frontiers | Frontiers in Human Dynamics

ORIGINAL RESEARCH
published: 14 June 2022
doi: 10.3389/fhumd.2022.858229

Assessment of Water-Migration-Gender Interconnections in Ethiopia

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In recent years, water stress has affected Ethiopian people and communities through shrinking water availability/quantity, poor quality and/or inadequate service provision. Water stress is further exacerbated by the impact of extreme events such as droughts and floods. For people exposed to water crises–whether slow-onset water stress or extreme water-related scenarios-migration often emerges as an adaptation strategy. Yet, knowledge on the interlinkages between water stress and migration pathways remains limited and particularly blind on the gender aspects. This paper contributes to the emerging literature on the nexus between water stress, migration, and gender in settings where large numbers of people and population live in vulnerable conditions and are regularly exposed to water stress. Our analysis in Ethiopia adopts the three-dimensional water-migration framework outlined by the United Nations University in 2020 comprising water quantity, water quality, water extremes. In addition, it has been customized to include a fourth dimension, i.e., water governance. Adapting this framework allowed for an enhanced understanding of the complex interactions between water-related causalities and migration decision making faced by communities and populations, and the gendered differences operating within these settings. We adopted a qualitative research approach to investigate the influence of water stress-related dynamics on migration and gender disparities in Ethiopia with a specific focus on opportunities for migration as an adaptation strategy to deal with water stress. Moreover, our approach highlights how gender groups in the state, especially women and girls, are facilitated or left behind in this pathway. Based on the examination of available information and stakeholders' interactions, we noted that when having the chance to migrate to a more progressive region, women and girls can benefit from other opportunities and options for education and emancipation. While existing policy responses for water governance focus on durable solutions, including the creation of sustainable livelihoods, as well as the improvement of (access to) water, sanitation, and hygiene (WASH) facilities and water infrastructure, they remained restricted on socioeconomic dimensions. Gendered aspects seem to be gaining attention but must be further strengthened in national and regional water management plans and public policies. This agenda would involve representation and consultation with different actors such as civil society and international

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Edited by:
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Specialty section:
This article was submitted to Migration and Society, a section of the journal Frontiers in Human Dynamics

Received: *19 January 2022*
Accepted: *22 April 2022*
Published: *14 June 2022*

Citation:
Färber L, Nagabhatla N and Ruyssen I (2022) Assessment of Water-Migration-Gender Interconnections in Ethiopia. Front. Hum. Dyn. 4:858229. doi: 10.3389/fhumd.2022.858229

(aid) organizations to support gender-sensitive investment for water management and for managing the spillover impacts of water crisis, including voluntary migration, and forced displacement. Taking note of selected Sustainable Development Goals (SDGs), particularly SDG 5 (gender equality), SDG 6 (clean water and sanitation), SDG 10 (reduced inequality), SDG 13 (climate action and peace) and SDG 16 (peace, justice, and strong institutions), we have outlined recommendations and strategies while discussing the multiple narratives applying to the water-gender-migration nexus. The key points include a focus on long-term sustainable solutions, boosting stakeholder participation in decision making processes, facilitating cooperation at all political levels, and creating inclusive, gender-sensitive and integrated water frameworks comprising support for regulated migration pathways as an adaptation strategy to water and climate crises.

Keywords: water stress, migration, gender, Ethiopia, internal displacement

INTRODUCTION

Migration and forced displacement are complex issues. People often use migration as an adaptation strategy to improve socio-economic circumstances leading to international and internal migration movements (Nagabhatla et al., 2020b). Furthermore, the nexus (or interconnections) between water stress, migration, and gender constitutes a critical research gap further pushed by the impacts of climate change and extreme events. Academic research and international reports increasingly acknowledge that environmental and water-related stress factors force people to leave their homes as they face situations such as loss of livelihood and income generation opportunities. A recent synthesis indicates that >50 % of the total forced displacement is related to climate change and water-related dimensions (Nagabhatla et al., 2020). Despite a growing understanding of the water stress and migration challenges, academic investigation and development/humanitarian assessments do not often collect, and report gender differentiated response mechanisms in water-stressed situations. How males and females are impacted by water crisis can vary significantly, as strong gender imbalance exists in water provisioning roles and responsibilities and options to choose migration as an adaptation strategy. The temporal and spatial heterogeneity in a country's ability to manage women's particular demands in migration and livelihoods are relatively under-researched despite the fact that in Africa and Asia, 70% of women and girls are responsible for domestic water collection and often migrate less than men (Nagabhatla et al., 2020a). In this context, the International Organization of Migration (IOM) states that acknowledging gender disparities in the connection between climate change and migration can help to "*reduce [the] vulnerability of populations exposed to environmental risk factors; prevent forced migration due to environmental factors to the extent possible; facilitate migration as an adaptation strategy to climate change; tailor assistance to populations on the move as a result of environmental causes; [and] identify durable solutions adapted to differentiated gender needs*." (International Organisation for Migration, 2014, p. 104). Therefore, water-related migration pathways remain a crucial aspect for people and populations living in vulnerable settings and call for a better understanding of the complex causes and repercussions of water-related displacement, particularly for women and girls.

Taking note of the current scientific knowledge, this article takes steps to provide a general overview of this nexus for Ethiopia and an in-depth deconstruction of the complexities of water stress, migration, and gender interlinkages focusing on specific regions withing the state. The ongoing climate change crisis, more frequent and severe droughts, along with a suite of water risks, have cumulatively caused substantial long-term water stress in Ethiopia. The Ethiopian case provides a suitable example to explain the water crisis settings and the spillover impacts such as migration and human displacement, along with the gender disparities that apply in the water sector and in the migration support mechanisms.

To assess the nexus, a three-dimensional framework outlined by Nagabhatla et al. (2020a) was used as a base guiding framework and modified to include the water governance dimension in order to analyse the direct and indirect impacts of water quantity, water quality, and water extremes on migration choices and pathways. The framework also allowed to examine the tendencies of migration decisions and to incorporate the gender perspective. Overall, a qualitative research approach is applied that includes examining expert interviews with participants engaged in water- and migration-related fields/sectors/agencies and projects/programs. Specifically, this article explores the following research (sub-)questions: (1) what are the interlinkages between water stress, migration, and gender in Ethiopia? (2) how do water stress-related dynamics, directly and indirectly, influence migration and gender disparities? (3) can (local) governments design water-related programs to enhance society's resilience and incorporate gender-sensitive aspects to support women and girls precisely?

The research design is constructed to present a methodological approach and test the application of an existing water-migration assessment framework in a specific setting (Ethiopia). We anticipate that the findings of this study can serve useful to support targeted policies toward sustainable livelihoods and better support for affected men and women in their adaptation processes. We also expect that the highlights from this study contribute valuable insights for this complex

nexus and thus elucidate upon a potential approach to analyse the interlinkages also in other regions.

RELATED LITERATURE

For providing an overview of academic literature on the different dimensions of the discussed nexus and knowledge on the interdependencies, we referred to the academic information from different disciplines such as migration, environmental change, gender, and development studies. The current status of the existing literature on the interdependencies between water stress, migration, and gender shows an insufficient consideration of the gender aspects (Miletto et al., 2017; Evertsen and van der Geest, 2020; Nagabhatla et al., 2020a). A considerable amount of information and literature sources, national and international agencies and agendas, and development reports make a general reference to "environmental migration" and "climate migrants" (Beine and Jeusette, 2019; Nagabhatla et al., 2020; UNESCO and UN-Water, 2020), thereby acknowledging that interlinkages between water and climate crises and their influence on migration are highly complex. Numerous articles such as Beine and Jeusette (2019), Bekaert et al. (2021), Black et al. (2011), Black et al. (2013), Coniglio and Pesce (2015), Falco et al. (2018), Gemenne (2011), Kaczan and Orgill-Meyer (2020) and Joarder and Miller (2013) have empirically researched these interlinkages, and their findings vary considerably. While it is noted that water crisis and climate change impact migration aspirations, the impact is not proportional, and people use different adaptation strategies such as selling assets and livestock, diversifying crops, and reducing consumption (Morrissey, 2012; Opiyo et al., 2015; Hermans and Garbe, 2019) to cope with the circumstances. Moreover, water stress or climate change-induced migration decisions are complex and differ between countries and contexts. There is no consensus on whether climate change impacts internal migration movements indirectly or directly, and in some studies, a causal relationship cannot be established, with people not willing or able to move due to climate change impacts (Falco et al., 2018; Wrathall et al., 2018). Recent studies, however, find increasing evidence for climate change impacts triggering internal and/or international migration either in a direct way (Beine and Jeusette, 2019), or through indirect spillover effects of water stress such as failure or crop production due to large variability in precipitation patterns, or loss of job and income opportunities in natural resource-focused sectors such as food production systems.

The existing literature fairly covers the interlinkage between water stress and migration but does not sufficiently incorporate the gender dimension and often lacks clear information on how men and women are differently affected by water stress and to what extent their migration responses differ. Moreover, as reflected in an IOM report, out-migration may impact gender roles and change gender relations (International Organisation for Migration, 2014), resulting in adverse outcomes for gender groups (Miletto et al., 2017). Hence, the need for focused research to better understand gendered migration decisions is pointed as a priority.

Migration decisions due to water stress seem complex, and vary among others with socioeconomic factors (Morrissey, 2012). A study from Kenya shows that "*migration was driven by the intersection of environmental change, ineffective governance, poverty, lack of adaptive capabilities, and individual desires*" (Stoler et al., 2021, p. 39). A global review on climate change, water insecurity, and migration at the household level indicates that livelihoods are disrupted by water collection roles, which in turn impact opportunities to attend school and conduct economic work. This is particularly the case for women and girls, as they often bear responsibility to meet the water needs of the household (Stoler et al., 2021). Moreover, when facing water scarcity and the economic impact of water stress situations, family members are often sent to cities to diversify the household's income.

Nevertheless, water scarcity also evokes obstacles to conduct work in urban and peri-urban regions. As water collection requires time and energy resources, men and women must trade-off sufficient water with employment opportunities, social engagements, and domestic tasks. These barriers can thus result in persistent poverty as household members cannot participate in other income generating activities (Stoler et al., 2021). Additionally, as gendered and socioeconomic inequalities increase, they give room to a discrimination toward affected people, and pose other threats in terms of poverty (International Organisation for Migration, 2014). Consequently, appropriately accounting gendered aspects in assessments of interconnections between water stress /scarcity and migration is critical to address the barriers to gender (in particular female) migration options, as seen in Bolivia (Stoler et al., 2021) and Ethiopia (Gray and Mueller, 2012; Mersha and Van Laerhoven, 2016). However, men can simultaneously be impacted by disasters, water, and climate crisis scenarios. They might face more difficulties to provide social capital for migration and may be less aware of risks.

