et al., 1996; Sanyal, 2006). Feminist political ecology gives prominence to environmental justice and seeks to locate and explain the origins and causes of oppression and injustices, vulnerabilities, and the social relations causing them. Through its holistic perspective, it reveals the connections and interactions between the environment, the economy, and politics on a local to global scale and how they are gendered, intending to decrease such inequalities, poverty, and other vulnerabilities (Rocheleau et al., 1996).

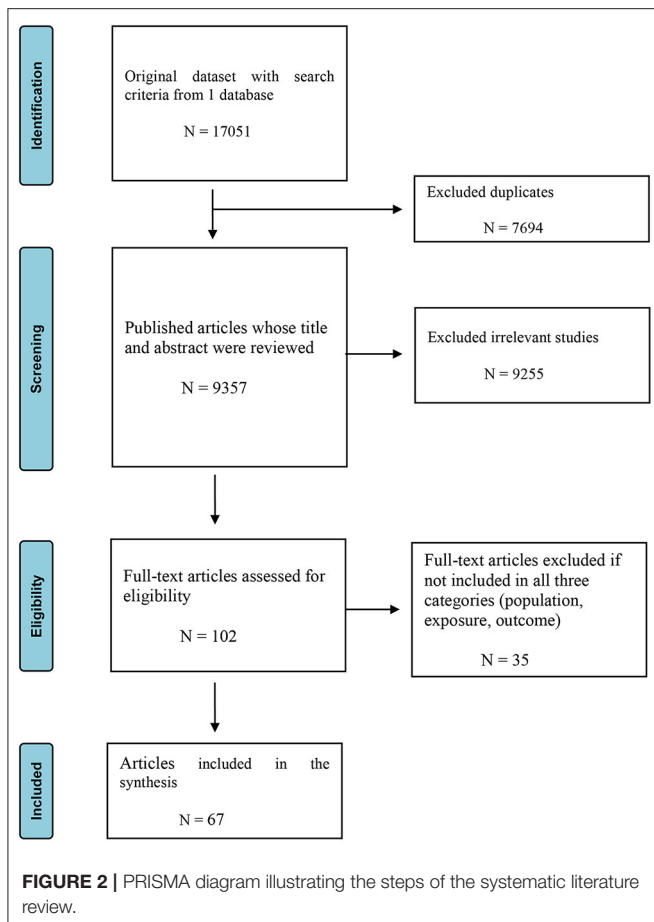
I created a conceptual framework (Figure 1) by combining feminist political ecology and a water-migration-gender nexus to develop a narrative of the interconnection of complex and

multifaceted social inequality and water resources governance for sustainability. The conceptual framework highlights women's roles, needs, responsibilities, constraints, and opportunities within water-related problems and power structures. In this way, I underscore the importance of bridging social and economic aspects at the water resources, migration challenges, and gender, and of intersectionality and inclusiveness in integrated water resource governance approach to recommend solutions to the needs of vulnerable environmental (non) migrants as well as to manage natural resources more responsibly and sustainably as well as protect human rights.

METHODS

Study Design

This study has been undertaken as a systematic literature review based on the PRISMA guidelines for an investigation that aimed to include key highlights, common patterns and/or relationships identified by each study concerning the water-migration nexus and its intersection with gender. The present study assesses each peer-reviewed paper that includes the impact of climate change



and/or water resources crisis on human (im)mobility and its intersection with gender. The steps in the systematic literature review method are documented in **Figure 2**.

Search Strategy and Eligibility Criteria

This systematic literature review includes peer-review papers on the effect of climate change/water-related hazards on human (im)mobility. Studies were eligible if water resources access (outcome) was reported as a part of the migration decision-making process. Water resources access outcomes were categorized based on the direct or indirect result of climate change/water-related hazards covering the issues such as sanitation, hygiene, health, food security, conflict, etc. At least one water resource access-related outcome (direct or indirect) either in the original or destination country needed to be included in the results.

The study population includes people who were affected by the exposures to climate change/water-related hazards and migrated to another country. Other environmental hazards such as geophysical hazards (e.g., earthquakes and volcanoes) were excluded. Migration was defined as an inclusive term including diverse human mobility such as population movement, forced displacement, migration, and non-migration/immobility at the individual, household, and community levels. The

studies addressing population migration regarding climate change/water-related hazards were also included, but not mobile people (nomads) and refugee camp settlements.

Three categories were used for searching: Population (migration/non-migration, original/destination country), Exposure to stressors (climate change/ water-related hazards), and Outcome (water resources access). Since I aimed to fill the gap about the individual/integrated governance strategies regarding the gender aspect, I also included respective keywords. Boolean operators “AND” and “OR” were applied to keywords and controlled vocabulary (e.g., plurals, synonyms, etc.) for the population, exposure, outcome, governance solution, and gender aspect categories by including all possible combinations of keywords (see **Table 1**). Some examples are:

“migration*” OR “refugee*”) AND (“women” OR “girl”) AND (“water management”).

Strings were used for full-text search through Scopus. Inclusion and Exclusion criteria were outlined in **Table 2**. After applying the search strategy, I documented the data to show:

- The number of primary studies focused on individual integrated water resources governance solutions for (non) migrants (specified as women and girls).
- The number of primary studies focused on integrated (water-migration nexus) water resources governance solutions for (non) migrants.
- The number of primary studies focused on integrated migration action regarding the environmental disaster.

This review collects empirical evidence about water and migration in the context of climate change through an interdisciplinary approach by bringing articles from different disciplines together. Scopus was used as a database and papers published between the years 1991–2021 were considered. The search process for this manuscript was conducted in May 2021. Study type inclusion criteria were limited to all open-access journal articles in the English language. Gray literature, reviews, and reports were excluded in this systematic literature review.

A two-stage screening process was adopted as a search strategy and studies were selected through two stages. The first stage was based on screening the studies for the inclusion of key strings in both title and abstract. The second stage was full-text reading. The main selection criterion was that the study included all three categories (population, exposure, and outcome).

Quality Appraisal Approach

Quality assessments of all 67 studies were done using the quality appraisal tool MMAT version 2018 a priori for internal and external validity for all eligible studies (Hong et al., 2018). MMAT consists of five quality appraisal questions (**Supplementary Table 1**) for five study types: mixed methods, quantitative descriptive, quantitative non-randomized, quantitative randomized control trials, and qualitative studies. The quality appraisal questions evaluated the studies regarding their sampling methods, representativeness of the target population, etc. Modeling studies cannot be appraised for quality using the MMAT; therefore, 8 studies included in this review were not appraised. This does not make a difference to the results

TABLE 1 | Search terms.

	Keywords	Num. of papers		Keywords	Num. of papers
Phase 1:1 Individual solutions: either from water or migration perspective	("environmental migrant" OR "climate migrant" OR "environmental refugee" OR "climate refugee" OR "population movement" OR "human movement" OR "population displacement" OR "human displacement" OR "forced displacement" OR "internal displacement" OR "internally displaced" OR "planned relocation" OR "migrant" OR "human mobility" OR "human immobility" OR "non-migration") AND ("water" OR "flood" OR "drought" OR "sea level rise" OR "climate change" OR "tsunami" OR "climate variability" OR "weather variability" OR "environmental disaster" OR "natural disaster" OR "climate hazard") AND ("WASH" OR "water sanitation" OR "water quality" OR "clean water" OR "safe water" OR "water access" OR "water security" OR "water availability" OR "water collection" OR "water management" OR "fetching water" OR "water fetching" OR "drinking water" OR "water source" OR "water resource" OR "water governance" OR "water policy") OR ("food security" OR "hygiene" OR "sanitation" OR "livelihood" OR "poverty" OR "malnutrition" OR "health" OR "unemployment" OR "political conflict" OR "disease" OR "violence" OR "housing" OR "infrastructure" OR "law" OR "social exclusion" OR "social network") AND ("governance" OR "solution" OR "management" OR "policy" OR "recommendation")	59	Phase 1:2 Integrated solutions: Water- Migration Nexus	1:1 AND ("nexus" OR "integrated" OR "intersectional" OR "holistic")	12
Phase 2:1 Individual solutions: either from water or migration perspective +gender	1:1 AND ("gender*" OR "woman*" OR "women*" OR "girl*" OR "girls*" OR "men" OR "man")	19	Phase 2:2 Integrated solutions: Water- Migration Nexus +gender	2:1 AND ("nexus" OR "integrated" OR "intersectional" OR "holistic")	2

because studies are not excluded based on poor quality (Nayna Schwerdtle et al., 2020).

RESULTS

Included Studies

From 9,357 studies identified by the search strategy, 67 eligible studies were included in the further analysis (see Table 3). The main reason for the exclusion of a study was that if the study did not focus on the nexus between climate change/water-related hazards, migration, and water resources access outcome, but was limited to "climate change/water-related hazards and migration (without water resources access outcome)" or "climate change/water-related hazards and water resources access outcome (without migration)." Studies that did not provide empirical evidence or investigated the water resources access and migration by animal or plant species were also excluded. The present study focuses on the governance approach, policy recommendations, and

further research extracted from the included studies. Most selected studies were conducted in Bangladesh ($n = 13$), India ($n = 5$), Kenya ($n = 5$), and Pacific Small Island States ($n = 5$). There were 79 study settings overall from 67 selected studies.

Quality Appraisal

As depicted in Supplementary Table 2, the overall quality of the included studies was high. The qualitative studies ($n = 30$) were appraised as high quality, 66% scoring between "good" and "very high." The quality of mixed methods studies ($n = 18$) was also high, overall 72% attaining a "good" or "high" quality rating. Yet no mixed methods studies achieved a "very high" quality score according to MMAT. The quality of quantitative descriptive studies ($n = 7$) was also high overall, with 71% of studies scoring between "good" and "high." Overall, the quantitative non-randomized studies ($n = 4$) achieved the highest quality assessment result, with 100% scoring between "good" and "high."

