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# Urban water insecurity and its gendered impacts: on the gaps in climate change adaptation and Sustainable Development Goals

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## ABSTRACT

It is commonly accepted that water insecurity, accelerated by climate change, is experienced by women in gender specific ways. Using a rapid review methodology this paper evaluates existing literature (2014–2021) on climate change adaptation in relation to water (SDG6) and gender (SDG5) in urban and peri-urban contexts. By analyzing water, gender, and adaptation literature a thematic mapping of SDG5 was done on the resulting 34 documents. Despite methodological limitations – time constraints, exclusion of gender-sustainable development literature, and narrow inclusion criteria – this paper finds a paucity of research in this space during the time period under study. Most literature focuses on low- and middle-income countries, primarily Asia and sub-Saharan Africa, to the exclusion of South America. Notably, evidence demonstrating interlinkages between SDG5 and climate change adaptations in the WaSH sector and gender sensitive dissemination of disaster warnings is lacking. Adaptation strategies resulting in negative impacts on women undermine SDG5 and maladaptive behaviours related to management of domestic water supply and disaster-risks are particularly concerning in this context. Subsequently, this paper establishes the need for practical research assessing the gendered dimensions of all adaptations, including research demonstrating interlinkages between adaptations, women-specific benefits, and strengthened legislation to promote gender equality and empowerment.

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Climate change; adaptation; water security; gender; Sustainable Development Goals; urban

## 1. Introduction

Water security is defined as

the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability. (UN Water, 2013)

The requirement for sustainability as part of water security is reflected in the Sustainable Development Goals (SDG), a set of 17 goals and associated targets agreed upon by UN member states to better balance social development, economic development, and environmental integrity by 2030. In addition to a stand-alone water security goal (SDG6), water-related targets can be found across the other goals. For example, Target 1.5 (reduce exposure and vulnerability to climate-related extreme events), Target 2.4 (resilient agriculture to floods and droughts), Target 3.3 (combat waterborne diseases), Target 11.5 (reduce economic impacts of water-related disasters), SDG 14 (life below water), and target 15.1 (conservation, restoration, and sustainable use of freshwater ecosystems).

Water security is highly gendered in many countries, where domestic responsibility including fetching and managing

household water supplies as well as taking care of the family, falls primarily to women and girls (SDG5.1; 5.4) (Kayser et al., 2019), even while productive responsibility (e.g. food production) is more nuanced (e.g. Doss et al., 2018). These gendered roles, coupled with the lack of access to adequate water, sanitation, and hygiene (WaSH) have specific sex and gender implications (e.g. Geere & Hunter, 2020; Pommels et al., 2018; Torondel et al., 2022). In other words, the achievement of SDG 6 contributes in large part to achievement of SDG5 targets, which are: 5.1–End all forms of discrimination against all women and girls everywhere; 5.2–Eliminate all forms of violence against all women and girls in the public and private spheres, including trafficking and sexual and other types of exploitation; 5.3–Eliminate all harmful practices, such as child, early and forced marriage and female genital mutilation; 5.4–Recognize and value unpaid care and domestic work through the provision of public services, infrastructure and social protection policies and the promotion of shared responsibility within the household and the family as nationally appropriate; 5.5–Ensure women’s full and effective participation and equal opportunities for leadership at all levels of decision making in political, economic and public life; 5.6–Ensure universal access to sexual and reproductive health

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and reproductive rights as agreed in accordance with the Programme of Action of the International Conference on Population and Development and the Beijing Platform for Action and the outcome documents of their review conferences; 5.a–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; 5.b–Enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women; and, 5.c–Adopt and strengthen sound policies and enforceable legislation for the promotion of gender equality and the empowerment of all women and girls at all levels. For example, lack of access to WaSH has been associated with increased physical health impacts and risk of exposure to domestic violence, child violence, peer violence, and animal attacks (SDG5.2) (Anwar et al., 2020; Collins et al., 2019; Mercer & Hanrahan, 2017; Pommells et al., 2018). Local water insecurity has also been associated with adverse mental health impacts (Workman & Ureksoy, 2017). These impacts affect the health and wellbeing of mother and child (Geere and Hunter, 2020; Schuster et al., 2020). WaSH services are also essential for menstrual hygiene management, and labour and delivery, i.e. the reproductive roles of females (SDG5.6) (Ellis et al., 2016; Schuster-Wallace et al., 2018).