A handful of studies and reports (Lindtjørn et al., 1993; Gray and Mueller, 2012; Morrissey, 2012, 2013; Alemayehu and Bewket, 2017; Cortés Ferrández, 2019) focus on the interlinkages between water stress and migration in the Ethiopian context. Predictions by Rigaud et al. (2018) for internal migration in developing countries state that by 2050, climate migration can rise, making 0.4 to 1.2 % of the entire population. According to developed scenarios therefore, the proportion of climate migrants in Ethiopia will increase until 2050 (Rigaud et al., 2018), and the northern regions may count as significant out-migration regions (Hermans and Garbe, 2019). It has also been pointed out that migration behavior in Ethiopia seems to differ by gender and region (Hermans and Garbe, 2019). Ezra and Kiros (2001), Gray and Mueller (2012), Mersha and Van Laerhoven (2016), and Miletto et al. (2017) identify gender-segregated impacts of droughts in different regions in Ethiopia. Ezra and Kiros (2001) find that females in Ethiopia have more opportunities to migrate than males. Contrarily, Miletto et al. (2017) note that female marriage migration rates decrease during droughts, and girls attend school to a lesser extent (Miletto et al., 2017). These findings are in accordance with Gray and Mueller (2012), who investigate the impacts of droughts on migration movements in north Ethiopia between 1994 and 2009. The authors find

that men tend to migrate more during drought periods to supplement the household's income, while women's marriage-related migration decreases. Reduced marriage migration can be identified because of lowered wealth due to droughts. Moreover, Mersha and Van Laerhoven (2016) state that female-headed households migrate less than male-headed households in the country's highlands. Women living in rural parts of the country tend to engage more in seasonal migration to the Middle East to send remittances. In contrast, men mainly migrate to nearby towns for daily work (Alemayehu and Bewket, 2017).

Additionally, in Ethiopia, women and girls are primarily responsible for domestic water collection, storage, and handling, resulting in them being the most affected by water scarcity and, rendering them most vulnerable. It is argued that water stress and the effects on women and girls can hinder the progress to achieve SDGs 5 and 6 (Baye, 2021). Stoler et al. (2021) report that women in the rural highlands of Ethiopia must collect water during odd hours and are often abused by men when not fulfilling their water supply tasks. Shame and depression resulting from household water scarcity might often lead to or stem from migration (Stoler et al., 2021). This is particularly the case in drought seasons, when women and girls have to collect water often walking more than 1 h to the water source such as shallow wells or unsecured ponds (Pickering and Davis, 2012) contaminated with diseases and waste (Shore, n.d.).

While many studies and reports on climate-induced migration have been conducted, several gaps exist in research on the interconnections between water stress, migration, and gender. The existing studies predominantly focus on specific regions in the northern and southern parts of the country, thereby missing out on heterogeneous contexts of water-induced migration across regions in the country. Moreover, the existing research primarily considers (semi-)arid rural regions, and to a lesser extent cities and urban landscapes. Most studies looked into reduced water availability (quantity) and extreme events such as droughts, while predominantly ignoring water quality and water governance aspects. Water quality parameters are insufficiently included in the classification for basic water services as reflected in the SDG 6, that calls for a "water for all" agenda (Gemeda et al., 2021). As water-related challenges affect women and men differently, it is key to assess the topic with a gendered perspective to account for specific barriers and opportunities. Furthermore, there has only been limited research on SDG 6.2 referring to sanitation services. It also becomes apparent that there are inequalities between populations in rural and urban areas (Baye, 2021). This study aims to add to our understanding of the complex interlinkages between water stress, migration, and gender, and thereby contribute to closing research gaps and assess the needs for future research.

METHODOLOGY

Literature Review

Based on literature sources, related data and information from different disciplines, this review provides crucial academic findings on the interlinkages between water stress, migration, and gender. Relevant literature available *via* search engines such as Google Scholar, Web of Science and Research Gate and information accessed by different combinations of the keywords viz., "migration," "environmental change," "climate change," "water," "water stress," "Ethiopia," "Sub-Saharan Africa," "gender," "women" and "girls," resulted in set of articles and web sources to provide sufficient information on the current knowledge related to this topic of interest. In the case of insufficient academic articles on a specific issue (e.g., the water crisis-gender nexus), these academic records were complemented with information from non-academic reports and databases provided by international organizations.

Guiding Framework and Research Design

To analyse the interconnection between water and migration using a gendered lens, we applied a qualitative approach and a deductive study design combining information from literature and thematic analysis of semi-structured expert interviews. The conceptional framework (**Figure 1**) outlined by Nagabhatla et al. (2020a) is used as the main guiding framework to construct our narratives for the selected area of interest. The framework accounts for three central dimensions of water-related push factors of migration: (i) water quantity, i.e., increasing aridity, increasing use, and the lack of access; (ii) water quality, i.e., groundwater contamination, surface water pollution, and wastewater management; and (iii) water extremes, i.e., floods, droughts, and sea-level rise. Identifying the adverse impacts of existing policies for the provision of water, water rights, alongside inclusion and equity issues, we extended the guiding framework by adding a fourth dimension, i.e., water governance, to reflect and account for existing water policies. We reckon that each of these dimensions may occur individually or simultaneously and note that even though the framework considers all major water-related push factors for migration, they are not necessarily initiating migration in a linear manner. Migration decisions also depend on economic, social, and political circumstances and available resources, which can positively and negatively impact water stress situations (Nagabhatla et al., 2020a). Furthermore, the framework emphasizes that people tend to migrate either forcibly or voluntarily as they face water pressure from these dimensions either directly or indirectly through disease burden, loss of livelihood, food insecurity, and income loss. The framework, hence, provides the appropriate theoretical/conceptual lens to analyse the nexus of water stress, migration, and gender in the case of Ethiopia. Combining the framework with qualitative research enabled us to examine the gendered migration aspirations in water-stressed areas.

Data Collection

Based on the key observations from the literature on the nexus, interviews were conducted to substantiate and compare our findings with existing information and knowledge on the topic in various settings. Throughout the primary data analysis, fresh insights and new information on water stress and migration as well as key points on the regional context of Ethiopia were extracted.

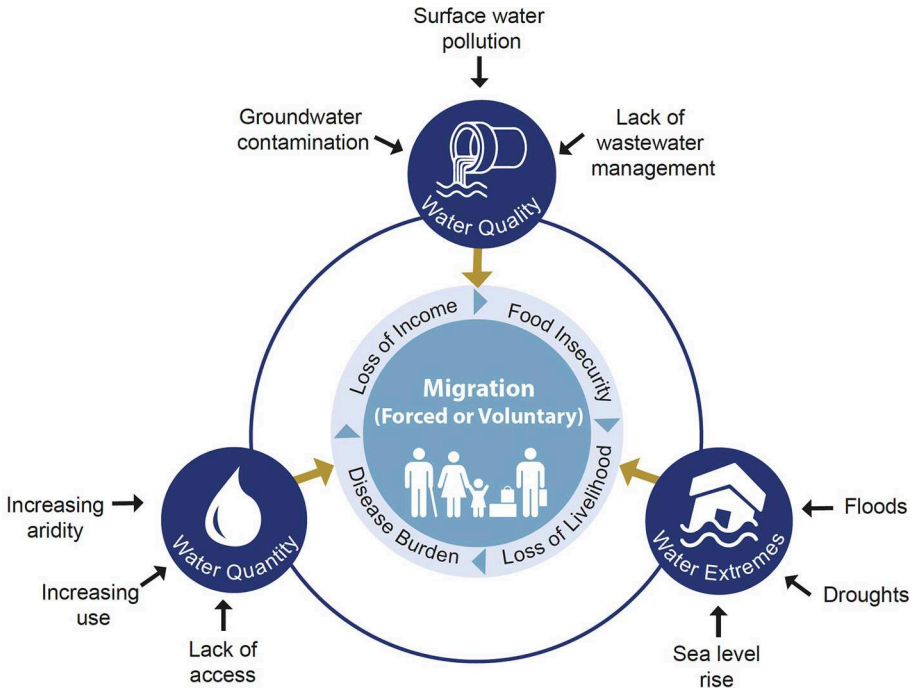

FIGURE 1 | Three-dimensional framework to assess the water-migration interconnections (Source: Nagabhatla et al., 2020a).

Expert Interviews

To better understand and identify different interlinkages of water stress, migration, and gender in Ethiopia, we interviewed a sample of experts (selected to represent various sectors applicable to the nexus) to provide a broad range of multi-sectoral information and data. Purposive sampling as also applied and explained by Matthews and Ross (2010) allowed adequate investigation of the nexus as the stakeholders/experts were chosen deliberately and purposively from representative fields, i.e., either water or migration-related professions. Interviewees shared their perspective and insights on the interrelationship between water stress and/or climate change and migration in Ethiopia. The unit of analysis comprises water stress-affected Ethiopians (national level). As selected fields differ by the interviewees' nature, this research benefits from insights from different viewpoints such as donors, researchers, project managers, policymakers, and international institutions (see **Annexure 1** for more details). Overall, the approach provides a broad scope of the nexus while identifying common points as well as interferences.

In total, seven semi-structured in-depth interviews with experts were conducted in English on the platform Microsoft Teams, which were non-standardized to explore the experts' experiences, understandings, and in-depth opinions aligning with the methodology by Matthews and Ross (2010). **Annexure 1** also reflects on the different institutions the interviewees work in and provides the institutions' roles. The duration of the interviews varied between 28 and 67 min, and were concluded when saturation (information redundancy) was noted, and no more new information could be collected (Matthews and Ross, 2010). An interview guide was formulated in advance including open-ended questions which could be adapted during the interview. Thus, the structure of interviews differed as appropriate questions were chosen depending on the interviewee's expertise. Interviews were digitally recorded to be literally transcribed afterwards. Participants were not offered monetary incentives.

Data Analysis

The interviews were thematically analyzed by identifying influential water-related factors on migration and gender and vice versa and the interdependent nature of the research (Braun and Clarke, 2006), which contributes to the current state of scientific knowledge. A deductive approach was applied by investigating existing data obtained with the scoping literature review in combination with newly obtained information from the in-depth interviews.

The thematic analysis was based on the three-dimensional framework (**Figure 1**), following a guideline for appropriate coding of relevant information obtained from the transcribed interviews. Patterns and joint statements were identified, and subsequent analysis comprised inductive (data-driven) and theory-driven deductions with attribution to literature and the framework. Categorisations were developed and further divided into subsequent themes. The information was coded manually to identify and structure information by topics and (sub-)themes.

Limitations

First, the interviews conducted comprised a small non-probability sample size with specific characteristics and selective insights. As the sampling method was purposefully designed to address the research problem at the national level, results are not statistically generalisable for the whole population and do not reflect all experiences as they depend on people's specific context (Matthews and Ross, 2010). However, as experts were selected based on specific criteria to ensure their expertise and interest in the topic, the research analysis reflects relevant information and knowledge and accounts for experienced insights. Thus, it gives a better grasp of the overall understanding of the nexus and reflects how the interlinkages can be examined using an approach that is scalable and interoperable.

Second, the direct voices and viewpoints of those affected are not included as they were not interviewed due to access challenges and the travel restrictions caused by the COVID-19 pandemic. However, the research assessment captured a wide range of professional expertise and in-depth experts, ensuring a profound basis for formulating policy suggestions. Moreover, although 21 governmental officials, researchers, experts working in Non-Governmental Organizations (NGOs) and (inter-) national institutions were approached, the response rate was relatively low with just seven participants willing to be interviewed. As the research on the nexus is relatively new, we selected experts from various institutions to cover different perspectives and capture their insights on the nexus to provide a basis for further research on the interlinkages in Ethiopia and other regions with similar settings. We acknowledge that throughout the research, a gender lens must be applied. Due to the limited date, we included findings from articles which cover gendered aspects to underline our findings. For instance (Oxfam and CARE Ethiopia, 2016), it was found that migration can impact gender dynamics and social norms as well as tensions between females and hosts evolve in receiving communities. Despite the challenges faced during the data collection due to the pandemic and disrupted field work, the overall approach holds potential to provide valuable insights into the nexus.