TABLE 2 | Inclusion and exclusion criteria.

Criterion	Inclusion	Exclusion
Population	Human mobility: any population, country, both migration or non-migration settings.	Not human migration: plant or animal.
Exposure	(1) water-related stressors, (2) climate/environmental change	Other migration drivers (e.g., political, economic, social, demographic) with no reference to climate or environmental change
Outcome	Water-related: either a direct measure of water outcome (i.e., food security and water/sanitation/hygiene) or an indirect measure of water (i.e., unemployment, political conflict); water-related security risks and development problems in the host and the original country	No water outcome
Nexus	Includes migration (population), climate change/water-related hazards (exposure), and water resources access (outcome).	Focus on two elements (dyad) of the nexus (i.e., climate-water, climate-migration)
Study Type	Peer-reviewed empirical research. All designs: quantitative, qualitative, mixed methods, modeling	Not empirical, systematic review, viewpoint, editorial, book chapter, gray literature, dissertation, conference proceeding, report
Time period	1991–2021	Outside this timeframe
Language	Full text available in English	Other languages
Accessibility	All open access	Other open access types

(100–81% Very high, 80–61% High, 60–41% Good, 40–21% Fair, <20% Poor).

The Links Between Water Resources—Environmental Migration—Gender

Studies were majorly associated with diverse immobility responses and water resource outcomes. The most studied hazards included climate change, floods, and drought. The most studied research setting included Non-migration ($n = 57$), both country of origin and host country ($n = 9$), and Migration ($n = 1$). The predominant water resource outcomes studied were livelihood, food and water security, water infrastructure, and infectious disease. The number of studies proposing individual water-migration solutions ($n = 58$) to alleviate the risks of hazards was much higher than studies suggesting integrated water-migration solutions ($n = 12$). For gender intersection ($n = 19$), studies included individual water-migration-gender solutions, whereas the number of the studies with integrated solutions regarding water-migration-gender is ($n = 2$).

Results and Gaps Learned From the Systematic Literature Review

This systematic literature review analyzed 67 peer-reviewed publications and collected the recommendations for the impact of climate change/water resources crisis on human (im)mobility and its intersection with gender. Existing case studies mainly focus on four thematic areas (technological, social-economic, political, and health), and they proposed individual solutions from water or migration perspectives. Yet, some studies gave insights into the integrated governance approaches combining water and migration issues.

Consistent recommendations for using and developing technological tools to increase resilience against climate and water-related problems were common in most of the analyzed literature. Specific suggestions included investment in technologic tools for supporting sustainable development of agriculture use and for increasing domestic water supply (e.g., water-intensive irrigation facilities, rainwater harvesting technologies, climate-smart agricultural options, enhancing access to water and sanitation) (Bellizzi et al., 2020; Ahmed et al., 2021; Rahman et al., 2021). Early warning systems and data acquisition based on reliable monitoring and surveillance systems to adapt or mitigate climate change effects (e.g., climate-sensitive diseases) were among other suggestions (Marcantonio et al., 2019; Parsons and Chann, 2019; Prívarová and Prívarová, 2019; Sy et al., 2020; Sabasteanski, 2021). Climate-related shocks and stresses impact women more than men since the abilities of men and women to adapt to climate change often differ (Quisumbing et al., 2017). However, such studies have only superficially mentioned gender-responsive technologies and practices (Christoff and Sommer, 2018; Lázár et al., 2020; Marchetti et al., 2020).

The second theme pertained to social-economical recommendations that sought to enable vulnerable people to adapt to social-ecological change. The focused recommendations were: (1) promoting community resilience and sustainability through livelihood and income diversification; for example, migrating from rural areas to more urban areas within a province to find work outside of agriculture due to decreasing water quantity, (2) investments in migration and relocation projects, and (3) raising awareness about socioeconomic vulnerability and preparedness (Qaisrani et al., 2018; Camfield et al., 2020; He et al., 2020; Sobczak-Szelc and Fekih, 2020; Erwin et al., 2021). Participation of the people in labor migration is seen as a major adaptation strategy. On the other hand, since their migrant status intersected with their land ownership status, whether or not they have water security is determined accordingly. For example, migrant laborers who are also renters have access to water; however, migrants who live in informal settlements often lack clean water access in destination countries (Erwin et al., 2021), which may cause problems for them. Social and economic participation in the destination country would be difficult since being unable to have clean water negatively affects health and wellbeing (Ayebe-Karlsson et al., 2020). Therefore, access to clean water resources, improving farm

TABLE 3 | Included studies.

No.	References	Title	Research setting	Study design and overall quality appraisal (see Supplemental Table 2)	Water-migration individual solution	Water-migration integrated solution	Water-migration-gender individual solution	Water-migration-gender integrated solution
1	Ahmed, Z., Guha, G.S., Shew, A.M., Alam, G.M.M.	Climate change risk perceptions and agricultural adaptation strategies in vulnerable riverine char islands of Bangladesh	Non-migration	Both Quantitative and Qualitative ****	X			
2	Slaviková, L., Hartmann, T., Thaler, T.	Paradoxes of financial schemes for resilient flood recovery of households	Non-migration	Qualitative *	X			
3	Ward, M., Poleacovschi, C., Perez, M.	Using AHP and spatial analysis to determine water surface storage suitability in Cambodia	Non-migration	Modeling NA	X			
4	Erwin, A., Ma, Z., Popovici, R., Salas O'Brien, E.P., Zanotti, L., Zeballos Zeballos, E., Bauchet, J., Ramirez Calderón, N., Arce Larrea, G.R.	Intersectionality shapes adaptation to social-ecological change	Both	Qualitative *****	X	X	X	
5	Sabasteanski, N.D.	Climate migration and health system preparedness in the United States	Both	Qualitative *****	X			
6	Adger, W.N., de Campos, R.S., Siddiqui, T., Gavonel, M.F., Szaboova, L., Rocky, M.H., Bhuiyan, M.R.A., Billah, T.	Human security of urban migrant populations affected by length of residence and environmental hazards	Migration	Both Quantitative and Qualitative ***	X			
7	Rahman, M.M., Bodrud-Doza, M., Shammi, M., Md Towfiqul Islam, A.R., Moniruzzaman Khan, A.S.	COVID-19 pandemic, dengue epidemic, and climate change vulnerability in Bangladesh: Scenario assessment for strategic management and policy implications	Non-migration	Both Quantitative and Qualitative ***	X			
8	Merten, J., Nielsen, J.Ø., Rosyani, Soetarto, E., Faust, H.	From rising water to floods: Disentangling the production of flooding as a hazard in Sumatra, Indonesia	Non-migration	Qualitative ***	X			
9	Kameyama, Y., Ono, K.	The development of climate security discourse in Japan	Both	Qualitative **	X			
10	Bellizzi, S., Lane, C., Elhakim, M., Nabeth, P.	Health consequences of drought in the WHO Eastern Mediterranean Region: hotspot areas and needed actions	Non-migration	Qualitative **	X		X	
11	Ward, de Rooter, Mård, Schröter, Van Loon, Veldkamp, T., von Uexkull, Wanders, AghaKouchak, Arnbjerg-Nielsen, Capewell, Carmen Llasat, Day, Dewals, Di Baldassarre, Huning, Kreibich, Mazzoleni, Savelli, Teutschbein, van den Berg, van der Heijden, Vincken, Waterloo, Wens	The need to integrate flood and drought disaster risk reduction strategies	Non-migration	Qualitative ***	X	X		

(Continued)

TABLE 3 | Continued

No.	References	Title	Research setting	Study design and overall quality appraisal (see Supplemental Table 2)	Water-migration individual solution	Water-migration integrated solution	Water-migration-gender individual solution	Water-migration-gender integrated solution
12	Sobczak-Szelc, K., Fekih, N.	Migration as one of several adaptation strategies for environmental limitations in Tunisia: evidence from El Faouar	Non-migration	Both Quantitative and Qualitative ***	X			
13	Ayeb-Karlsson, S., Kniveton, D., Cannon, T.	Trapped in the prison of the mind: Notions of climate-induced (im)mobility decision-making and wellbeing from an urban informal settlement in Bangladesh	Non-migration	Both Quantitative and Qualitative **	X		X	
14	Frumkin, H., Das, M.B., Negev, M., Rogers, B.C., Bertolini, R., Dora, C., Desai, S.	Protecting health in dry cities: Considerations for policy makers	Non-migration	Qualitative *	X			
15	He, W., Liu, Y., Sun, H., Taghizadeh-Hesary, F.	How does climate change affect rice yield in China?	Non-migration	Quantitative descriptive ***	X			
16	Chowdhury, M.A., Hasan, M.K., Hasan, M.R., Younos, T.B.	Climate change impacts and adaptations on health of Internally Displaced People (IDP): An exploratory study on coastal areas of Bangladesh	Non-migration	Both Quantitative and Qualitative ***	X			
17	van der Ploeg, J., Sukulu, M., Govan, H., Minter, T., Eriksson, H.	Sinking Islands, drowned logic; Climate change and community-based adaptation discourses in Solomon Islands	Non-migration	Qualitative ***	X			
18	Lázár, A.N., Nicholls, R.J., Hall, J.W., Barbour, E.J., Haque, A.	Contrasting development trajectories for coastal Bangladesh to the end of century	Non-migration	Simulation study NA		X	X	
19	Singh, S.	Farmers' perception of climate change and adaptation decisions: A micro-level evidence from Bundelkhand Region, India	Non-migration	Qualitative **	X			
20	Camfield, L., Leavy, J., Endale, S., Tefera, T.	People Who Once Had 40 Cattle Are Left Only with Fences: Coping with Persistent Drought in Awash, Ethiopia	Non-migration	Qualitative **	X			
21	Marchetti, L., Cattivelli, V., Cocozza, C., Salbitano, F., Marchetti, M.	Beyond sustainability in food systems: Perspectives from agroecology and social innovation	Non-migration	Qualitative ***	X			X
22	Nagabhatla, N., Brahmabhatt, R.	Geospatial Assessment of water-migration scenarios in the context of sustainable development goals (SDGs) 6, 11, and 16	Non-migration	Simulation study NA		X		
23	Ishiwatari, M., Koike, T., Hiroki, K., Toda, T., Katsube, T.	Managing disasters amid COVID-19 pandemic: Approaches of response to flood disasters	Non-migration	Qualitative **	X			
24	Zaveri, E.D., Wrenn, D.H., Fisher-Vanden, K.	The impact of water access on short-term migration in rural India	Non-migration	Quantitative descriptive ****		X		