Hydroclimatic changes, the most common manifestation of climate change for a majority of the world population, particularly in the form of floods and droughts, impact WASH and health in urban areas (Caretta et al., *in press*). This is juxtaposed against a predicted 80% increase in urban water demand (Flörke et al., 2018). Given the fact that the majority of the world's population is living in urban areas, and this is projected to keep on increasing, it is crucial to examine how climate change has impacted and will impact urban areas (Dodman et al., *in press*). Yet, analyses of how climate change will worsen impacts in urban areas, particularly as they concern health and WaSH, remain sparse (e.g. Bhandari et al., 2020) and evidence on how these challenges are mediated through adaptation is similarly limited (McIver et al., 2016; Tong et al., 2016). Notably, much of this evidence has been published in relation to rural contexts. Accordingly, in an attempt to assess existing evidence, this paper was developed as part of the United Nations Intergovernmental Panel on Climate Change 6th Assessment Report (IPCC AR6) of the Working Group II (WGII) focusing on Impacts, Vulnerability, and Adaptation to Climate Change. In this assessment cycle, WGII is called to provide a comprehensive assessment particularly related to how climate change adaptation can be facilitated or hampered by the SDGs (Schipper et al., *in press*). While literature intersecting gender and adaptation has increased substantially since 2014, the evidence related to WaSH remains to be examined, specifically in urban areas. Thus, the aim of this paper is to examine the specific contributions to gendered dimensions of climate change adaptation in the context of water in urban areas. This is achieved through an assessment of the literature since the previous fifth assessment cycle (IPCC, 2014). Given the centrality of water security in climate change impacts (Caretta et al., *in press*) and the increasing urban dimensions of climate change (Dodman

et al., *in press*), we argue, that it is crucial to understand the implications of existing climate change adaptation measures on SDG5 targets.