Third, political information is underrepresented as only one representative working in The Federal Ministry of Water, Irrigation, and Electricity (MoWIE) was interviewed. However, as interviewees are engaged in different sectors, the study is a novel attempt to offer reliable information on the interlinkages between water stress, migration, and gender by capturing and synthesizing the perspective of the representative stakeholders.

Fourth, as little data is available and experts often only report from their experiences and conversations with affected people, policymakers, actors, and stakeholders, some statements are not evidence-based but anecdotal, since the study attempted to capture viewpoints and perceptions on gender aspects in the water sector and migration setting by connecting with local and regional experts. Moreover, by interviewing experts working in different fields, we also noted their concern, that served as a barrier to our assessment. However, it brought to light the fact that some interviewees feared facing reputational risk if they disclose their identity. Also, the interviewee may not always have been comfortable answering specific questions. Moreover, they might not have given straightforward answers. To minimize this risk, anonymisation of the interviewees was guaranteed. Finally, the researchers analyzed the given information objectively to avoid misinterpretation which might occur during qualitative research. To further mitigate such concerns, interviewees were able to validate the interview transcript.

RESULTS

The overall analysis from this study is showcased in four parts. References to items highlighted by interviewees appear in square brackets (i.e., S1 till S7). Further information about the different institutions the interviewees work in are provided in **Annexure 1**.

Analysis of the Water Stress and Climate Change Situation in Ethiopia Using 3 Scenarios

All interviewees confirmed the water stress situation in Ethiopia is bad and severe [S1-S7] and about half of its total area is water-stressed [S3]. It became clear that there is a need to consider regional differences because of the variation in environmental circumstances within the country [S4, S5]. Climate-induced internally displaced people (IDPs) are housed mainly in parts of the Somali region, the border region of Afar-Dire Dawa and Southern Nations, Nationalities, and Peoples' Region (SNNP)–Oromia (see **Figure 2**).

Flood-affected people (partly in combination with desert locusts) primarily live in the Somali region and Afar (see **Figure 2**) (UNICEF Ethiopia, 2020).

Water Quality

In terms of water quality, the urban population, which makes up around 21% of the total Ethiopian population, largely has access to tap water [S4]. Ethiopia does not have a country-wide systematic monitoring and regulatory body and responsibilities are distributed between several institutions (Gemeda et al., 2021). Data on sanitation is not adequately collected and monitored. If there is data available, it is not segregated regarding geography, gender, and community disparities (Baye, 2021). Thus, the Joint Monitoring Program (JMP) is the most reliable database for the WASH sector [S1]. According to this source, 50 % of the Ethiopians have access to (basic) drinking water, 9% to (basic) sanitation, and 8% to hygiene services (**Figure 3**) (WHO/UNICEF, 2021). Despite the overall improved situation in cities, poor water quality and hygiene, as well as the risk of cholera [S1] and diarrhea outbreaks, are reported (Cortés Ferrández, 2019; Baye, 2021). Around 34% of the basic water services in Ethiopia do not meet the standards of "safe drinking water" (Gemeda et al., 2021) specified in SDG 6.1, which emphasizes "by 2030, achieve universal and equitable access to safe and affordable drinking water for all" (WHO/UNICEF, 2017, p. 2). Obstacles in the water infrastructure construction were highlighted as Ethiopia lacks good companies that can close existing gaps [S1]. It is challenging to build, maintain, and operate water infrastructures such as wells, pipes, and water taps in remote areas as there further exists a shortage of human resources

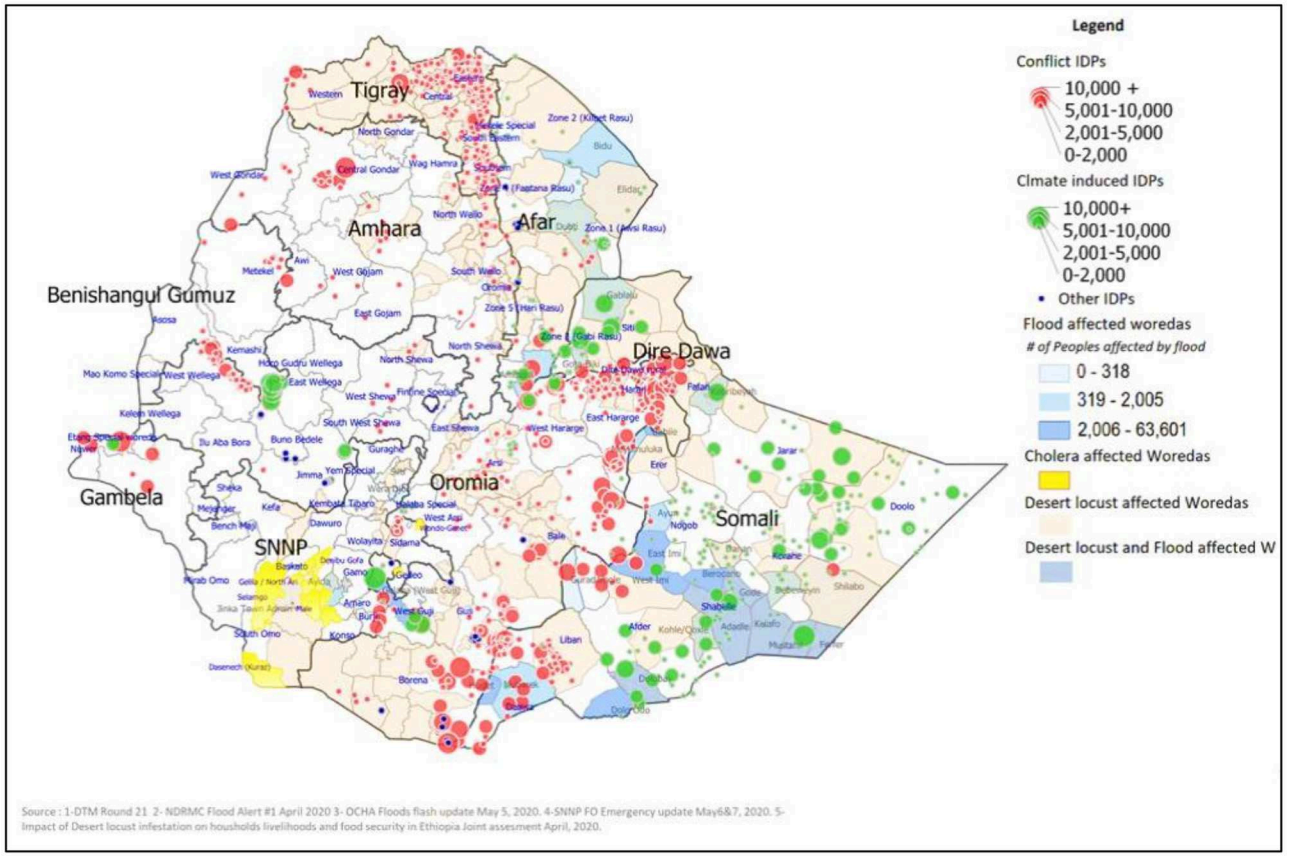

FIGURE 2 | Current displacement scenario in Ethiopia in 2020 (May) (Source: UNICEF PHEEC, 2020).

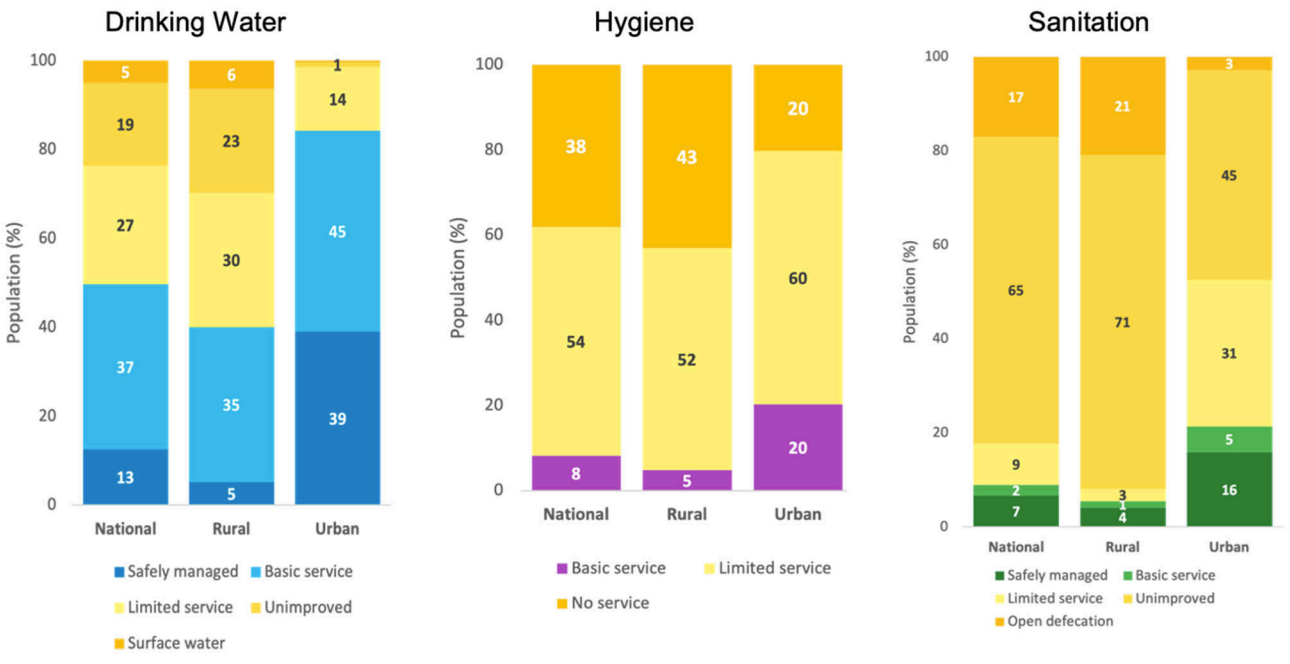

FIGURE 3 | Access to drinking water, hygiene and sanitation services in Ethiopia on national, rural and urban level (Source: WHO/UNICEF, 2021).

for regional water bureaus and skilled workers. Consequently, mainly men are responsible for these tasks but do not receive any salary [S1, S3]. Another obstacle represents the payment of operating international companies as they issue bills in foreign currency for importing machines such as generators or pumps. However, access to foreign currency is challenging in Ethiopia, and equipment is highly taxed, making it expensive [S1]. Lastly, the lack of wastewater treatment contaminating rivers, streams and other surface water aversively impacts the wellbeing and health of those using this source for drinking water (Baye, 2021).

To investigate the interlinkages between water stress and migration, the former is divided in the three dimensions of the framework.