(Continued)

TABLE 3 | Continued

No.	References	Title	Research setting	Study design and overall quality appraisal (see Supplemental Table 2)	Water-migration individual solution	Water-migration integrated solution	Water-migration-gender individual solution	Water-migration-gender integrated solution
25	Scheele, Wilson, Lane, ECrowley, Hughes, Davies, Horspool, Williams, Le, Uma, Lukovic, Schoenfeld, Thompson	Modeling residential habitability and human displacement for tsunami scenarios in Christchurch, New Zealand	Non-migration	Modeling NA	X			
26	Sy, B., Frischknecht, C., Dao, H., Consuegra, D., Giuliani, G.	Reconstituting past flood events: The contribution of citizen science	Non-migration	Both Quantitative and Qualitative **	X			
27	Smolak, K., Kasieczka, B., Fialkiewicz, W., Rohm, W., Siła-Nowicka, K., Kopańczyk, K.	Applying human mobility and water consumption data for short-term water demand forecasting using classical and machine learning models	Non-migration	Modeling NA	X			
28	Paerregaard, K.	Communicating the Inevitable: Climate Awareness, Climate Discord, and Climate Research in Peru's Highland Communities	Non-migration	Ethnography ****	X			
29	Sultana, P., Thompson, P.M., Wesselink, A.	Coping and resilience in riverine Bangladesh	Both	Both Quantitative and Qualitative **	X	X	X	
30	Rao, N., Singh, C., Solomon, D., Camfield, L., Sidiki, R., Angula, M., Poonacha, P., Sidibé, A., Lawson, E.T.	Managing risk, changing aspirations and household dynamics: Implications for wellbeing and adaptation in semi-arid Africa and India	Non-migration	Both Quantitative and Qualitative ****	X		X	
31	Chepkoech, W., Mungai, N.W., Stöber, S., Lotze-Campen, H.	Understanding adaptive capacity of smallholder African indigenous vegetable farmers to climate change in Kenya	Non-migration	Quantitative non-randomized studies ***	X		X	
32	Döring, S.	Come rain, or come wells: How access to groundwater affects communal violence	Non-migration	Quantitative descriptive ****	X			
33	Cashman, A., Yawson, D.	Water, livelihoods, and migration in SIDS: Climate change and future prospects for carriacou, West Indies	Non-migration	Both Quantitative and Qualitative ***	X	X		
34	Marcantonio, R.A., Field, S., Regan, P.M.	Toxic trajectories under future climate conditions	Non-migration	Simulation study NA	X			
35	Parsons, L., Chann, S.	Mobilizing hydrosocial power: Climate perception, migration and the small scale geography of water in Cambodia	Non-migration	Both Quantitative and Qualitative ****		X		
36	Bayar, M., Aral, M.M.	An analysis of large-scale forced migration in Africa	Non-migration	Quantitative non-randomized ****	X	X		

(Continued)

TABLE 3 | Continued

No.	References	Title	Research setting	Study design and overall quality appraisal (see Supplemental Table 2)	Water-migration individual solution	Water-migration integrated solution	Water-migration-gender individual solution	Water-migration-gender integrated solution
37	Giuliani, M.M., Gatta, G., Cappelli, G., Gagliardi, A., Donatelli, M., Fanchini, D., De Nart, D., Mongiano, G., Bregaglio, S.	Identifying the most promising agronomic adaptation strategies for the tomato growing systems in Southern Italy <i>via</i> simulation modeling	Non-migration	Modeling study NA	X			
38	Prívará, A., Prívarová, M.	Nexus between climate change, displacement and conflict: Afghanistan case	Both	Quantitative descriptive **	X			
39	Tauzer, E., Borbor-Cordova, M.J., Mendoza, J., De La Cuadra, T., Cunalata, J., Stewart-Ibarra, A.M.	A participatory community case study of periurban coastal flood vulnerability in southern Ecuador	Both	Qualitative *****	X			
40	Honarmand Ebrahimi, S., Ossewaarde, M.	Not a security issue: How policy experts de-politicize the climate change-migration nexus	Non-migration	Qualitative *****	X		X	
41	Ferdous, M.R., Wesselink, A., Brandimarte, L., Slager, K., Zwarteveen, M., Di Baldassarre, G.	The costs of living with floods in the Jamuna floodplain in Bangladesh	Non-migration	Quantitative descriptive ****	X			
42	Weber, K., Wernhart, S., Stickler, T., Fuchs, B., Balas, M., Hübl, J., Damyanovic, D.	Risk communication on floodings: Insights into the risk awareness of migrants in rural communities in Austria	Non-migration	Both Quantitative and Qualitative ***	X	X		
43	Kelman, I., Næss, M.W.	Climate change and migration for Scandinavian Saami: A review of possible impacts	Non-migration	Qualitative ***	X			
44	Jabeen, H.	Gendered space and climate resilience in informal settlements in Khulna City, Bangladesh	Both	Qualitative *****			X	
45	Trundle, A., Barth, B., Mcevoy, D.	Leveraging endogenous climate resilience: urban adaptation in Pacific Small Island Developing States	Non-migration	Qualitative *****	X		X	
46	Kamara, J.K., Agho, K., Renzaho, A.M.N.	Understanding disaster resilience in communities affected by recurrent drought in Lesotho and Swaziland—A qualitative study	Non-migration	Qualitative *****	X		X	
47	Currenti, R., Pearce, T., Salabogi, T., Vuli, L., Salabogi, K., Doran, B., Kitson, R., Ford, J.	Adaptation to Climate Change in an Interior Pacific Island Village: a Case Study of Nawairuku, Ra, Fiji	Non-migration	Qualitative *****	X			
48	Warner, K., Zommers, Z., Wreford, A., Hurlbert, M., Viner, D., Scantlan, J., Halsey, K., Halsey, K., Tamang, C.	Characteristics of transformational adaptation in climate-land-society interactions	Non-migration	Qualitative *	X	X	X	

(Continued)

TABLE 3 | Continued

No.	References	Title	Research setting	Study design and overall quality appraisal (see Supplemental Table 2)	Water-migration individual solution	Water-migration integrated solution	Water-migration-gender individual solution	Water-migration-gender integrated solution
49	Simpson, N.P., Shearing, C.D., Dupont, B.	Climate gating: A case study of emerging responses to Anthropocene Risks	Non-migration	Both Quantitative and Qualitative *	X			
50	Onwutuebe, C.J.	Patriarchy and Women Vulnerability to Adverse Climate Change in Nigeria	Non-migration	Qualitative ***			X	
51	Qaisrani, A., Umar, M.A., Siyal, G.E.A., Salik, K.M.	What Defines Livelihood Vulnerability in Rural Semi-Arid Areas? Evidence from Pakistan	Non-migration	Quantitative non-randomized ***	X		X	
52	Borgomeo, E., Hall, J.W., Salehin, M.	Avoiding the water-poverty trap: insights from a conceptual human-water dynamical model for coastal Bangladesh	Non-migration	Simulation study NA	X			
53	Greene, C.	Broadening understandings of drought – The climate vulnerability of farmworkers and rural communities in California (USA)	Non-migration	Both Quantitative and Qualitative ****	X			
54	Scott, D., Ipinge, K.N., Mfune, J.K.E., Muchadenyika, D., Makuti, O.V., Ziervogel, G.	The story of water in windhoek: A narrative approach to interpreting a transdisciplinary process	Non-migration	Qualitative *	X			
55	McLeod, Arora-Jonsson, Masuda, Bruton-Adams, Emaurois, Gorong, Hudlow, James, Kuhlken, Masike-Liri, Musrasrik-Carl, Otzelberger, Relang, Reyuw, Sigrav, Stinnett, Tellei, Whitford	Raising the voices of Pacific Island women to inform climate adaptation policies	Non-migration	Qualitative *****			X	
56	Christoff, P.S., Sommer, J.M.	Women's empowerment and climate change adaptation in Gujarat, India: A case-study analysis of the local impact of Transnational Advocacy Networks	Non-migration	Qualitative *			X	
57	Mardy, T., Uddin, M.N., Sarker, M.A., Roy, D., Dunn, E.S.	Assessing coping strategies in response to drought: A micro level study in the north-west region of Bangladesh	Non-migration	Both Quantitative and Qualitative ****	X			
58	Paerregaard, K.	The climate-development nexus: using climate voices to prepare adaptation initiatives in the Peruvian Andes	Non-migration	Quantitative descriptive ***	X			
59	Beyerl, K., Mieg, H.A., Weber, E.	Comparing perceived effects of climate-related environmental change and adaptation strategies for the Pacific small island states of Tuvalu, Samoa, and Tonga	Non-migration	Quantitative non-randomized ***	X			
60	Alston, M., Clarke, J., Whittenbury, K.	Contemporary feminist analysis of Australian farm women in the context of climate changes	Non-migration	Both Quantitative and Qualitative ****			X	