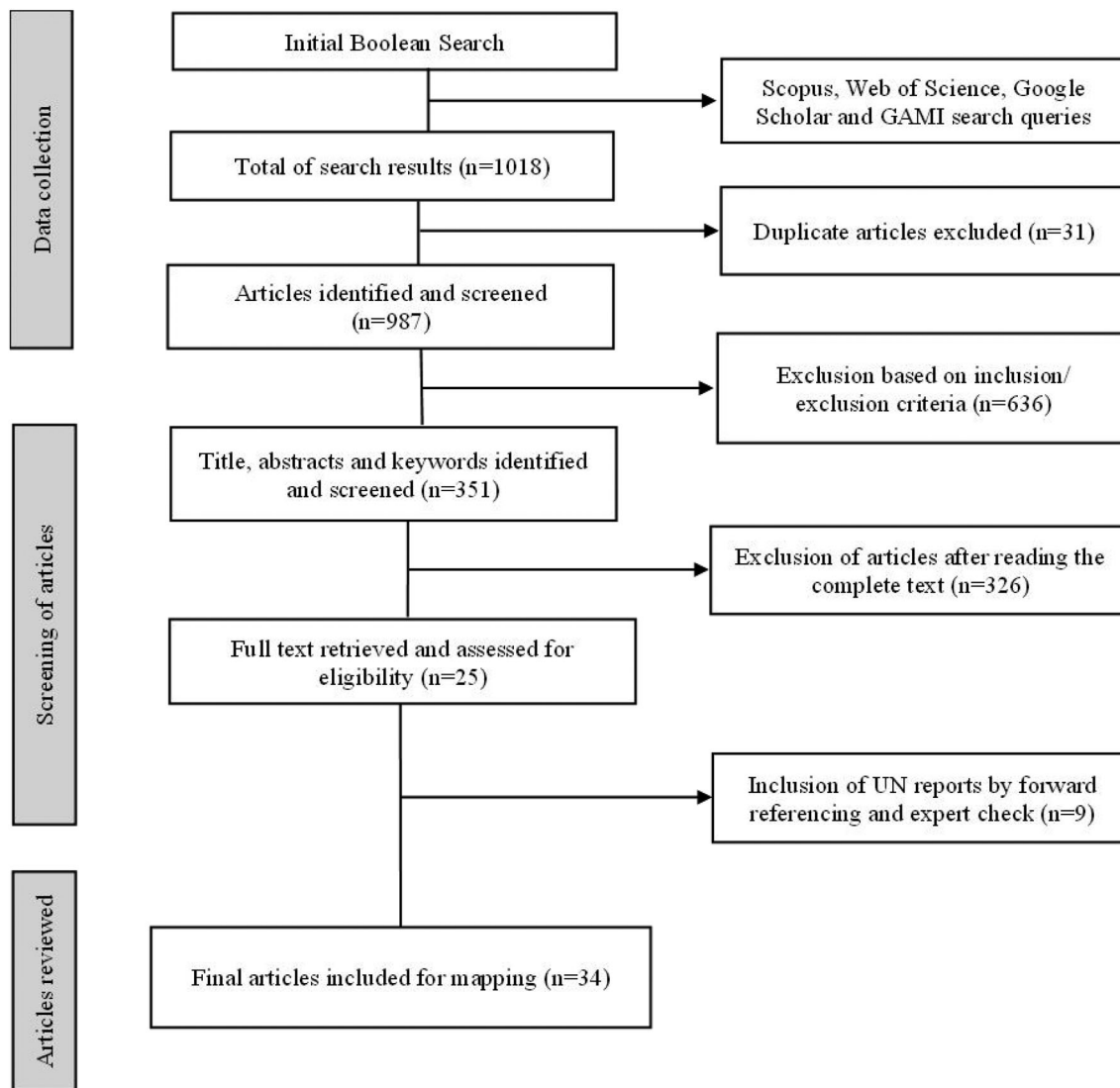
## 2. Methodology

The review carried out in this article is based on a rapid review methodology (Bryant & Gray, 2006; Liem et al., 2020; McCartney et al., 2017) Grey. Rapid reviews follow the principles of systematic reviews but are undertaken within shorter timelines and are commonly used in health studies and technology (Sharpe et al., 2017). Key characteristics of a rapid review are: a short timeline (approximately 6–8 weeks), specific research question(s) for the study, limited sources, explicit strategies for data collection, and literature screening via a robust critical appraisal process. The three main steps (data collection; screening; and, final review) involved in the rapid review process were influenced by the PRISMA protocol (see Figure 1). Systematic reviews following the PRISMA protocol are increasingly being used to understand the growing climate change adaptation literature (Berrang-Ford et al., 2015; Biesbroek et al., 2013; Vij et al., 2017).

To circumscribe the focus of the assessment, following IPCC Special Report 1.5 and its feasibility assessment of adaptation options (see de Coninck et al., 2018), literature only referring to urban systems and cities was included in the analysis. Urban systems are not only locations of rapid population growth, but also high population densities expose large numbers of people to climate change-related water insecurity and water-related disasters. Further, the review only focuses on work published after the Fifth Assessment Report (AR5) of IPCC (2014 and later) and draws upon selected but important grey literature.

To assess the literature that establishes the interlinkages between SDG5 and climate change adaptation, two data collection strategies were employed. First, a search of the ongoing *Global Adaptation Mapping Initiative (GAMI)* a global review of adaptation literature conducted to generate evidence for the IPCC AR6, was undertaken. This was repeated using search strings in academic search engines including *SCOPUS*, *Web of Science*, and *Google Scholar*. The search strings consisted of an urban term (i.e. urban, city/cities, settlement), a gender term (i.e. gender, women, woman, man, SDG5), a water term (water, sanitation, flood, natural disaster) and 'climate adapt\*', returning a total of 1018 scientific articles (see Figure 1). Second, documents (grey literature, n = 9) from development partners such as United Nations and two books/chapters were included. Forward referencing was employed via Google Scholar to ensure that we included important grey literature and book chapters in the text. Forward referencing is used to include literature that cites an original article after it has been published.

A three-step text screening process was employed for this study. First, the authors removed all duplicate articles (n = 31) emerging from different search strings. Only English language, peer-reviewed, full-text original articles available and published in 2014 or later were included in the data collection. No articles published before 2014 were considered, as they were already part of the assessment in AR5. Second, the



**Figure 1.** Steps involved in the rapid review.

authors went through the abstract, keywords and title to screen for irrelevant articles, specifically focusing on the interlinkages between urban adaptation measures and its influence on SDG5 targets. Third, articles were included only if they explicitly examined gender within the context of one or more of the urban adaptation responses identified, i.e. WaSH infrastructure, WaSH behaviour change, flood infrastructure, or nature-based solutions. This step was supported by forward referencing, where 9 grey literature (published after 2014) documents were included, making a total count of 34 (25 + 9) documents (see Figure 1).