Water Quantity

In general, Ethiopia benefits from sufficient rainfall, surface and (ground-)water resources, and potential [S2, S3, S7]. However, steady water supply is a massive challenge for society [S7] which is further aggravated by climate change impacts [S3]. Water quantity which applies to increasing aridity is considered the main issue influencing the water stress situation in the country [S4]. Primarily, people following an (agro-)pastoralist lifestyle [S4] are impacted as they face the loss of livestock due to water stress (Cortés Ferrández, 2019). Pastoralists who sustain their living by the "production, sale and consumption of livestock and its products" (Cortés Ferrández, 2019, p. 9) are most impacted as they are exposed to vulnerable settings. Cities are impacted by increasing water use with simulations highlighting that water needs of populations and communities may not be met in the future [S5]. Another major issue is the inadequate water infrastructure as institutions do not extract and distribute water resources strategically [S2]. The Government of Ethiopia's (GoE) attempts to implement water governance and infrastructure and fully exploit the available potential of water is inadequate [S3, S7], thus leading to insufficient (drinking) water supply [S7] and access situations. Due to insufficient water infrastructure investments [S4], people are forced to fetch water with buckets or water trucks delivering water from a nearby source [S3, S4] or 100 to 200 kilometers away [S7]. Particularly the poor living in remote rural and drought-prone areas face severe water scarcity because they cannot afford to buy water or lack the means (technical capacity) to dig deep wells. For instance, Afar and Tigray people are consequently exposed to health risks, leading to loss of life in many instances [S3]. As irrigation systems are costly and inefficiently installed, people must rely on rain-fed agricultural production [S7]. Thus, limited irrigation infrastructure and access hamper economic growth, which further pressures the water stress situation.

Regarding water governance, Ethiopia is following a federal system, and water regulation is mainly carried out through independent institutions and administrations within the federal provinces. However, regions lack cooperation which results in possible conflicts about, for instance, transboundary rivers and shared water resources. Moreover, the governance systems and the link between different ministries and policy levels as well as cities lack the capacity to implement the law [S2]. The need to regulate water distribution and governance for upstream and downstream water extraction as industries can use unlimited water amounts persists. While water consumption tariffs were adopted to make users pay for utilization, a revenue that can then be invested to develop the water infrastructure and improve water governance [S4], this approach is not fully functional. Moreover, capacity building and better institutions at the regional level are needed as the current administrative staff bears limited capacity with formulating laws and developing/implementing strategies [S2]. When building sufficient infrastructure, maintenance of the infrastructure (such as cleaning, repairing, etc.) is critical. Institutions lacking monetary assets to employ staff and build capacity can act as a critical barrier [S6]. The challenges faced by building, developing and maintaining infrastructure for sanitation, hygiene and drinking water pose threats to achieve universal access to these services for all as formulated in SDG 6 (Baye, 2021). Furthermore, as many people rely on rain-fed agriculture, economic progress is limited, calling for GoE to invest in agricultural infrastructure development [S7].

Even though a financing mechanism is in place and theoretically enough money is available, investments in addressing pre-existing WASH gaps remain insufficient. As money from donors, loans, subsidies, and raised tariffs is inadequate, there exists an estimated financing gap of 1.6 billion USD to reach the SDG 6 standards by conservative estimations [S1]. Groundwater contamination differs by region. For instance, the Ethiopian Rift Valley is a volcanic area making the region prone to fluoride contamination. Thus, the water is not drinkable and affects the calcium level [S1]. In the worst case scenario, an overdose of fluoride can lead to skeletal fluorosis, joint stiffness, and calcification of tendons (Ayele et al., 2021). However, unavailable technology makes it difficult to decontaminate fluoride. Biological contamination in the form of iron and coliforms is another crucial issue as it is insufficiently monitored [S1]. Often, Ethiopians having access to water resources face surface water pollution not providing safe drinking water (Gemeda et al., 2021). Surface water such as that in rivers can be polluted, contaminated, and of low quality [S4], as predominantly experienced in urbanized areas such as Addis Ababa [S7]. If water is contaminated with wastewater and feces, woredas are affected by cholera regularly [S1]. Moreover, land degradation leads to increasing silt pollution and invasive species [S7]. These pollution threats affect people's health and pose significant risks for affected communities. Additionally, people face challenges accessing portable water due to unplanned urbanization and improper wastewater management [S7]. To achieve SDG 6, it is key to improve basic water services since they are the predominant source for drinking water in communities (Gemeda et al., 2021).

Water Extremes

Because of climate change, Ethiopia experiences heavy rainfall during the rainy seasons, leading to floods at the beginning of the season [S1], followed by severe droughts [S3]. Thus, the country often either faces water shortages or extreme water surpluses. Regarding floods, the country experienced indirect impacts through heavy rainfalls in 2018, followed by floods

leading to the locust infestation in spring 2019 [S1, S4]. However, distinguishing by geographical scope, floods mainly occur in the lowland regions [S4]. Drought-as a main stress factor-leads to water insecurity and the disruption of livelihoods (Groen et al., 2020). El-Niño data from the 1950s onwards shows that the interval frequency of extreme El-Niño events has increased (Kelem and Derbew, 2017). Devastating drought extremes consequently occurred every 2 to 5 years over recent decades, such as between 2015 and 2017 [S6] (see also Mersha and Van Laerhoven, 2016; Mera, 2018). Particularly the areas of the north, such as Tigray, are mainly affected by drought since they lack natural water resources, thus making them insufficient to supply water for the whole population [S2]. The water stress further adds to the impacts of the conflict in Tigray which turned into a civil war in November 2020 (Ploch Blanchard, 2021; Mulugeta and Gebregziabher, 2022). By early 2022, more than 2.2 million people had already fled from the conflict since its start (International Medical Corps, 2022). The southern areas, such as the Somali region, experienced rain failure in the rainy seasons between 2015 and 2017. Consequently, pastoralists were no longer able to feed and keep their animals [S6].

Additional outcomes of water stress and drought include the fast dry-up of boreholes, predominantly impacting water and rainfall-dependent people [S6]. Moreover, despite the mixture of different water stressors, droughts and lower availability of water are predominant throughout the country. Specifically, water stress affects primarily agropastoral people located in rural areas. As these communities are not sedentary, they mainly migrate circularly. Additionally, people are impacted indirectly by the lack of school attendance for children and forced movements to urban areas affecting every aspect of their life [S4].

Implications From Poor Water Availability, Quality, and Water Extremes

Effects of poor water quality [S1, S4, S7] (see also Section Water Quality), impacts of low water quantity [S2, S3, S4, S5, S7] (compare Section Water Quantity) and severe droughts [S1, S2, S4, S6] are identified (compare Section Water Extremes). Accordingly, people in rural areas, specifically semi-arid lowlands, face severe water shortages impacting pastoralists as they can no longer sustain their livelihoods (Cortés Ferrández, 2019) and do not have the capacity to diversify their income [S6]. Furthermore, poor water quality of drinking water negatively impacts people living mainly in rural areas (Gemeda et al., 2021). As it became clear throughout the interviews, climate change worsens the water stress situation [S3], which adds to the insufficient water infrastructure [S2, S3, S5. S7]. As the GoE fails in implementing laws and regulations for water utilization, people cannot access enough water [S3, S7]. Cities face water shortages due to population pressure and increasing water use [S7]. Moreover, poor water quality poses risks to people's health. Particularly fluoride contamination [S1], invasive species [S7], cholera [S1], and diarrhea are mentioned (Cortés Ferrández, 2019) as adverse impacts which can further result from poor wastewater management [S7].

Assessment of the Interlinkages in the Nexus

Interlinkages Between Water Stress and Migration

As migration itself is highly complex [S5], it is challenging to isolate water stress as the main factor for migration decisions [S5] which is further emphasized in current literature (de Haas et al., 2020). Migration might not always be the only adaptation strategy but is considered an effective adaptation and coping option for water stress. Such migration might be voluntary but also forced, although this distinction is not always clear. In what follows, we break down this nexus and its different dimensions.

Specifically, as people are regularly displaced by floods and droughts [S1, S7], direct interlinkages between water stress and migration can be identified. Most of the migration in the country occurs due to climate change which "basically means a shortage of water" [S7]. Displacements are "mainly climate and drought-induced" [S1]. When analyzing migration decisions, people often mention economic and employment reasons for migrating [S5]. However, if people are asked more specifically, they note that environmental changes lead to diminishing returns in fishing and farming. They then migrate to find work in another region or sector [S5].

Circular migration movements among pastoralists-who make up 14–18% of the population and inhabit 60–65% of the land (Bahuguna and Abrioux, 2019)-are regular, circular migration movements are regular. Respectively, people migrate during the dry season for income supplement, and then return to their land at a later stage [S5]. Nevertheless, people are increasingly impacted by water stress leading to faster and further migration movements and displacements. Destinations are often regions, small towns, and villages characterized by pre-existing water resource scarcity and insufficient infrastructure (e.g., roads, shops) [S1, S3]. Thus, there exists the possibility that settlement areas get overwhelmed, and due to the lack of social cohesion, tensions and conflict between the different groups and ethnicities can evolve [S3]. Thus, the main water stress-induced impact occurs indirectly through livestock and livelihoods resulting in high mortality rates. This loss forms an additional impact for affected people as the animals are regarded as family members, and water is essential to keep animals alive [S6]. The described interlinkages emphasize the connections between SDG 6 and SDG 2.

Whereas, some interviewees report more international migration movements, other experts state that climate change induces more internal movement [S1]. Often, the first movements are made to the nearest urban areas [S5, S7], further migrating to major urban centers or a foreign country [S4]. Water is perceived as an important determinant of migration as people mainly move when their livelihoods cannot be sustained anymore [S2], in which case they move in pursuit of economic activities to major urban areas [S4, S7]. For instance, in the Somali region, water stress affected communities mainly migrated from rural areas to semi-urban areas. The reason for this displacement is water stress impacting their nomadic livelihoods associated with the death of the livestock. At present, people usually have the capacities and resources to leave and

reside in tents in IDP camps outside of (semi-) urban areas. Yet, they tend to prefer to stay around smaller towns and cities as their children have access to education which is a positive outcome. Despite the faced obstacles due to the lack of skills and capabilities to work in urban cities, they desire to continue their nomad and (agro-)pastoral life closer to urbanization as they identify more opportunities for their families [S6].

However, when the opportunity arises, some also migrate from urban centers to other countries [S4]. This intermediate rural-urban migration is not a necessarily condition, as also direct international migration from rural areas due to water stress occurs [S2]. Higher international migration rates from water-stressed areas in Ethiopia such as north-east Amhara or parts of Tigray were reported [S4]. High food insecurity, malnutrition, and the impacts of the war lead to millions of IDPs (Ploch Blanchard, 2021; Mulugeta and Gebregziabher, 2022). Furthermore, low agricultural productivity adds to the precarious situation and contributes to migration to, e.g., the Middle East [S4]. Nevertheless, people from more humid areas also migrate internationally. Whereas, most women migrate to the Gulf countries to work in house maid services, men predominantly migrate to South Africa (SA) and later sponsor their wives to follow, leading to a migration feminisation to SA [S4].

It became increasingly clear that water scarcity has a lower impact on people living in urban areas than those in rural areas [S5]. People living in peri-urban areas, however, are directly and indirectly affected by low water quantity. Directly, people lack water to survive [S4, S6]. Indirectly, as people in rural areas are more reliant on rain-fed agriculture, they are more vulnerable to water stress, impacting food security. Thus, when rain fails in two or more consecutive seasons, crops may be entirely devastated [S5, S6]. Hence, people use migration as a coping strategy to water stress [S4]. However, water stress is not decisive as several factors such as low soil fertility and landlessness also influence migration decisions and are influential for not staying in original places. Hence, migration is regarded as an effective part of people's future making process [S4]. Except in the case of rapid onset environmental impacts such as floods, usually only one household member migrates to seek work in another town, region or village when facing diminishing returns due to water stress. As such, income can be diversified and supplemented, and remittances are used for other adaption mechanisms, such as building irrigation systems [S5].