(Continued)

TABLE 3 | Continued

No.	References	Title	Research setting	Study design and overall quality appraisal (see Supplemental Table 2)	Water-migration individual solution	Water-migration integrated solution	Water-migration-gender individual solution	Water-migration-gender integrated solution
61	Sánchez-Triana, E., Ortolano, L., Paul, T.	Managing water-related risks in the West Bengal Sundarbans: policy alternatives and institutions	Non-migration	Qualitative ***	X			
62	Thomas, A., Benjamin, L.	Policies and mechanisms to address climate-induced migration and displacement in Pacific and Caribbean small island developing states	Both	Qualitative *****	X		X	
63	Schwan, S., Yu, X.	Social protection as a strategy to address climate-induced migration	Both	Qualitative ****	X			
64	Sultana, P., Thompson, P.M.	Adaptation or conflict? Responses to climate change in water management in Bangladesh	Non-migration	Qualitative ***	X			
65	Mulligan, J., Harper, J., Kipkemboi, P., Ngobi, B., Collins, A.	Community-responsive adaptation to flooding in Kibera, Kenya	Non-migration	Quantitative descriptive **	X	X		
66	Nanekely, M., Scholz, M., Al-Faraj, F.	Strategic framework for sustainable management of drainage systems in semi-arid cities: An Iraqi case study	Non-migration	Both Quantitative and Qualitative ***	X			
67	Sugden, Shrestha, Bharati, Gurung, Maharjan, Janmaat, Price, Sherpa, Bhattarai, Koirala, Timilsina	Climate change, out-migration and agrarian stress: The potential for upscaling small-scale water storage in nepal	Non-migration	Both Quantitative and Qualitative **	X			X

productivity, and offering alternative development opportunities can sustain efforts toward mitigating the effects of climate change and water-related problems to prevent migration (Warner et al., 2019; He et al., 2020; Singh, 2020; Sultana et al., 2020; Zaveri et al., 2020). Despite climate change with gender aspect being a recent topic, some studies focused on the social-economic aspect of gender in the climate context. These studies suggested empowering women in education, rural development, knowledge, innovation, and land-use strategies as mitigation measures to migration (Lázár et al., 2020; Marchetti et al., 2020; Sultana et al., 2020). They addressed calls specifically for women's economic empowerment, women's disproportionate burden of unpaid work (Jabeen, 2019; Kamara et al., 2019), enhancing women's voice in water and land stewardship or providing sufficient credit to women (Rao et al., 2020). Although this theme incorporated studies about climate change/water-gender-migration nexus, the included studies tended to focus on rural with the most focus on sending communities rather than urban and host communities.

The third theme highlighted the importance of the political implications of climate change adaptation. Studies state that government agencies should raise awareness, resilience, and preparedness against environmental risks and water stress among vulnerable groups. Through good governance, participatory and consultative approaches in which government, citizens, stakeholders, institutions, and scientists work interdisciplinary and collaboratively (Nanekely et al., 2016; Sultana and Thompson, 2017; Greene, 2018; Kelman and Næss, 2019; Trundle et al., 2019; Warner et al., 2019; Paerregaard, 2020; Sy et al., 2020) by supporting the safety and sustainability of cities (clean water, sanitation, etc.) affected by environmental challenges (e.g., climate change, water stress, environmental challenges, and migration) (Beyerl et al., 2018; Mardy et al., 2018; Sánchez-Triana et al., 2018; Scott et al., 2018; Thomas and Benjamin, 2018; Bayar and Aral, 2019; Kamara et al., 2019; Weber et al., 2019; Ayeb-Karlsson et al., 2020; Bellizzi et al., 2020; Chepkoech et al., 2020; Scheele et al., 2020; Zaveri et al., 2020; Erwin et al., 2021; Slavíková et al., 2021). Recommendations in the studies were mainly related to local adaptation strategies revealing a potential gap in researching the nexus in national and global settings. Furthermore, in the selected studies, there was very little to no reference to the geopolitical crisis due to the water scarcity that might cause conflicts between local communities over resources, which has the potential for violence and human rights violations across national borders (Ayeb-Karlsson et al., 2020; Döring, 2020; Nagabhatla and Brahmabhatt, 2020). Finally, although included studies revealed many gender-inclusive adaptation strategies, such as taking into account the vulnerability of women in the face of climate change (Alston et al., 2018; Qaisrani et al., 2018; Ayeb-Karlsson et al., 2020; Marchetti et al., 2020; Rao et al., 2020; Sultana et al., 2020; Erwin et al., 2021) or the promotion of women's participation and leadership in all forms of decision-making (McLeod et al., 2018; Jabeen, 2019; Kamara et al., 2019; Trundle et al., 2019), yet competing and conflicting over water use discourse, with a gendered lens, was less analyzed.

The fourth theme brought out health recommendations, which was the least mentioned theme regarding the water-migration-gender nexus. The included studies focus on climate-induced policy discussions on non-economic losses and damages of (im)mobile populations (e.g., sense of belonging, physical and mental health, or emotional wellbeing) (Ayeb-Karlsson et al., 2020) and training of health workers on water quality assessment and surveillance mechanisms for contagious disease control during and after natural disasters (Bellizzi et al., 2020; Sabasteanski, 2021), public health management (Nanekely et al., 2016) to advance regulatory capacity and mechanism about natural disasters and risk management, and to coordinate various sectors and organizations at the national and local levels (Nanekely et al., 2016; Ishiwatari et al., 2020). Again there was less attention paid to women's health concerning the water-migration-gender nexus (Ayeb-Karlsson et al., 2020; Bellizzi et al., 2020; Rao et al., 2020).

Strengths and Limitations of the Systematic Literature Review

There are strengths and limitations of this study design. The strengths include an a priori protocol for publication selection, quality appraisal to limit research bias, and the inclusion of all three elements of the water-migration-gender nexus required for inclusion in the assessment (none of the publications focus on a "dyad" within the nexus). These give more concrete results to answer my research questions. This systematic literature review only analyzed peer-reviewed publications, not the gray literature. This may result in a possible exclusion of some findings due to the large number of key findings published by humanitarian organizations; however, peer-reviewed publications align better with the research objectives by synthesizing empirical evidence, and this is considered strength. There are limitations when considering the implications of the study. First, I included only English publications, and this may cause omitting appropriate papers published in other languages. Second, modeling studies cannot be assessed for quality using the MMAT; therefore, eight studies included in this review were not appraised.

DISCUSSION

I identified the gaps in social inequalities and water resources governance neglected in migration and gender frames to understand women's roles, needs, responsibilities, constraints, and opportunities compared to men within the water-related (non) migration processes and unequal power structures. The result of the systematic literature review demonstrated that the existing case studies mainly suggest individual policies and solutions to water or migration problems in four main domains (technological, social-economic, political, and health). However, there is a need to study social, economic, and political inequalities arising from climate change and environmental (non) migration through the water-migration-gender nexus to solve the complex and multifaceted problems, inequalities, and injustices faced by vulnerable people.

Through a conceptual framework in which feminist political ecology is integrated into the context of the water-migration-gender nexus, I created a narrative using the existing case studies and moving forward on the feminist political ecology approach with the lessons learned from the systematic literature review. In this way, I aim to suggest integrative governance strategies highlighting the importance of gender in water and migration contexts. Feminist political ecology is a practical approach and is commonly used to analyze gender issues in human-environment interactions, including access and exclusion, treating women as environmental change agents at micro to macro levels (Buechler et al., 2020). Yet, more can be done toward linking feminist political ecology to environmental (non) migration due to climate change and water-related hazards that aim to establish a sustainable adaptation of both men and women to environmental risks and water stress. The following strategies are designed to enhance feminist political ecology in addressing the water-related (non) migration context. In line with the results, these recommendations are framed across three dimensions of the feminist political ecology for the adaptation of integrated governance strategies which could synergistically mitigate and regulate water-related (non) migration challenges with a gendered lens.

Strategy 1: Holistic Policy and Implementation

The first dimension of feminist political ecology identifies rights to, use of, and control over resources by examining who has access to resources, who depends on them, who is responsible for using them productively, and who is in charge of resource management (Rocheleau et al., 1996; Ylipaa et al., 2019). Although environmental challenges are not socially constructed, their impacts are as vulnerability and insecurity flow from the dynamics and relationships of power. In addition to environmental challenges, the political, economic, and social dynamics and relations also create vulnerability and insecurity among different social groups, implying that the problems of environmental challenge and social inequality are too broad to be pursued without connections across disciplines (Ackerly, 2016). Therefore, there is a need for an interdisciplinary analysis of water resource efficiency and management, migration, and gender for a more comprehensive understanding of multi-faceted situations to develop more meaningful policies. For example, Foran (2015) showed that large-scale water diversion and hydropower in the Mekong region could lead to out-migration of non-viable small farmers, leading to increased energy demand in urban settlements. The systematic review revealed that a few studies consider the main directions of water-migration-gender interrelate in an interdisciplinary way (see **Table 1**).

Studies mainly analyze the problems from one discipline perspective, not utilizing a combination of different disciplines. A good understanding of this nexus needs to be tested and improved in practice by using interdisciplinary research methods and bringing scholars from various disciplines such as feminists, migration and natural science, and policymakers to discuss the interconnections among resources and the adaptation strategies

of different social groups, to integrate migration in water governance frameworks and reciprocally water management issues in migration governance frameworks with the intersection of gender and to investigate trade-offs and synergies. In that way, policies that focus on women's constraints and opportunities for access to the water resources and sustainability of water resources management can be developed.