Interlinkages Between Water Stress and Gender

Interviewees highlight that women and girls living in water stressed areas are differently impacted than males [S1] as they are responsible for fetching water and provisioning for household water needs [S4]. As increasing water stress in the form of less and unsafe water availability and poor quality occurs-hence preventing sufficient standards indicated by SDG 6 from being met (Gemeda et al., 2021)-women and girls must collect water from sources that are further away. When water stress increases and less water is available, they spend most of their time collecting water. Moreover, they are confronted with abuse and dangerous situations on their way [S1]. These water-related differences are consistent with prevailing literature, confirming that women and girls are predominantly responsible for water collection and management in households (Nagabhatla et al., 2020a), thereby increasing water-related gender disparities and inequalities (SDG 10).

Interlinkages Between Migration and Gender

In Ethiopia, migration decisions differ between communities and tribal groups [S6] and in their outcomes. Typically, migration decisions are made at the household level, where men decide when and where to go [S2, S4, S6]. Often, men migrate more than women as men are moving to find better jobs and opportunities to change their lives. Women on the other side are responsible for household-related tasks and childcare. Firstly, working options are looked for in urban areas within Ethiopia as men can be more adaptive to working in urban areas [S2, S6]. However, if men identify the opportunity to move abroad, they often avail it, leaving women behind [S2].

However, role changes may also manifest after displacements, which could be both positive and challenging. Before displacement happens, the whole family shares work tasks and livestock responsibilities. After displacements, females probably take on the role of the central breadwinner [S6]. However, this statement cannot be generalized and is subjective, depending on individual and local conditions. To this end, they might be more likely to migrate to cities to conduct daily work, sell entities such as milk, and take available work opportunities. Additionally, men lose their roles within the households, potentially leading to depression and psychological problems and a lower social role [S6]. These issues occur as men in (peri-)urban areas have the primary responsibility for the livestock, which is lost once the livestock dies due to droughts [S6]. However, the cases again depend on individual circumstances.

When examining migration processes, it can be concluded that women are more vulnerable in every part of the migration process as they experience more (sexual) violence, trafficking, and forced labor. They are more likely to work in informal sectors and conduct individual work. Nevertheless, very few migration policies are gender-specific, resulting in the insufficient protection of female migrants. These results highlight the need for inclusive policies and the need to act toward reducing inequalities and thus, supporting and achieving SDG 5. Positive changes can be identified as the proportional increase in independent migration of women, giving them more opportunities [S5].

Interlinkages Between Water Stress, Migration, and Gender

The topic of interlinkages between water stress, migration, and gender is "fairly new and fairly urgent" [S5] as the issue was not explicitly included in discussions until recently. However, while the issue gains attention in multilateral dialogues of NGOs and academia, the gender aspect is barely discussed in communities. This results in a primarily top-down approach. Furthermore, sometimes communities are even not familiar with the topic of climate change. Regardless, it is difficult to prove and measure these interlinkages [S5].

Gendered aspects are paramount when talking about migration and water stress [S6]. Water extremes such as floods tend to displace males and females equally. However, when water stress affects the economic household situation, males tend to migrate more, leaving behind females who remain responsible for household tasks [S7]. Due to the stress factor of displacement (gendered), violence can occur [S6], and women are 14 times more likely to die from natural disasters than men [S5]. However, when evacuating areas affected by water extremes, women and children come first and receive first-hand assistance before males [S7].

Water stress-induced migration movements lead to role changes within households. Predominantly young people who move due to water stress and want to return often stay in the destination areas. Reasons, therefore, comprise gaining skills and increasing opportunities [S5]. Moreover, sometimes families lose the men, or the men move to another bigger city to find employment and increase their income [S6]. According to Interviewee 5, the power of possibilities to move to and stay in urban areas and work is underestimated. People start to migrate, hoping to find improved livelihood chances not available in their origin areas. Once women from conservative places migrate to more progressive regions, they might feel more freedom and possibilities and thus, do not want to return. Particularly women can gain more skills when moving to bigger towns/cities that they would not learn when staying in origin areas. This can further build resilience and create new opportunities. The migration of Malawian women to SA forms an example of such migration patterns. The proportion of female migration increased as they identified more job opportunities in the domestic and agricultural sectors, which can be linked to increased environmental degradation [S5].

Moreover, factors such as the value of money play an essential role. The purchasing power is higher in rural than in urban areas. Thus, using migration and sending remittances as combating strategies may have a direct and immediate development impact: it can positively affect girls and women as remittances might enable girls to attend school, receive education, and access health services [S5], which may reduce existing gendered and migration-related disparities. Yet, still, men tend to make migration decisions giving them a more decisive and predominant role. As differences between males and females remain, it is crucial for programs and responsible institutions to specifically support and enable women and girls to adapt to the scenarios of water and climate crisis, including support for mobility.

Current Responses and Programs Related to Water Stress and Water-Induced Migration

Several responses address water-related and water-induced migration issues. Assistance consists of both emergency and long-term programs. The primary response is realized by UN agencies and NGOs such as UNICEF who act as a last resort in assisting people [S1]. Even though the GoE, NGOs, and other active actors must follow a gender-sensitive approach to receive assistance from the UN and the European Commission (EC), they are criticized because existing programs often do not include the aspect of gender [S6]. However, following a holistic approach to enhance cooperation between the stakeholders toward advancing the achievement of the interconnected SDGs 5, 6, 10, 13 and 17 was clearly noted as important. These suggestions reflect the findings from a study conducted by Oxfam and CARE Ethiopia (2016), highlighting that particularly females were highly vulnerable in cases of access to food and water, livelihoods, education and WASH, leading the authors to call for enhanced coordination mechanisms and to transform gender dynamics.

Emergency Response

The GoE, UN agencies, and NGOs assist affected people after arriving in peri-urban or urban areas with tents out of plastic, wood, clothes, and facilities such as small emergency shelters [S6]. Furthermore, the government helps for large-scale migration in (temporary) settlement areas after flooding. When it comes to individual migration due to (slow onset) water stress, actors such as the GoE face hurdles to provide sufficient assistance, monitor migration, and sufficiently accommodate people in the host communities [S7]. However, no specific efforts are conducted to integrate people locally, which would help them out of the emergency status [S6]. For instance, in the Somali region, integration could simply be achieved as people have the same ethnicity, and hence, conflicts would less likely occur [S6].

The Ethiopian Ten-Year Plan: "Ethiopia: an African Beacon of Prosperity"

The GoE targets water management and policies to improve the overall water stress situation and therefore, by establishing a separate irrigation commission, more attention was given to this sector [S4]. In 2020, the GoE adopted the Ten-Year Plan: 'Ethiopia: An African Beacon of Prosperity' [S4]. The strategy is aligned to the 2030 Agenda (Baye, 2021) and inter alia aims at providing universal access to food (SDG 2), shelter, essential health (SDG 3), education (SDG 4), and clean drinking water (SDG 6) by 2030. The second pillar mainly addresses issues related to climate change, extreme weather events, desert locust infestation, and other vulnerabilities such as COVID-19. To combat these challenges, the GoE points out building a climate-resilient green economy and investing and improving irrigation infrastructure to reduce the reliance on rain-fed agriculture (*Ethiopia 2030: The Pathway to Prosperity. Ten Years Perspective Development Plan (2021–2030)*, 2020). It aims at providing sufficient irrigation water for commercial consumption and industrialization. Furthermore, the responsible ministries build adequate access to food and water when establishing new towns, for instance, in the pastoral lowlands. Moreover, safety nets are created to reduce rural to urban migration [S4]; but gendered aspects are not incorporated in current water stress and migration responses [S5]. Sanitation is also inadequately addressed in policies at the national level (Baye, 2021). However, the GoE mostly invests money in building water infrastructure which aims at positively contributing to the overall water situation throughout the country and has positive spillovers to

further economic growth and wellbeing (Baye, 2021). The GoE included water-related strategies, showing its awareness of the issues, and prioritizing sustainable solutions to combat them. However, the actions undertaken to provide sufficient water infrastructure for all and thus addressing inequality issues (SDG 5) and water access (SDG 6) are not sufficient to meet the 2030 Sustainability Agenda goals (Baye, 2021). The GoE and responsible ministries such as the MoWIE provide assistance but rely on international assistance.

ONE WASH National Program

The GoE leads the OWNP in cooperation with other donor organizations such as UK Aid, the World Bank, the African Development Bank and UNICEF [S1] from 2013 to 2020. By bringing together all critical actors in the OWNP, the program is well coordinated, and water infrastructure can be improved by drilling boreholes, resulting in increased water quantity [S3]. This can be regarded as a good example of implementing SDG 17. The program focuses on developing WASH systems such as water networks in small towns due to their pull function of attracting people and businesses. It is perceived as a long-term solution that often takes more than 5 years to be built. The OWNP is crucial, as usually, IDPs and refugees stay in the destination communities and refugee camps for up to 20 years, calling for more capacity and resilience building that provides them with livelihood opportunities [S1].

As practiced and implemented in some OWNP projects, water is sold at different rates to cover operation and maintenance costs. Furthermore, the program focuses on the community level to strengthen capacity and provide specific training [S2]. In addition to building water infrastructure, people are equipped with aqua tabs, restrooms, and hygiene products to improve the overall WASH situation [S1]. To support women, the program comprises a gender-sensitive approach when conducting environmental and social impact assessments, developing civil work contracts, and implementing construction work [S1].

Durable Solutions Initiative

In 2019, the Ethiopian Government and the UN jointly implemented the Durable Solutions Initiative (DSI) which is partly aligned to climate-induced displacement [S6]. It comprises a principled operational framework dedicated to IDPs and host communities in the Somali Region affected by slow-onset climate change (Cortés Ferrández, 2019). By supporting the cooperation between different governmental levels (national, regional, and local) and the international community, the initiative builds on official strategies and frameworks such as the UN Guiding Principles on Internal Displacement (Ayalew and Atrafi, n.d.). The overall goal is to better understand and improve solutions for local integration of IDPs in arid and semi-arid lowlands (Cortés Ferrández, 2019).

In general, the coordination between the GoE, which initiates and coordinates the initiative, international institutions, and NGOs is perceived well [S6, S7]. By further enhancing this cooperation, the fourth dimension of the framework and SDG 17 can be accelerated. However, the initiative faces different implementation obstacles. First, funding significantly decreased to only 30% of the 1.3 billion USD for the governmental humanitarian response plan due to the rise in conflict (Cortés Ferrández, 2019). Regions in need of monetary assistance are therefore not always considered [S6]. Donors must close the funding gap, and the GoE prioritizes these long-term solutions to improve livelihood opportunities (Cortés Ferrández, 2019) sustainably. Second, there is no accurate published information on the number of assisted people [S6]. The project does aim to, however, fill gaps in reliable data and evaluation by simultaneously gathering data and evidence (Ayalew and Atrafi, n.d.).

Challenges further comprise the alignment of durable solutions with short-term humanitarian needs and long-term development approaches, which call for improved coordination. The program's main takeaways to date are that local integration is the most feasible solution, and people appreciate livelihood creation such as diversifying economic income opportunities most [S6]. Moreover, voluntary mobility should be continued, and displacement-affected communities and people be allowed to actively engage in all planning, implementation, and monitoring stages. This will ensure the consideration of individual needs and local contexts (Ayalew and Atrafi, n.d.). Further actions should be taken regarding individual solutions for vocational training, providing start-up capital, and enhancing social protection benefits while allowing access to safety net programs. Moreover, there is a call for building roads, marketplaces, and WASH systems (Cortés Ferrández, 2019). Till date, building training skills and diversifying economic opportunities seem to work best. Additionally, they are related to restocking as more livestock and land cultivation can enhance resilience building [S6].

Challenges, Gaps, and Potential Improvements to Overcome Water and Migration Related Issues

Annexure 2 covers specific policy recommendations whereas the following sections provide detailed information on a selection of policy actions which should be taken.

Boosting Sustainable Ground and Surface Water Management Practices

Water stress affects the country on a large scale. There are no specific regulations on water abstraction in Ethiopia, and general water governance is insufficiently implemented. Notably, the state requires a legal framework and appropriate policies for water source protection, development, delineation, monitoring, etc. (Sahilu et al., 2018). Currently, decisions are primarily taken at the macro level, which inadequately includes regional needs. Coping with water and climatic challenges with water footprint requires smart strategies for water resource management and a shift in laws and regulations from a top-down to a bottom-up approach. This suggestion also refers to meso and micro policy levels having more power to better diagnose and categorize the consequences, further leading to improved strategies and action [S2]. Additionally, cooperation between the various federal agencies (viz., water ministry, human

welfare, etc.) should be fostered. Here, the GoE could expand its responsibility for enhancing its policy role by initiating and coordinating initiatives and the collaboration between the different stakeholders. The Ethiopian population is growing, leading to increasing demand for resources such as water. Even though the water supply system is expanding to cope with the need, it is challenging to keep pace with the population growth rate. Institutions such as the World Bank finance water supply. However, maintenance and operations are covered by revenues from selling water and financial support of GoE [S2]. As Godfrey et al. (2019) tested in the Somali region, deep yielding boreholes can supply drought-prone areas with groundwater. Therefore, it is essential to conduct systematic feasibility studies, including lithology and hydrogeological examination, predrilling, supervision, project management, and monitoring, and sustainable financing. Moreover, a reliable electricity supply is needed to provide energy for the pumps. While it is a cost-intensive option, water supply through deep groundwater can provide the Ethiopian society with sufficient water in water-stressed areas. It is important, however, that the over-extraction and the collapse of boreholes are addressed in tandem (Godfrey et al., 2019).

Water access determines the health and agricultural productivity in deep rural areas, leading to economic vibrancy [S4]. Agriculture functions as the backbone of the country's economy, but still, people use old techniques for irrigation. Transforming the agricultural sector and economy while giving people livelihood opportunities in rural areas could positively impact poverty levels and reduce reliance on rain-fed agriculture [S2]. The farming community often does not have access to irrigation infrastructure and streams and often the size of the production area is limited. In some regions, farmers only have access to the limited hectarage making it difficult to cultivate and generate sustainable income. While plans exist to improve irrigation systems, the country lacks human capital such as engineers for installing irrigation infrastructure [S4]. Thus, it is essential to consider these interdependencies and act across different dimensions to solve these challenges and support relevant SDGs.

Enhancing Water Provisioning Systems and Service Delivery

In collaboration with different actors, the GoE must cooperate to support the affected water stress communities. This may require adequate financial, human capacities, and resources systems [S7]. For instance, financial, and human means for maintaining and operating pumps, etc., must be included in the planning process. Knowledge and financial resources for WASH systems should be targeted and invested in pastoralist regions (BMU, 2021) to provide the most deprived people with improved opportunities. As Baye (2021) shows, improved WASH systems have positive impacts on people's wellbeing and can contribute to achieving inter alia SDGs 3, 5, 6 and 13. In addition, when planning and implementing water capacity projects, actors should account for individual needs, ensure consistent evaluation, and prioritize the sustainability of constructed infrastructure and capacities.

In addition to building and improving water infrastructure, roads, electricity, and housing [S4], education and health institutions should be established or strengthened. In combination with diversified income possibilities and the economy, these improvements will allow durable solutions, local integration [S6] and contribute to the achievement of the 2030 Agenda. By successfully collaborating on sustainable solutions in the water sector, the Ethiopian society could benefit from accessible WASH systems and protected water sources addressed in SDG 13 on climate action.

Supporting the Water Need and Rights of Pastoral Communities

Ethiopia faces disparity issues in development. While the country's north is relatively wealthy and receives investments from the international community and the GoE, the southern regions are relatively underdeveloped. Generally, in the southern areas and particularly in the Somali region, there are many (agro-)pastoralists who live a nomadic lifestyle. They also lack resources such as schools or health institutions. Hence, impoverished regions are more affected by underdevelopment, water stress, and (gender) inequalities as the tribes are patriarchal.

For pastoralists, their passage of rights granting them access to land and water resources have already been suffering from lack of support acknowledging cultural rights and inadequate opportunities for livelihood diversification, obstacles to receive social and economic assistance, and barriers to access economic markets, rendering them most vulnerable (Cortés Ferrández, 2019). It is anticipated that communities will benefit from actions and investments toward inclusive water governance and improved WASH systems and better livelihoods options. In some instances, supplying people with sufficient water access and providing jobs could reduce migration assuming that people will be willing to stay in their native habitat if social support systems are put in place [S2, S4].

Engaging in Impact Investment Programs Focusing on the Water and Human Security Nexus (Including Migration and Gender Dimensions)

Donors and international institutions must be cautious when providing development aid and engaging in domestic projects. A critical issue is the sensitive character of development aid, as Africa is especially vulnerable due to colonialism. When donors and huge organizations criticize countries and governments, they address a highly political issue [S3]. Instead, stakeholders could approach the topic from the context of implementing dedicated IDPs-focused programs and design projects to improve the infrastructure, including specific needs of IDPs. Furthermore, programs and assistance directly dedicated to IDPs can be implemented. It is noted that projects lack an effective evaluation system as no indicators are developed and identified to measure if infrastructure improvements are positively affecting migration movements and conflict. The emerging challenge of diminishing funding due to the COVID-19 pandemic, as donors primarily focus on health-related emergency assistance [S3], should not discount the focus on this nexus [S6].

Gender and Culturally Sensitive Approach to Water Governance and Migration Management

While the government agencies communicate following a gender-sensitive approach, this is less obvious in the operational space [S3]. An inclusive approach and a prioritization of gender aspects by providing different responses and assistance are vital to ensure the future agendas of water governance, migration policies and the 2030 Agenda, particularly the SDG 5 targets. When formulating policy suggestions and designing projects, it is essential to consider the ethnicities and cultural complexities of the region. If stakeholders ignore these cultural differences, including language and food culture, conflicts will most probably emerge quickly [S4]. Tensions, reception of migrants, and social cohesion depend on ethnicity, language, and cultural backgrounds of the receiving community and migrants. For instance, reception can increase when there already exists a certain social cohesion in the receiving community. A different language or ethnicity can be an important factor when the host community expresses general xenophobia and negative perception. Yet, increasing migration movements also put pressure on job opportunities, and already scarce land, which might not feed the families [S7] and act as a potential source of conflict [S5]. Also, the fact that infrastructure, health, and educational facilities are already stressed [S5] puts additional pressure on host communities and resources. Challenges in urban areas occur as unemployment is prevalent; thus, the influx of people can lead to crime and political problems, which should be prevented [S2, S4]. A sustainable solution would include affected people (migrating people and host communities) in decision-making projects (Cortés Ferrández, 2019).

Supporting Community Resilience With a Focus on Capacity Strengthening

Communities and migrant populations (mostly IDPs) must adapt to the cities outside of the camps as institutions do not provide sustainable solutions and long-term assistance, which can help them change and improve their lives. Assistance by NGOs usually lasts for 3–5 months. People receive food and shelter, but administrations are challenged by creating jobs for arriving migrants [S2]. Another huge challenge is that stakeholders predominantly focus on migration movements, but communities who get trapped in immobility are often overlooked. Many people are attached to their homes which they do not want to leave, or they do not have the assets to move, which gets them stuck in the poverty trap [S5]. Also, it is questionable and challenging to settle pastoralists who follow the nomadic lifestyle for millennia [S4] and do not want to settle.

Furthermore, investments in approved water access or quality might reduce migration incentives. Improved drinking water quality is essential for achieving SDG 6 (Gemeda et al., 2021). This further would positively impact other SDGs such as SDG 10. This is shown for instance by Zaveri et al. (2020), who investigate the effects of secure water access on migration movements in rural India and find that the provision of wells for irrigation purposes and, thus, secure water access reduces short-term migration movements in these regions. Also Rigaud et al. (2018) call for building and improving infrastructure for housing and transportation, establishing social services, and providing employment opportunities. The study suggests that if managed properly, these measures can lead to economic benefits in cities (SDG 11 sustainable cities and communities) and building climate-smart infrastructure, diversify income, provide social protection for affected communities, invest in education, and empower women to combat climate change challenges.

DISCUSSION

This study builds on up-to-date data and information on the interconnections between water stress, migration, and gender, and reinforces that water-induced migration is complex. Due to limited data availability, limited access to information due to the COVID-19 pandemic and the novelty of the water stress-migration-gender interconnections, the qualitative research method with expert interviews proved adequate to provide a conceptional framework for analyzing the nexus. It thereby lays out possible steps which can be expanded and adapted regarding the individual context. The applied three-dimensional framework on water and migration allowed the integration of gender aspects and offered an appropriate theoretical foundation to investigate the nexus. Accordingly, we expanded the framework by adding the "water governance" dimension noting the need for enhancing awareness on this dimension. While it is apparent that water governance challenges are crucial to Ethiopia, and the state is viewed as water sufficient, the lack of infrastructure development for service delivery and limited collaboration between the federal states, and weak regulatory framework and policies are key barriers. However, the GoE takes an approach to act on SDGs 5 and 6 by aligning its development plans and efforts to the 2030 Agenda.

Specifically, we showcase strong interconnections between water stress, migration, and gender in Ethiopia and conclude that the lack of water governance and insufficient water infrastructure is posing pressure on society and accelerating the water stress. Therefore, when investigating water-induced migration movements, an important point is distinguishing between slow-onset and rapid water stress situations and direct vs. indirect impacts. The results indicate that particularly water extremes settings such as floods displace household members directly. Indirectly, water stress is often regarded as an underlying factor influencing livelihoods i.e., loss of livestock, which potentially results in migration movements. Commonly, men tend to migrate to towns for income diversification and access to essential services. If the situation and resources allow, both males and females decide on the migration option. However, it was observed that not all the people impacted by water-stress use migration as an adaptation strategy. Those who do migrate tend to acknowledge the benefits of their decision which may make them decide not to return, but, at the same time, many of them want to keep their pastoral lifestyle. This could be a difficult decision as explained for pastoral communities in the Central African Region by Nagabhatla et al. (2021). As people often lack the required skills for other jobs, it is hard to find employment in cities. In case they do find work and send remittances back to the household members left behind, the money can be used to invest

in irrigation infrastructure and help survive dry periods. The influx of water induced IDPs and migrants in host communities may, however, lead to conflicts over scarce resources and jobs.