Climate change is a threat to human security in general. Yet the essential point is that the decision-makers and key stakeholders should understand the different types of vulnerability, perception, and experience of climate change that women and men face and their gendered implications (Denton, 2002; Ylipaa et al., 2019). Since social, economic, and political hierarchies are so determinative of how differently people perceive, experience, and adapt to environmental challenges, studies and policies regarding the environment and social inequalities need to utilize the best tools for analyzing such hierarchies. The intersectional analysis is a tool pioneered by feminist theorists to study complex processes with multiple interrelated social, political, and economic hierarchies (Ackerly, 2016). It reveals political and historical differences and reasons why particular populations, in which these hierarchies function through categories such as gender, race and ethnicity, experience intense deprivations. For example, Ackerly (2016) showed that without an intersectional analysis of poverty and gender, the impacts of the storm look like the natural consequence of a severe storm hitting a country with many impoverished people who had no access to shelter from the storm. She showed that among people living in poverty, poor women aged 20–44 were more likely to die than men of the same age by using intersectional analysis as a methodological tool. The systematic literature review illustrated that intersectional analysis of the water-migration-gender nexus does not exist. In that sense, an intersectional analysis is crucial to inform academic debates and policy making. Because, without an intersectional analysis of poverty and gender, the injustice of water resources and migration challenges is rendered invisible.

The study of the environment and social inequalities needs to integrate the study of local, national, and global dynamics (Ackerly, 2016). For example, the geopolitical crisis due to the water scarcity, which might cause conflicts between local communities over resources, has the potential for violence and human rights violations across national borders (Döring, 2020; Nagabhatla and Brahmabhatt, 2020). The results from the systematic literature review are mainly related to local adaptation strategies revealing a potential gap in researching the nexus in national and global settings. Thus, cooperation between local, national, and global authorities should be intensified toward projects emphasizing women as actors to improve living conditions and opportunities for vulnerable populations and to discuss women's immediate needs. However, it is crucial to emphasize one last point regarding the design and implementation of global strategies. There is a lack of representativeness of the included studies concerning global governance strategies as the majority of included studies were conducted in Bangladesh, India, Kenya, and the Pacific Small Island States, which are regions of wide-ranging climates with

different governance structures. This implies that translating or generalizing these findings to a range of diverse settings and populations may present risks. Therefore, it is recommended to understand the risks, exposures, vulnerabilities, and capacities of unique populations and settings to inform policy and practice decisions. That is possible only if global governance strategies consider country and population-specific contexts and structures (e.g., social and cultural) since environmental migration and water scarcity vary over space and time.

The majority of the included studies in the analysis point out adaptation strategies rather than mitigation activities by government and non-governmental organizations. This aspect is crucial because, in some cases, people who face environmental risk are unable to migrate and forced to stay and adapt to water scarcity since people's social and economic capitals, capability, and social networks structure their migration opportunities (Etzold et al., 2016). The science-policy interface is a social process concerning the interactions between scientists and other actors (e.g., decision-makers, knowledge-brokers, citizens, etc.) in the policy process. It encompasses exchanges, co-evolution, and joint construction of knowledge that aim to enrich decision-making (Van den Hove, 2007). By combining good governance and an effective science-policy interface for promoting the water-migration-gender nexus, the mitigation activities are put forward. Because, in that way, the political and social contexts provide an insightful perspective for understanding the nexus process, from the scientific domain to policy, to accelerate good governance of the whole society (Xu, 2020). Mercure et al. (2019) illustrated that energy, water, and food are highly interrelated in Brazil, such that policy for managing one likely affects the other two sometimes in unpredictable ways. They proposed a scientific analysis of the nexus to solve the problem that the nexus approach is one that not only captures these interlinkages, but that does so in an understandable and actionable way by decision-makers. Therefore, the complexity of the water-migration-gender nexus requires integrative approaches, which bridge several disciplines and policy sectors (Hoffmann, Hoffmann) in order to: (1) understand climate change in different contexts, (2) find out the root causes of environmental migration related to water insecurity, (3) promote to the access of vulnerable groups to water resources, and (4) enhance sustainable development.

Lastly, studies included in the systematic literature review emphasized the importance of participatory and consultative approaches in which government, citizens, stakeholders, institutions, and scientists work collaboratively to raise awareness, resilience, and preparedness among vulnerable groups against environmental risks and water stress. Yet, only a few studies emphasized the gender dimension along with the participatory approach. For example, Melloni et al. (2020) analyzed that the participatory approach facilitates the communication between several stakeholders in Brazil, enhancing social representation in the decision-making process of the water-energy-food nexus assessment to achieve long-term efficiencies. In that sense, an appropriate participatory approach ensures the key relationships and their integration at different facets and vertices of the water-migration-gender nexus by

conceptualizing and analyzing the interaction of natural-human system(s) (Parkes et al., 2010).

Strategy 2: Equal Knowledge Creation and Dissemination Among Men and Women

The second dimension of feminist political ecology indicates who has the power to construct knowledge and how gender affects perceptions of and expectations for that knowledge (Rocheleau et al., 1996; Ylipaa et al., 2019). Climate-related shocks and stresses impact women more than men since the abilities of men and women to adapt to climate change often differ (Quisumbing et al., 2017). The systematic literature review displays that education, knowledge, and innovation (social and technological) would increase the sustainability of natural resources. However, existing literature focuses on gender-responsive technologies and practices but not in-depth, and there is a lack of policy-making on that topic. Therefore, I recommend that macro-level policies such as robust programs of vocational training and education by the government for women would help them compete for new jobs. The government should promulgate policies to support and ensure sufficient agricultural labor supply and take effective post-disaster measures to alleviate labor loss following the negative shock of environmental hazards. Women would likely benefit from knowledge sharing that might help them respond to the challenge of building sustainable livelihoods in the face of climate change. Besides sustainable farms, there is a need for non-farm employment opportunities in rural and urban areas for the poor and landless rural women. A long-term commitment to gender-sensitive education and continued dialogue through workshops on gender inequities and their linkage with climate change and environmental challenges is crucial to increasing awareness among key professionals, actors, practitioners, and stakeholders. For example, Hemstock et al. (2017) indicated that the limited availability of appropriate formal training in the Pacific Small Island Developing States led to a lack of locally trained people to implement and monitor projects; in turn, unsuccessful projects caused maladaptation or increasing vulnerability and risk. Thalheimer et al., 2022 emphasized that anticipatory humanitarian action (e.g., early warnings and forecast-based financing mechanisms) can contribute to climate risk knowledge and information; and thus can enhance the capacity before natural hazards compound and sustainability and resilience of the societies. Therefore, increasing the knowledge and information of women about agricultural adaptation techniques and technologies would diminish the decision of vulnerable people to migrate due to the water stress-related economic challenges. Lastly, socio-economic policies included in the systematic literature review tended to focus more on rural settings with the most focus on sending communities rather than urban and host communities. However, environmental migrants, especially women, adolescents, and children, who reside in urban slums, struggle with mental health issues and lower quality of life due to water scarcity and lack of water infrastructure (Ayebe-Karlsson et al., 2020). Therefore, the governments and non-government organizations should promulgate social and economic policies for women in urban

settings and host communities; for example, helping migrant women obtain better-paid work or strengthening cooperation to protect their homes and families, to establish sustainable adaptation and to reduce obstacles they face in urban areas.

Strategy 3: Increasing Women's Rights and Responsibilities

The third dimension of feminist political ecology is analyzing participation, representation, and access to political arenas by mapping out who has the possibility and power to influence policy-making and who lacks access to the political sphere (Rocheleau et al., 1996; Ylipaa et al., 2019). The systematic literature review demonstrated that studies mostly neglected the issue of participation and leadership of women in decision-making on climate change and water-related migration. Legal access to land has become an issue of gender inequality. For example, Ylipaa et al. (2019) identified differentiated rights and responsibilities between female and male farmers in Vietnam that leads to unequal opportunities and immobility for females making them more vulnerable to climate impacts. Thus, I recommend developing social protections and local level associations aimed at women to ensure lawful access to the property to enable them to generate their income. Migration policies can result in desirable outcomes when prioritizing human rights (Wrathall et al., 2018). In that sense, governments should consider the gendered needs of women and develop policies increasing women's participation and representation in politics to prevent or alleviate the problems due to climate change by ensuring the human right (e.g., water access for all or equal income between men and women). The least mentioned theme revealed from the systematic literature review was the health theme regarding the water-migration-gender nexus. Women and girls are at heightened risk groups, which require careful consideration in the context of climate change and water stressors. Climate-induced problems are more likely to affect women and girls due to, on average, their lower educational levels and health status and limited access to natural resources (Chindarkar, 2012). Therefore, there is a need to provide socially and culturally appropriate gender-specific health adaptation/mitigation policies (e.g., water, sanitation, hygiene, or infantile diseases), such as alleviating financial and geographic barriers to healthcare services. The results of the systematic literature review regarding political theme indicated many gender-inclusive adaptation strategies (e.g., taking into account the vulnerability of women in the face of climate change or the promotion of women's participation and leadership in all forms of decision-making). Yet competing and conflicting over water use discourse was less analyzed with a gendered lens. The competition and conflict over water use discourse play a crucial role in women's life because women and men have different power over access to resources and decision-making processes and their experiences in conflict situations are remarkably different (Tadesse et al., 2010). Therefore, gender aspects should be touched upon extensively in political conflict discourse, and the adaptation strategies should be rearranged by

considering the socio-cultural dimension of gender prejudices embedded in traditional practices (Paerregaard, 2018; Currenti et al., 2019; Onwutuebe, 2019).