Also, it can be emphasized that migration movements create further gender disparities. Migration decisions are made at the household level and primarily by men. Due to the predominantly male-dominated migration, women and girls are often left behind and must take on additional household activities and responsibilities. In contrast, women migrate more after displacement to work in urban areas and diversify their income. Men, on the other hand, suffer from depression. Owing to the already existing gender contrasts, differences can be reinforced by migration-specific disparities. However, if women are allowed to migrate, these chances can lead to more freedom and options that potentially reduce gender disparities. This showcases that reducing obstacles for females can significantly contribute to reducing inequalities and the agenda outlined in SDG 5, for instance Target 5.a to undertake reforms to give women equal rights to economic resources, as well as access to ownership and control over land and other forms of property, financial services, inheritance and natural resources, in accordance with national laws, as well as Target 5.c calling to adopt and strengthen sound policies and enforceable legislation for the promotion of gender equality and the empowerment of women and girls at all levels.

Our results are in line with previous studies (Ezra and Kiros, 2001; Gray and Mueller, 2012; International Organisation for Migration, 2014; Mersha and Van Laerhoven, 2016; Miletto et al., 2017; Stoler et al., 2021), noting that women are differently impacted by water stress. The findings underpin that Ethiopian women and girl are predominantly responsible for water-related household tasks (as is the case also in other developing countries), resulting in gender disparities. Water stress reinforces pre-existing gender roles as males frequently make migration decisions and move, whereas females are left behind and face violence and abuse (International Organisation for Migration, 2014; Stoler et al., 2021).

In this research, we noted that water stress further indirectly affects females as they can hardly receive education and engage in family planning due to the time they must spend on water management. With increasing dry periods, walking distances for water collection are commonly noted to rise as well. Further, it was indicated that sufficient water infrastructure could positively affect people-especially females-as they have more time for attending school and engaging in family planning agenda. Also, this may improve livelihoods which can result in decreased involuntary movements. It is apparent that even though females suffer from restricted migration possibilities, a shift in gendered migration in Ethiopia is noted. Ethiopian women are not automatically left behind but also migrate for income diversification when the household experiences slow-onset water stress. Particularly, migration movements from conservative to progressive areas provide increased freedom and livelihood opportunities. There seems to occur a shift in the perception of women's role in society and the household. Overall, this research adds novel and valuable knowledge to the current understanding of this complex nexus. We call for further research to investigate which factors lead to these specific migration decisions. However, as only a few migration policies are gendered, women receive inadequate protection when affected by water stress and violence. The results highlight the urgency to implement and re-sharpen policies regarding inclusivity with a special focus on women. Our analysis shows, nonetheless, that males are equally impacted by water stress as they report depression and other mental health issues due to the loss of their jobs.

From an institutional perspective, the GoE shows awareness of these interconnections by addressing water stress, climate change, and migration in its ten-year plan and by aligning it to the 2030 Agenda. Based on this strategy and in collaboration with international actors, projects such as the OWNP and DSI are implemented and contribute to Ethiopia's overall water stress and migration situation as they target water stress and water-induced migration. These efforts further show the efforts, the GoE is taking to achieve the highlighted SDGs, particularly SDG 6. Interviewed actors perceive the collaboration between participating actors engaged in the OWNP and DSI program as well-functioning and identify positive outcomes as people benefit from improved livelihood opportunities. The program offers interesting and promising opportunities to provide long-term solutions to those affected by water stress. However, international interventions remain a political topic as they question the government's sovereignty and ability to protect its citizens. Barriers like limited funding, lack of data, and political operations such as insufficient collaboration between the federal states pose obstacles to developing and improving existing projects and policies. Additionally, GoE lacks sufficient financial means and human capital despite these challenges, making it somewhat reliant on international assistance. Thus, the governance, political and economic aspect in this nexus remains a critical point for attention. Few interviewees indicated that implemented policies and projects include gendered aspects. Moreover, it was surprising that the ministry's representative perceived water trucking as best practice whereas other interviewees regarded it as ineffective and costly. Instead, they promote long-term solutions in the form of improved water infrastructure and similar sustainable solutions. Yet, as no accurate and well-developed evaluation system exists, it remains challenging to develop evidence-based conclusions and identify best practices. No clear conclusion about sufficient inclusion of gendered aspects can be made as the interviewees' statements are at times contradictory.

Water-related obstacles seem to occur in a vicious cycle. When facing water stress, particularly women lack the time and opportunities to attend school. Thus, as no competencies are built, chances of human capital development and women empowerment are compromised. Human capital and skills are key to operating and maintaining water infrastructure and augmenting water stress. Moreover, due to pre-existing gender roles, females are poorly empowered and often deprived of migration opportunities. To combat these challenges and unclarities, it is suggested to adopt a holistic approach that incorporates the interdependencies and mutual influence and outline sustainable solutions that can be implemented for boosting community resilience. It is not sufficient to solely

improve the overall water infrastructure to provide households with an adequate water supply. Society's perception of women and girls, their educational and job opportunities, and general rights and freedoms must be enhanced to provide balanced opportunities for migration or/and work. Eventually, it is important to disaggregate and evaluate data by gender and ethnicity to identify their specific needs and opportunities. Furthermore, decision-makers should work on long-term solutions for provision of sufficient water infrastructure and such solutions should be gendered.

During the analysis, some noteworthy considerations were also identified. First, when assessing the nexus, it is relevant to discuss if people migrate or are displaced. The term "migration" is used primarily when people can no longer sustain their livelihoods. In contrast, when being impacted by floods, households are described to be "displaced." For comprehensive investigation and potential interventions, properly distinguishing these terms could potentially increase awareness of this nexus and related challenges. However, it is acknowledged that the discussion on this nexus can be complex, and it is challenging to conclusively outline the realities without consulting the people who are directly impacted. In addition, when considering gendered aspects, it is critical to account for special needs for women and girls and further aim for an overall inclusive "leave no one behind" (LNOB) approach by including other vulnerable groups such as disabled persons and acknowledging the negative impacts for men. In addition, sufficient financial means, as well as political and societal willingness, are central to designing appropriate support systems.

CONCLUSIONS

We conclude that there are clear linkages between water stress and migration as Ethiopians are displaced by settings of water quantity (low). Water stress is often perceived as an influential underlying factor that indirectly impacts households. People lack sufficient water to cultivate their land and feed their animals. Predominantly, people in rural areas are impacted to a greater extent as they are often reliant on agriculture. Due to experienced water stress, pastoralists are driven to migrate further and faster, causing more pressure on resources, and potentially leading to conflicts. Controversially, to slow-onset water stress, people are displaced rapidly by floods. However, multiple factors influence migration decisions, including insufficient water quantity, droughts, and floods. When analyzing slow-onset migration movements, migration decisions remain unclear. In our analysis, we also noted that the nexus of water stress, migration, and gender needs to be analyzed holistically and that migration-related disparities should be examined in a gender-sensitive manner. Gender differences become more apparent in the case of slow-onset water stress settings. Ethiopians have used migration as an adaptation strategy when being impacted by water stress. Men migrate more than women to find new income opportunities, and women and girls often stay behind and take on more household tasks. However, when women are given a chance to migrate, they benefit from more opportunities and options. In contrast, men tend to be impacted by adverse psychological impacts when losing their livestock and their role in the household. It can be concluded that water stress-related dynamics can increase migration and gender disparities but also contribute to gender equality when these existing disparities lessen by, e.g., offering females migration opportunities. Despite these valuable and promising insights, it remains unclear how exactly this shift can be achieved, calling for more in-depth research on gendered aspects in the water-migration nexus. Neither enough reliable data, nor concreate scientific evidence backing was available caused by restrictions due to the COVID-19 pandemic to complement the analysis undertaken in this study. Therefore, we have outlined clear gender-specific gaps and underline the need for future research to understand this nexus. Note that accounting gender disaggregated approach in migration and gender assessments is flagged as a key priority by international experts and development agencies (International Organisation for Migration, 2014; Pouramin et al., 2020). This will further contribute to reduce gender-based inequalities and thereby achieving SDG 5.

Subsequent research should focus on determining appropriate monitoring and evaluation variables to investigate the effects of the implemented programs and undertake improvements in future interventions. Additionally, conducting case studies in other geographic settings would help identify intersecting patterns and differences and thus providing enhanced insights on interconnections. Furthermore, case studies on water-induced migration should focus on smaller areas, specific time frames, and ethnicities/cultural setups to explore migration decisions and reasons at the local/regional level. Furthermore, it would be useful to investigate the topic with a mixed-methods approach. Conducting surveys on affected peoples' experiences and opinions disaggregated by, e.g., gender, age, and ethnicity combined with in-depth interviews can provide representative insights. Finally, the relationship between different influential factors in migration assistance can be assessed in-depth to provide context specific outcomes and steer gender-sensitive migration management strategies. Noting that this nexus has received relatively limited attention, while this study adds insights on gendered impacts of water stress and spill over impacts like voluntary or forced migration, and considering the highlighted limitations, future water and migration-related projects should specifically account for gendered goals and targets outlined in the SDG portfolio so that gender-sensitive projects, interventions, and policies can support the creation of equal and better livelihood opportunities in the long run. In that regard, specific policy suggestions are outlined in **Annexure 2**.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

AUTHOR CONTRIBUTIONS

LF with contributions from NN and IR designed the research idea and the basis of the content for the manuscript. LF conducted

data extraction, analyzed the data, and wrote the first draft of the manuscript. LF, NN, and IR revised and edited the manuscript. All authors contributed to the article and approved the submitted version.

ACKNOWLEDGMENTS

We would like to thank the interviewees for their information and time which added a lot of value to this article. We would like to acknowledge the institutional support from UNU-CRIS, UNU-MERIT and University of Ghent, Belgium for facilitating cooperation and partnership for this research work. We would also like to Ms. Mini Dixit at UNU-CRIS for the language refinement. We thank Ghent University for financial support to allow open access publication.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fhumd.2022.858229/full#supplementary-material

REFERENCES

Alemayehu, A., and Bewket, W. (2017). Smallholder farmers' coping and adaptation strategies to climate change and variability in the central highlands of Ethiopia. *Local Environ.* 22, 825–839. doi: 10.1080/13549839.2017.1290058

Ayalew, M., and Atrafi, H. (n.d.). Durable Solutions Initiative.

Ayele, B. A., Godebo, T. R., Tekle-Haimanot, R., and Yifru, Y. M. (2021). Neuro-medical manifestations of fluorosis in populations living in the Main Ethiopian Rift Valley. *Environ. Geochemistr. Health.* 8, 16. doi: 10.1007/s10653-021-01016-8

Bahuguna, S., and Abrioux, E. (2019). *UNICEF Ethiopia—Education for Pastoralist Children*. Available online at: https://www.unicef.org/ethiopia/media/1151/file/PastoralistEducationAdvocacybrief.pdf (accessed July 20, 2021).

Baye, D. (2021). Sustainable development goals (sdg) target 6.2 in ethiopia: challenges and opportunities. *OALib.* 08, 1–28. doi: 10.4236/oalib.1107458

Beine, M., and Jeusette, L. (2019). A meta-analysis of the literature on climate change and migration. *IZA Discuss. Paper*. 19, 12639. doi: 10.2139/ssrn.3468587

Bekaert, E., Ruyssen, I., and Salomone, S. (2021). Domestic and international migration intentions in response to environmental stress: a global cross-country analysis. *J. Demograph. Econ*. 20, 1–54. doi: 10.1017/dem.2020.28

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

Black, R., Arnell, N. W., Adger, W. N., Thomas, D., and Geddes, A. (2013). Migration, immobility and displacement outcomes following extreme events. *Environ. Sci. Policy*. 27, S32–S43. doi: 10.1016/j.envsci.2012.09.001

BMU. (2021). *From dialogues to results. Recommendations for accelerating cross-sectoral SDG 6 implementation*. Available online at: https://waterdialogues4results.com/wp-content/uploads/2021/06/210621_Water-Dialogues_Konferenz_Policy-Recommendations_EN.pdf (accessed July 9, 2021).

Braun, V., and Clarke, V. (2006). Using thematic analysis in psychology. *Qual. Res. Psychol*. 3, 77–101. doi: 10.1191/1478088706qp063oa

Coniglio, N. D., and Pesce, G. (2015). Climate variability and international migration: an empirical analysis. *Environ. Develop. Econ*. 20, 722. doi: 10.1017/S1355770X14000722

Cortés Ferrández, P. (2019). *"Nothing to Put in Your Mouth": Durable Solutions to Drought Displacement in Ethiopia (Issue December)*. Available online at: https://www.internal-displacement.org/publications/durable-solutions-drought-displacement-ethiopia (accessed April 9, 2021).

de Haas, H., Castles, S., and Miller, M. J. (2020). *The Age of Migration: International Population Movements in the Modern World (6th Edition)*. London: Red Globe Press.

Evertsen, K. F., and van der Geest, K. (2020). Gender, environment and migration in Bangladesh. *Clim. Develop*. 12, 12–22. doi: 10.1080/17565529.2019.1596059

Ezra, M., and Kiros, G.-E. (2001). Rural out-migration in the drought prone areas of Ethiopia: a multilevel analysis. *Int. Migrat. Rev*. 749–771. doi: 10.1111/j.1747-7379.2001.tb00039.x

Falco, C., Donzelli, F., and Olper, A. (2018). Climate change, agriculture and migration: a survey. *Sustainability*. 10, 1–21. doi: 10.3390/su10051405

Gemeda, S. T., Springer, E., Gari, S. R., Birhan, S. M., and Bedane, H. T. (2021). The importance of water quality in classifying basic water services: the case of Ethiopia, SDG6.1, and safe drinking water. *PLoS ONE*. 16, 1–24. doi: 10.1371/journal.pone.0248944

Gemenne, F. (2011). Why the numbers don't add up: a review of estimates and predictions of people displaced by environmental changes. *Global Environ. Change*. 21, 41–49. doi: 10.1016/j.gloenvcha.2011.09.005

Godfrey, S., Hailemichael, G., and Serele, C. (2019). Deep groundwater as an alternative source of water in the Ogaden Jesoma sandstone aquifers of Somali region, Ethiopia. *Water*. 11, 8. doi: 10.3390/w11081735

Gray, C., and Mueller, V. (2012). Drought and population mobility in rural Ethiopia. *World Develop*. 40, 134–145. doi: 10.1016/j.worlddev.2011.05.023

Groen, D. J., Kebede, D. S., Ketema, A., Kleinendorst, T., and Asrat, P. A. (2020). Groundwater mapping for climate resilient WASH in arid and semi-arid areas of Ethiopia. *Dissemination Workshop*. 2521, 223.

Hermans, K., and Garbe, L. (2019). Droughts, livelihoods, and human migration in northern Ethiopia. *Reg. Environ. Change*. 19, 1101–1111. doi: 10.1007/s10113-019-01473-z

International Medical Corps. (2022). *Ethiopia-Tigray Region Humanitarian Update. Situation Report*. Available online at: https://www.wfp.org/countries/haiti%0Ahttps://ahacentre.org/situation-update/situation-update-no-2-massive-floods-in-greater-jakarta-area-indonesia/ (accessed February 18, 2022).

International Organisation for Migration. (2014). *IOM Outlook on Migration, Environment and Climate Change*.

Joarder, M. A. M., and Miller, P. W. (2013). Factors affecting whether environmental migration is temporary or permanent: evidence from Bangladesh. *Global Environ. Change*. 23, 1511–1524. doi: 10.1016/j.gloenvcha.2013.07.026

Kaczan, D. J., and Orgill-Meyer, J. (2020). The impact of climate change on migration: a synthesis of recent empirical insights. *Climatic Change*. 158, 281–300. doi: 10.1007/s10584-019-02560-0

Kelem, G., and Derbew, A. (2017). The frequency of El-Niño and Ethiopian drought. *Nat. Meterol*. Agency 17, 2–3.

Lindtjørn, B., Bjorvatn, B., and Alemu, T. (1993). Population growth, fertility, mortality and migration in drought prone areas in ethiopia. *Transact. Royal Soc. Tropic. Med. Hygiene*. 87, 24–28. doi: 10.1016/0035-9203(93)90407-H

Matthews, B., and Ross, L. (2010). *RESEARCH METHODS. A practical guide for the social sciences*. London: Pearson Education Limited.

Mera, G. A. (2018). Drought and its impacts in Ethiopia. *Weather Clim. Extrem*. 22, 24–35. doi: 10.1016/j.wace.2018.10.002

Mersha, A. A., and Van Laerhoven, F. (2016). A gender approach to understanding the differentiated impact of barriers to adaptation: responses to climate change in rural Ethiopia. *Reg. Environ. Change*. 16, 1701–1713. doi: 10.1007/s10113-015-0921-z

Miletto, M., Caretta, M. A., Burchi, M. B., and Zanlucchi, G. (2017). *Migration and its Interdependencies With Water Scarcity, Gender and Youth Employment*. Available online at: https://unesdoc.unesco.org/ark:/48223/pf0000258968 (accessed March 18, 2021).

Morrissey, J. (2012). "Contextualising links between migration and environmental change in northern Ethiopia," in *Climate Change and Human Mobility:*

Challenges to the Social Sciences, eds K. F. Olwig and K. Hastrup (London: Cambridge University Press), p. 110.

Morrissey, J. (2013). Understanding the relationship between environmental change and migration: the development of an effects framework based on the case of Northern Ethiopia. *Global Environ. Change*. 23, 1501–1510. doi: 10.1016/j.gloenvcha.2013.07.021

Mulugeta, A., and Gebregziabher, M. (2022). Saving children from man-made acute malnutrition in Tigray, Ethiopia: a call to action. *Lancet Glob. Health*. 22, 2021–2022. doi: 10.1016/S2214-109X(22)00023-7

Nagabhatla, N., Cassidy-Neumiller, M., Francine, N. N., and Maatta, N. (2021). Water, conflicts and migration and the role of regional diplomacy: lake Chad, Congo Basin, and the Mbororo pastoralist. *Environ. Sci. Policy*. 122, 35–48. doi: 10.1016/j.envsci.2021.03.019

Nagabhatla, N., Pouramin, P., Brahmnbhatt, R., Fioret, C., Glickman, T., Newbold, K. B., et al. (2020a). *Water and Migration: A Global Overview*.

Nagabhatla, N., Pouramin, P., Shin, S., Sharma, P., Glickman, T., Brahmbhatt, R., et al. (2020b). Water and food security crisis influencing human mobility patterns: a comprehensive overview. *Food Security Land Use Change Under Conditions Clim. Variabil. Multidimension. Perspect*. 20, 49–76. doi: 10.1007/978-3-030-36762-6_4

Nagabhatla, N., Ruyssen, I., Ait L'Houssain, A., Sayan, R. C., and Debevec, L. (2020). *Water-Gender-Migration: The Complex Nexus and Interlinkages*. Available online at: https://www.frontiersin.org/research-topics/18028/water-gender-migration-the-complex-nexus-and-interlinkages?fbclid=IwAR27_ubt3-6k-BIA9eNR5EX3o8dMlxnwpJrxK65xbxVA_JN74Wsy_jcLXAk (accessed July 15, 2021).

Opiyo, F., Wasonga, O., Nyangito, M., Schilling, J., and Munang, R. (2015). Drought adaptation and coping strategies among the turkana pastoralists of Northern Kenya. *Int. J. Disaster Risk Sci*. 6, 295–309. doi: 10.1007/s13753-015-0063-4

Oxfam and CARE Ethiopia. (2016). *Consolidated Gender Analysis for the Ethiopian Drought Response (Issue March)*. Available online at: https://www.humanitarianresponse.info/en/operations/ethiopia/document/cp-situationalcontextual-monitoring-indicators (accessed May 22, 2021).

PHEEC. (2020). *Ethiopia 2030: The Pathway to Prosperity. Ten Years Perspective Development Plan (2021-2030)*.

Pickering, A. J., and Davis, J. (2012). Freshwater availability and water fetching distance affect child health in Sub-Saharan Africa. *Environ. Sci. Technol*. 46, 2391–2397. doi: 10.1021/es203177v

Ploch Blanchard, L. (2021). *Ethiopia's Transition and the Tigray Conflict*. Available online at: https://crsreports.congress.gov.

Pouramin, P., Nagabhatla, N., and Miletto, M. (2020). A systematic review of water and gender interlinkages: assessing the intersection with health. *Front. Water*. 2, 1–25. doi: 10.3389/frwa.2020.00006

Rigaud, K. K., de Sherbinin, A., Jones, B., Bergmann, J., Clement, V., Ober, K., et al. (2018). *Groundswell. Preparing for International Climate Migration*. Available online at: https://openknowledge.worldbank.org/handle/10986/29461 (accessed March 24, 2021).

Sahilu, G., Abate, E., and Tadesse, D. (2018). *The Study of Water Use and Treated Wastewater Discharge Charge*. Water Abstraction Charge Setting for Domestic and Non-Domestic Water Supply.

Shore, R. (n.d.). *Water in crisis—Ethiopia. The Water Project*. Available online at: https://thewaterproject.org/water-crisis/water-in-crisis-ethiopia (accessed March 14, 2021).

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

UNESCO and UN-Water. (2020). *The United Nations World Water Development Report 2020*. Water and Climate Change.

UNICEF Ethiopia. (2020). *Humanitarian Situation Report*. Available online at: https://www.unicef.org/media/83101/file/Ethiopia-SitRep-Jan-Jun-2020.pdf

WHO/UNICEF. (2017). *Progress on drinking water, sanitation and hygiene: 2017 update and SDG baselines*.

WHO/UNICEF. (2021). *JMP Ethiopia. World Health Organisation, UNICEF*. Available online at: https://washdata.org/data/household#!/

Wrathall, D. J., Hoek, V., Den Walters, A., and Devenish, A. (2018). *Water Stress and Human Migration: A Global, Georeferenced Review of Empirical Research (No. 11; Land and Water Discussion Paper)*. Available online at: http://www.fao.org/3/i8867en/I8867EN.pdf

Zaveri, E. D., Wrenn, D. H., and Fisher-Vanden, K. (2020). The impact of water access on short-term migration in rural India. *Austr. J. Agricult. Resour. Econ*. 64, 505–532. doi: 10.1111/1467-8489.12364

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.