CONCLUSION

In this paper, I answered: "To what extent can integrated governance strategies be used to reduce the water-related problems of the environmental (non) migrants, considering the gender dimension?" Migration and water security are complex and multifaceted global challenges of today's world which have several human problems in both home and host countries. They are influenced by several interacting factors, ranging from economic causes, socio-cultural conditions, and geopolitical considerations. Although the water-migration nexus has been examined, the literature on the water-migration-gender nexus is scarce. This study carried the debates about water and migration one step further and examined the water-migration-gender nexus by analyzing current case studies through a feminist perspective to provide integrated governance strategies covering water resource sustainability, migration challenges, and gender inequalities for designing and implementing more concrete and practicable policies at the national and international levels to eliminate or minimize future uncertainties of climate change. This paper concludes that the current solutions and policies toward climate change and the nexus approach are insufficient to solve water sustainability and resource-inefficiency if human systems and social implications are underrepresented. Experiences, needs, and priorities of environmental (non) migrants differ based on gender. These differences should be touched upon if policies are to be inclusive. Adaptation to climate change requires a broader conceptualization of equitable, legitimate, and sustainable development in an effective and resilient response. Therefore, an enhanced understanding of the nexus between access to water resources, drivers of migration, and gender inequality is required to decrease social inequalities due to climate change and to achieve SDGs which prioritize water security for the benefit of humans and nature.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

ACKNOWLEDGMENTS

I thank the reviewers AO and LT for their helpful comments and suggestions.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/frwa.2022.921459/full#supplementary-material>

REFERENCES

- Abbaspour, K. C., Faramarzi, M., Ghasemi, S. S., and Yang, H. (2009). Assessing the impact of climate change on water resources in Iran. *Water Resour. Res.* 45, W10434. doi: 10.1029/2008WR007615
- Abel, G. J., Brottrager, M., Cuaresma, J. C., and Muttarak, R. (2019). Climate, conflict and forced migration. *Global Environ. Change* 54, 239–249. doi: 10.1016/j.gloenvcha.2018.12.003
- Ackerly, B. A. (2016). “Hidden in plain sight: social inequalities in the context of environmental change,” in *Environmental Migration and Social Inequality. Advances in Global Change Research*, Vol. 61, eds R. McLeman, J. Schade, and T. Faist (Cham: Springer), p. 131–149.
- Ahmed, Z., Guha, G. S., Shew, A. M., and Alam, G. M. M. (2021). Climate change risk perceptions and agricultural adaptation strategies in vulnerable riverine char islands of Bangladesh. *Land Use Policy* 103, 105295. doi: 10.1016/j.landusepol.2021.105295
- Alston, M., Clarke, J., and Whittenbury, K. (2018). Contemporary feminist analysis of Australian farm women in the context of climate changes. *Soc. Sci. T.* 7, 16. doi: 10.3390/socsci7020016
- Andrew, C., and Agu, H. U. (2022). 2 using a feminist political ecology lens to explore the gendered dimensions of wildlife trafficking literature. *Women Wildlife Trafficking Participants Perpetrators Victims* 11, p. 11–26. doi: 10.4324/9781003121831-2
- Ayeb-Karlsson, S., Kniveton, D., and Cannon, T. (2020). Trapped in the prison of the mind: notions of climate-induced (Im)mobility decision-making and wellbeing from an urban informal settlement in Bangladesh. *Palgrave Commun.* 6, 62. doi: 10.1057/s41599-020-0443-2
- Bayar, M., and Aral, M. M. (2019). An analysis of large-scale forced migration in Africa. *Int. J. Environ. Res. Public Health* 16, 4210. doi: 10.3390/ijerph16214210
- Bellizzi, S., Lane, C., Elhakim, M., and Nabeth, P. (2020). Health consequences of drought in the WHO Eastern Mediterranean Region: hotspot areas and needed actions. *Environ. Health* 19, 114. doi: 10.1186/s12940-020-00665-z
- Beyerl, K., Mieg, H. A., and Weber, E. (2018). Comparing perceived effects of climate-related environmental change and adaptation strategies for the Pacific small island states of Tuvalu, Samoa, and Tonga. *Island Stud. J.* 13, 25–44. doi: 10.24043/isj.53
- Biggs, E. M., Bruce, E., Boruff, B., Duncan, J. M. A., Horsley, J., Pauli, N., et al. (2015). Sustainable development and the water-energy-food nexus: a perspective on livelihoods. *Environ. Sci. Policy* 54, 389–397. doi: 10.1016/j.envsci.2015.08.002
- Black, R., Adger, W. N., Arnell, N. W., Dercon, S., Geddes, A., and Thomas, D. (2011). The effect of environmental change on human migration. *Global Environ. Change* 21, S3–S11. doi: 10.1016/j.gloenvcha.2011.10.001
- Buechler, S. (2009). Gender, water, and climate change in Sonora, Mexico: implications for policies and programmes on agricultural income-generation. *Gender Dev.* 17, 51–66. doi: 10.1080/13552070802696912
- Buechler, S., Vázquez-García, V., Martínez-Molina, K. G., and Sosa-Capistrán, D. M. (2020). Patriarchy and (electric) power? A feminist political ecology of solar energy use in Mexico and the United States. *Energy Res. Soc. Sci.* 70, 101743. doi: 10.1016/j.erss.2020.101743
- Camfield, L., Leavy, J., Endale, S., and Tefera, T. (2020). People who once had 40 cattle are left only with fences: coping with persistent drought in awash, Ethiopia. *Euro. J. Dev. Res.* 32, 889–905. doi: 10.1057/s41287-019-00245-z
- Cannon, T. (2002). Gender and climate hazards in Bangladesh. *Gender Dev.* 10, 45–50. doi: 10.1080/13552070215906
- Chepkoech, W., Mungai, N. W., Stöber, S., and Lotze-Campen, H. (2020). Understanding adaptive capacity of smallholder African indigenous vegetable farmers to climate change in Kenya. *Clim. Risk Manag.* 27, 100204. doi: 10.1016/j.crm.2019.100204
- Chindarkar, N. (2012). Gender and climate change-induced migration: Proposing a framework for analysis. *Environ. Res. Lett.* 7, 025601. doi: 10.1088/1748-9326/7/2/025601
- Christoff, P. S., and Sommer, J. M. (2018). Women’s empowerment and climate change adaptation in Gujarat, India: a case-study analysis of the local impact of Transnational Advocacy Networks. *Sustainability* 10, 1920. doi: 10.3390/su10061920
- Collins, S. M., Mbullo Owuor, P., Miller, J. D., Boateng, G. O., Wekesa, P., Onono, M., et al. (2019). ‘I know how stressful it is to lack water!’ Exploring the lived experiences of household water insecurity among pregnant and postpartum women in western Kenya. *Global Public Health* 14, 649–662. doi: 10.1080/17441692.2018.1521861
- Currenti, R., Pearce, T., Salabogi, T., Vuli, L., Salabogi, K., Doran, B., et al. (2019). Adaptation to climate change in an interior Pacific island village: a case study of Nawairuku, Ra, Fiji. *Hum. Ecol.* 47, 65–80. doi: 10.1007/s10745-019-0049-8
- Denton, F. (2002). Climate change vulnerability, impacts, and adaptation: why does gender matter? *Gender Dev.* 10, 10–20. doi: 10.1080/13552070215903
- Djoudi, H., and Brockhaus, M. (2011). Is adaptation to climate change gender neutral? Lessons from communities dependent on livestock and forests in northern Mali. *Int. Forestry Rev.* 13, 123–35. doi: 10.1505/146554811797406606
- Döring, S. (2020). Come rain, or come wells: how access to groundwater affects communal violence. *Polit. Geogr.* 76, 102073. doi: 10.1016/j.polgeo.2019.102073
- Dulal, H. B., Shah, K. U., and Ahmad, N. (2009). Social equity considerations in the implementation of Caribbean climate change adaptation policies. *Sustainability* 1, 363–383. doi: 10.3390/su1030363
- Enarson, E., and Fordham, M. (2001). From women’s needs to women’s rights in disasters. *Environ. Hazards* 3, 133–136. doi: 10.3763/ehaz.2001.0314
- Erwin, A., Ma, Z., Popovici, R., Salas O’Brien, E. P., Zanotti, L., Zeballos Zeballos, E., et al. (2021). Intersectionality shapes adaptation to social-ecological change. *World Dev.* 138, 105282. doi: 10.1016/j.worlddev.2020.105282
- Etzold, B., Ahmed, A. U., Hassan, S. R., Neelormi, S., and Afifi, T. (2016). Rainfall variability, hunger, and social inequality, and their relative influences on migration: evidence from Bangladesh,” in *Environmental Migration and Social Inequality. Advances in Global Change Research*, Vol. 61, eds R. McLeman, J. Schade, and T. Faist (Springer, Cham), p. 27–41.
- Foran, T. (2015). Node and regime: Interdisciplinary analysis of water-energy-food nexus in the Mekong region. *Water Altern.* 8, 655–674.
- Greene, C. (2018). Broadening understandings of drought - the climate vulnerability of farmworkers and rural communities in California (USA). *Environ. Sci. Policy* 89, 283–291. doi: 10.1016/j.envsci.2018.08.002
- Haines, A., Kovatsa, R. S., Campbell-Lendrum, D., and Corvalan, C. (2006). Climate change and human health: impacts, vulnerability and public health. *Public Health* 120, 585–596. doi: 10.1016/j.puhe.2006.01.002
- He, W., Liu, Y., Sun, H., and Taghizadeh-Hesary, F. (2020). How does climate change affect rice yield in China? *Agriculture* 10, 441. doi: 10.3390/agriculture10100441
- Heinonen, U. (2006). Environmental impact on migration in Cambodia: water-related migration from the Tonle Sap Lake Region. *Int. J. Water Resour. Develop.* 22, 449–462. doi: 10.1080/07900620500482865
- Hemstock, S. L., Jacot Des Combes, H., Martin, T., Vaike, F. L., Maitava, K., Buliruarua, L. A., et al. (2017). “A case for formal education in the Technical, Vocational Education and Training (TVET) sector for climate change adaptation and disaster risk reduction in the Pacific Islands region,” in *Climate Change Adaptation in Pacific Countries* (Cham: Springer), 309–324.
- Hoff, H. (2011). “Understanding the nexus,” in *Background Paper for the Bonn 2011 Conference: The Water, Energy and Food Security Nexus*. Stockholm: Stockholm Environment Institute.
- Hoff, H., Alrahaife, S. A., El Hajj, R., Lohr, K., Mengoub, F. E., Farajalla, N., et al. (2019). A nexus approach for the MENA region—from concept to knowledge to action. *Front. Environ. Sci.* 7, 48. doi: 10.3389/fenvs.2019.00048
- Hoffmann, R. Contextualizing climate change impacts on human mobility in African drylands. *Earth’s Future*. 10, e2021EF002591. doi: 10.1029/2021EF002591
- Hong, Q. N., Pluye, P., Fàbregues, S., Bartlett, G., Boardman, F., Cargo, M., et al. (2018). The mixed methods appraisal tool (MMAT) version 2018 for information professionals and researchers. *Education for Information*. 34, 285–291. doi: 10.3233/EFI-180221
- IOM (2007). *Discussion Note: Migration and the Environment. Ninety-Fourth Session*. MC/INF/288, Original: English, Geneva, 1 November 2007.
- Ishiwatari, M., Koike, T., Hiroki, K., Toda, T., and Katsube, T. (2020). Managing disasters amid COVID-19 pandemic: approaches of response to flood disasters. *Progress Disaster Sci.* 6, 100096. doi: 10.1016/j.pdisas.2020.100096
- Jabeen, H. (2019). Gendered space and climate resilience in informal settlements in Khulna City, Bangladesh. *Environ. Urbanization* 31, 115–138. doi: 10.1177/0956247819828274

- Jobbins, G., Langdown, I., and Bernard, G. (2018). *Water and Sanitation, Migration and the 2030 Agenda for Sustainable Development*. ODI Briefing Note. London: ODI.
- Kamara, J. K., Agho, K., and Renzaho, A. M. N. (2019). Understanding disaster resilience in communities affected by recurrent drought in Lesotho and Swaziland-A qualitative study. *PLoS ONE* 14, e0212994. doi: 10.1371/journal.pone.0212994
- Kelman, I., and Naess, M. W. (2019). Climate change and migration for Scandinavian Saami: a review of possible impacts. *Climate* 7, 47. doi: 10.3390/cli7040047
- Lama, P., Hamza, M., and Wester, M. (2021). Gendered dimensions of migration in relation to climate change. *Climate Dev.* 13, 326–336. doi: 10.1080/17565529.2020.1772708
- Lázár, A. N., Nicholls, R. J., Hall, J. W., Barbour, E. J., and Haque, A. (2020). Contrasting development trajectories for coastal Bangladesh to the end of century. *Reg. Environ. Change* 20, 93. doi: 10.1007/s10113-020-01681-y
- Lynch, B. D. (2012). Vulnerabilities, competition and rights in a context of climate change toward equitable water governance in Peru's Rio Santa Valley. *Global Environ. Change* 22, 364–373. doi: 10.1016/j.gloenvcha.2012.02.002
- Marcantonio, R. A., Field, S., and Regan, P. M. (2019). Toxic trajectories under future climate conditions. *PLoS ONE* 15, e0230094. doi: 10.1371/journal.pone.0230094
- Marchetti, L., Cattivelli, V., Cocozza, C., Salbitano, F., and Marchetti, M. (2020). Beyond sustainability in food systems: perspectives from agroecology and social innovation. *Sustainability* 12, 7524. doi: 10.3390/su12187524
- Mardy, T., Uddin, M. N., Sarker, M. A., Roy, D., and Dunn, E. S. (2018). Assessing coping strategies in response to drought: a micro level study in the north-west region of Bangladesh. *Climate* 6, 23. doi: 10.3390/cli6020023
- McLeman, R., Schade, J., and Faist, T. (eds.) (2016). Environmental migration and social inequality. *Adv. Global Change Res.* 61, 3–23. doi: 10.1007/978-3-319-25796-9_1
- McLeod, E., Arora-Jonsson, S., Masuda, Y. J., Bruton-Adams, M., Emaurois, C. O., Gorong, B., et al. (2018). Raising the voices of Pacific Island women to inform climate adaptation policies. *Marine Policy* 93, 178–185. doi: 10.1016/j.marpol.2018.03.011
- Melloni, G., Turetta, A. P. D., Bonatti, M., and Sieber, S. (2020). A stakeholder analysis for a water-energy-food nexus evaluation in an atlantic forest area: implications for an integrated assessment and a participatory approach. *Water* 12, 1977. doi: 10.3390/w12071977
- Mercure, J. F., Paim, M. A., Bocquillon, P., Lindner, S., Salas, P., Martinelli, P., et al. (2019). System complexity and policy integration challenges: the Brazilian energy-water-food nexus. *Renew. Sustain. Energ. Rev.* 105, 230–243. doi: 10.1016/j.rser.2019.01.045
- Milán-García, J., Caparrós-Martínez, J. L., Rueda-López, N., and de Pablo Valenciano, J. (2021). Climate change-induced migration: a bibliometric review. *Global. Health* 17, 74. doi: 10.1186/s12992-021-00722-3
- Mohtar, R. H., and Daher, B. (2012). "Water, energy, and food: The ultimate nexus," in *Encyclopedia of Agricultural, Food, and Biological Engineering*, 2nd Edn (CRC Press). doi: 10.1081/E-EAFE2-120048376
- Munoz, S. M. (2021). Environmental mobility in a polarized world: questioning the pertinence of the "climate refugee" label for Pacific Islanders. *J. Int. Migration Integration* 22, 1271–1284. doi: 10.1007/s12134-020-00799-6
- Nagabhatla, N., and Brahmabhatt, R. (2020). Geospatial assessment of water-migration scenarios in the context of sustainable development goals (Sdgs) 6, 11, and 16. *Remote Sens.* 12, 1376. doi: 10.3390/rs12091376
- Nagabhatla, N., Pouramin, P., Brahmabhatt, R., Fioret, C., Glickman, T., Newbold, K. B., et al. (2020). *Water and Migration: A Global Overview*. UNU-INWEH Report Series, Issue 10. United Nations University Institute for Water, Environment and Health, Hamilton, ON.
- Nanekely, M., Scholz, M., and Al-Faraj, F. (2016). Strategic framework for sustainable management of drainage systems in semi-arid cities: an Iraqi case study. *Water* 8, 406. doi: 10.3390/w8090406
- Nayna Schwerdtle, P., Stockemer, J., Bowen, K. J., Sauerborn, R., McMichael, C., and Danquah, I. (2020). A meta-synthesis of policy recommendations regarding human mobility in the context of climate change. *Int. J. Environ. Res. Public Health* 17, 9342. doi: 10.3390/ijerph17249342
- Onwutuebe, C. J. (2019). Patriarchy and women vulnerability to adverse climate change in Nigeria. *SAGE Open*. 9:1–7. doi: 10.1177/2158244019825914
- Paerregaard, K. (2018). The climate-development nexus: using climate voices to prepare adaptation initiatives in the Peruvian Andes. *Climate Dev.* 10, 360–368. doi: 10.1080/17565529.2017.1291400
- Paerregaard, K. (2020). Communicating the inevitable: climate awareness, climate discord, and climate research in Peru's highland communities. *Environ. Commun.* 14, 112–125. doi: 10.1080/17524032.2019.1626754
- Pahl-Wostl, C., Holtz, G., Kastens, B., and Knieper, C. (2010). Analyzing complex water governance regimes: the management and transition framework. *Environ. Sci. Policy* 13, 571–581. doi: 10.1016/j.envsci.2010.08.006
- Pahl-Wostl, C., Palmer, M., and Richards, K. (2013). Enhancing water security for the benefits of humans and nature-the role of governance. *Curr. Opin. Environ. Sustain. Aquatic Marine Syst.* 5, 676–684. doi: 10.1016/j.cosust.2013.10.018
- Papadopoulou, C.-A., Papadopoulou, M., Laspidou, C., Munaretto, S., and Brouwer, F. (2020). Towards a low-carbon economy: a nexus-oriented policy coherence analysis in greece. *Sustainability* 12, 373. doi: 10.3390/su12010373
- Parkes, M. W., Morrison, K. E., Bunch, M. J., Hallström, L. K., Cynthia Neudoerffer, R., Venema, H. D., et al. (2010). Towards integrated governance for water, health and social-ecological systems: the watershed governance prism. *Global Environ. Change* 20, 693–704. doi: 10.1016/j.gloenvcha.2010.06.001
- Parsons, L., and Chann, S. (2019). Mobilising hydrosocial power: climate perception, migration and the small scale geography of water in Cambodia. *Polit. Geogr.* 75, 102055. doi: 10.1016/j.polgeo.2019.102055
- Piao, S., Ciais, P., Huang, Y., Shen, Z., Peng, S., Li, J., et al. (2010). The impacts of climate change on water resources and agriculture in China. *Nature* 467, 43–51. doi: 10.1038/nature09364
- Piper, N. (ed.). (2008). "International migration and gendered axes of stratification: introduction," in *New Perspectives on Gender and Migration: Livelihood, Rights and Entitlements* (New York, NY: Routledge), 1–18.
- Prívará, A., and Prívarová, M. (2019). Nexus between climate change, displacement and conflict: Afghanistan case. *Sustainability* 11, 5586. doi: 10.3390/su11205586
- Qaisrani, A., Umar, M. A., Siyal, G. E. A., and Salik, K. M. (2018). What defines livelihood vulnerability in rural semi-arid areas? Evidence from Pakistan. *Earth Syst. Environ.* 2, 455–475. doi: 10.1007/s41748-018-0059-5
- Quisumbing, A. R., Kumar, N., and Behrman, J. A. (2017). Do shocks affect men's and women's assets differently? Evidence from Bangladesh and Uganda. *Dev. Policy Rev.* 36, 3–34. doi: 10.1111/dpr.12235
- Rahman, M. M., Bodrud-Doza, M., Shammí, M., Md Towfiqul Islam, A. R., and Moniruzzaman Khan, A. S. (2021). COVID-19 pandemic, dengue epidemic, and climate change vulnerability in Bangladesh: scenario assessment for strategic management and policy implications. *Environ. Res.* 192, 110303. doi: 10.1016/j.envres.2020.110303
- Rao, N., Singh, C., Solomon, D., Camfield, L., Sidiki, R., Angula, M., et al. (2020). Managing risk, changing aspirations and household dynamics: implications for wellbeing and adaptation in semi-arid Africa and India. *World Dev.* 125, 104667. doi: 10.1016/j.worlddev.2019.104667
- Rocheleau, D., Thomas-Slayter, B., and Wangari, E. (1996). *Feminist Political Ecology: Global Issues and Local Experience*. Routledge: Abingdon.
- Sabasteanski, N. D. (2021). Climate migration and health system preparedness in the United States. *Climate Policy* 21, 368–382. doi: 10.1080/14693062.2020.1828795
- Sánchez-Triana, E., Ortolano, L., and Paul, T. (2018). Managing water-related risks in the West Bengal Sundarbans: policy alternatives and institutions. *Int. J. Water Resour. Dev.* 34, 78–96. doi: 10.1080/07900627.2016.1202099
- Sanyal, N. (2006). *Political ecology of environmental crises in Bangladesh* (Durham theses). Durham University. Available online at: <http://etheses.dur.ac.uk/2893/>
- Scheele, F., Wilson, T., Lane, E. M., Crowley, K., Hughes, M. W., Davies, T., et al. (2020). Modelling residential habitability and human displacement for tsunami scenarios in Christchurch, New Zealand. *Int. J. Disaster Risk Reduct.* 43, 101403. doi: 10.1016/j.ijdrr.2019.101403
- Schmidt, K. (2016). "Social inequality and international migration related to climate stressors: the case of Mexico," in *Environmental Migration and Social Inequality* (New York, NY: Springer International Publishing), 117–128.
- Schreier, H., Kurian, M., and Ardakanian, R. (2014). *Integrated Water Resources Management: A Practical Solution to Address Complexity by Employing the Nexus Approach*. Working Paper No. 2. Available online: <https://flores.>

- unu.edu/wp-content/uploads/2014/07/unu_wp\hbox2--2014_ansicht.pdf (accessed January 4, 2017).
- Scott, D., Ipinge, K. N., Mfune, J. K. E., Muchadenyika, D., Makuti, O. V., and Ziervogel, G. (2018). The story of water in windhoek: a narrative approach to interpreting a transdisciplinary process. *Water* 10, 1366. doi: 10.3390/w10101366
- Singh, S. (2020). Farmers' perception of climate change and adaptation decisions: A micro-level evidence from Bundelkhand Region, India. *Ecol. Indic.* 116, 106475. doi: 10.1016/j.ecolind.2020.106475
- Slavíková, L., Hartmann, T., and Thaler, T. (2021). Paradoxes of financial schemes for resilient flood recovery of households. *WIREs Water* 8, e1497. doi: 10.4324/9781003179863
- Smajgl, A., Ward, J., and Pluschke, L. (2016). The water-food-energy Nexus - realising a new paradigm. *J. Hydrol.* 533, 533–540. doi: 10.1016/j.jhydrol.2015.12.033
- Sobczak-Szelc, K., and Fekih, N. (2020). Migration as one of several adaptation strategies for environmental limitations in Tunisia: evidence from El Faouar. *Comparative Migr. Stud.* 8, 8. doi: 10.1186/s40878-019-0163-1
- Steffen, W., Crutzen, P. J., and McNeill, J. R. (2007). The anthropocene: are humans now overwhelming the great forces of nature? *Ambio* 36, 614–621. doi: 10.1579/0044-7447(2007)36[614:TAAHNO]2.0.CO;2
- Stoler, J., Brewis, A., Kangmennang, J., Keough, S. B., Pearson, A. L., Rosinger, A. Y., et al. (2021). Connecting the dots between climate change, household water insecurity, and migration. *Curr. Opin. Environ. Sustain.* 51, 36–41. doi: 10.1016/j.cosust.2021.02.008
- Sugden, F., Shrestha, L., Bharati, L., Gurung, P., Maharjan, L., Janmaat, J., et al. (2014). *Climate Change, Out-Migration and Agrarian Stress: The Potential for Upscaling Small-Scale Water Storage in Nepal (Research Report)*. Colombo: International Water Management Institute (IWMI).
- Sultana, F. (2018). "Gender and water in a changing climate: challenges and opportunities" in *Water Security Across the Gender Divide*, eds C. Fröhlich, G. Gioli, R. Cremades, and H. Myrntinen (London: Springer), 17–33.
- Sultana, P., and Thompson, P. M. (2017). Adaptation or conflict? Responses to climate change in water management in Bangladesh. *Environ. Sci. Policy* 78, 149–156. doi: 10.1016/j.envsci.2017.09.011
- Sultana, P., Thompson, P. M., and Wesslink, A. (2020). Coping and resilience in riverine Bangladesh. *Environ. Hazards Human Policy Dimensions* 19, 70–89. doi: 10.1080/17477891.2019.1665981
- Sy, B., Frischknecht, C., Dao, H., Consuegra, D., and Giuliani, G. (2020). Reconstituting past flood events: the contribution of citizen science. *Hydrol. Earth Syst. Sci.* 24, 61–74. doi: 10.5194/hess-24-61-2020
- Tadesse, B., Tesfaye, Y., and Beyene, F. (2010). Women in conflict and indigenous conflict resolution among the Issa and Gurgura clans of Somali in Eastern Ethiopia. *Afr. J. Conflict Resolut.* 10, 85–110. doi: 10.4314/ajcr.v10i1.59308
- Thalheimer, L., Simperingham, E., and Jjemba, E. W. (2022). The role of anticipatory humanitarian action to reduce disaster displacement. *Environ. Res. Lett.* 17, 014043. doi: 10.1088/1748-9326
- Thaller de Zarate, C. (2020). *Silent Waters - Diving Beyond The Resource Nexus?: A Critical Case Study Of Clothing Brands On Water Sustainability Issues* (Dissertation). Department of Earth Sciences, Uppsala University, Uppsala, Sweden. Available online at: <http://urn.kb.se/resolve?urn=urn:nbn:se:uu:diva-419420>
- The United Nations (2015). *Transforming Our World: The 2030 Agenda for Sustainable Development*. Available online at: http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E (accessed March 06, 2022).
- Thomas, A., and Benjamin, L. (2018). Policies and mechanisms to address climate-induced migration and displacement in Pacific and Caribbean small island developing states. *Int. J. Climate Change Strategies Manage.* 10, 86–104. doi: 10.1108/IJCCSM-03-2017-0055
- Tignino, M., and Mach, E. (2018). *Migration and Water Governance (Policy Brief Series; 2, Vol. 4)*. Available online: <https://archive-ouverte.unige.ch/unige:129027>
- Trundle, A., Barth, B., and Mcevoy, D. (2019). Leveraging endogenous climate resilience: urban adaptation in Pacific Small Island Developing States. *Environ. Urbanization* 31, 53–74. doi: 10.1177/0956247818816654
- Van den Hove, S. (2007). A rationale for science-policy interfaces. *Futures* 39, 807–826. doi: 10.1016/j.futures.2006.12.004
- Warner, K., and Afifi, T. (2013). Where the rain falls: Evidence from 8 countries on how vulnerable households use migration to manage the risk of rainfall variability and food insecurity. *Climate Dev.* 6, 1–17. doi: 10.1080/17565529.2013.835707
- Warner, K., Zommers, Z., Wreford, A., Hurlbert, M., Viner, D., Scantlan, J., et al. (2019). Characteristics of transformational adaptation in climate-land-society interactions. *Sustainability* 11, 356. doi: 10.3390/su11020356
- Weber, K., Wernhart, S., Stickler, T., Fuchs, B., Balas, M., Hübl, J., et al. (2019). Risk communication on floodings: insights into the risk awareness of migrants in rural communities in Austria. *Mountain Res. Dev.* 39, D14–D26. doi: 10.1659/MRD-JOURNAL-D-18-00060.1
- Wrathall, D. J., Van Den Hoek, J., Walters, A., and Devenish, A. (2018). *Water Stress and Human Migration: A Global, Georeferenced Review of Empirical Research (No. ISBN 978-92-5-130426-6)*. Rome: Food And Agriculture Organization of the United Nations. Available online: <http://www.fao.org/3/I8867EN/i8867en.pdf>
- Xu, S. (2020). Governing the energy-water nexus in China: an analysis from the perspective of the science-policy interface. *J. Environ. Manage.* 272, 111119. doi: 10.1016/j.jenvman.2020.111119
- Ylipaa, J., Gabrielson, S., and Jerneck, A. (2019). Climate change adaptation and gender inequality: insights from rural Vietnam. *Sustainability* 11, 2805. doi: 10.3390/su11102805
- Zaveri, E. D., Wrenn, D. H., and Fisher-Vanden, K. (2020). The impact of water access on short-term migration in rural India. *Austral. J. Agric. Resource Econ.* 64, 505–532. doi: 10.1111/1467-8489.12364
- Conflict of Interest:** The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.
- Publisher's Note:** All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.
- Copyright © 2022 Irbik. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.