Both inductive and deductive coding methods were used to analyse the articles. Deductive coding was used for basic descriptive analysis (coverage, methods used in the study and scope). Following an interpretive approach, inductive coding was used for document analysis (Yanow, 2000). Documents (articles and grey literature) were divided between authors, and two authors iteratively assessed each paper individually before documents were assessed by all authors in a group setting. During step 3 (Figure 1), each document was

thoroughly read, and excerpts were marked that were relevant to urban water-related adaptation measures. Excerpts that were marked in each article were further condensed and interpretations were made regarding the adaptation options. These interpretations are presented in the findings section. Our analysis explained the interlinkages between climate change adaptation measures, urban water (in)security or governance, and their influence on SDG5 targets. Particular emphasis was placed on whether connections between the adaptation measures and the nine targets of SDG5 were positive or negative, influenced by the research mapping conducted by Nilsson et al. (2018) and Roy et al. (2018). A positive connection was identified where an adaptation strategy provided benefits to at least one SDG5 target, and a negative connection identified adaptation strategies that adversely impacted one or more SDG5 targets (see Table 2).

Three limitations were identified during the rapid review process. First, due to time constraints that shaped the rapid review process and the emphasis on urban areas, we made a choice to omit the large body of research undertaken in

rural, coastal, and indigenous contexts. Second, there is a possibility that the combination of search terms used may have excluded gender-sustainable development literature, representing the broader limitation of systematic and rapid reviews (Haddaway et al., 2020). Finally, the focus on positive or negative influences on SDG5 resulted in narrow inclusion criteria that did not sufficiently allow for the identification of reflexive interactions between SDGs.

### 3. Findings

While a majority of the studies focused on low- and middle-income countries, some review papers included high-income countries or global level analyses. Of the 34 documents analysed (Table 1), studies based in Asia dominated the regional composition with 18 documents, while sub-Saharan Africa was represented by four studies, and the Americas by two (one was undefined). In terms of individual countries, articles focused on India ( $n = 6$ ) most often, followed by Bangladesh ( $n = 5$ ), and Nepal ( $n = 4$ ). The literature analysed were primarily extracted from environment and disaster-risk related peer-reviewed journals ( $n = 14$ ), two articles identified were published in gender related peer-reviewed journals and two in climate change journals (Table 1). The diversity of journal types is unsurprising given the interdisciplinary nature of gender and water studies, and the consequent variability in emphasis in terms of both research questions and author disciplines. However, this also means that the literature is highly dispersed and unlikely to be viewed in aggregate except through reviews such as this. It could also suggest that the research is not being driven from a gender studies perspective. Across the literature, gender was conceptualised in five identifiable ways, with a 'roles and responsibilities' framework dominating (Table 1). Our analysis further shows that, where identified, while researchers employed a variety of methods for data collection, qualitative ( $n = 11$ ) and mixed ( $n = 15$ ) methods dominated the studies (Table 1). This heavy emphasis on either qualitative or mixed methods suggests that climate change and gender research cannot solely be predicated on quantitative techniques and numerical analysis. Qualitative methods such as focus groups, interviews, and ethnography, reveal the grassroot realities of women's and men's lived experiences with climate adaptations (or the lack thereof).

In this review, the regional spread of urban water-related adaptation literature that explicitly engages gender clearly shows an over-representation of Asia, while research from North and South America are lacking. Notably, the lack of studies from sub-Saharan Africa appears to contradict previous investigations that identified the region as a significant source of gender-engaged adaptation, resilience, and vulnerability literature between 2006 and 2014 (Bunce & Ford, 2015). Not only does this study assess literature post-2014, the focus on urban and adaptation (rather than vulnerability or resilience) in the search strings may also account for the differences that emerge. Similarly, the lack of inclusion of high-income countries does not indicate a lack of water-related adaptation research, but rather a lack of gendered adaptation research. Indeed, a recent review of water-adaptation responses found that only 14% included evidence of

**Table 1.** Summary of study locations, journal types, methods, and approaches.

Descriptor	Categories (Frequencies)
Country(s) of Study (where specified)	Bangladesh ( $n = 5$ ) Bhutan ( $n = 1$ ) China ( $n = 2$ ) Colombia ( $n = 1$ ) India ( $n = 6$ ) Indonesia ( $n = 1$ ) Mexico ( $n = 2$ ) Nepal ( $n = 4$ ) Nigeria ( $n = 1$ ) Pakistan ( $n = 1$ ) Sri Lanka ( $n = 1$ ) Tanzania ( $n = 2$ ) Zimbabwe ( $n = 1$ )
Journal type	Environment ( $n = 8$ ) Environment & disaster ( $n = 1$ ) Disaster ( $n = 2$ ) Climate change ( $n = 2$ ) Environment & health ( $n = 1$ ) Environment & development ( $n = 2$ ) Development ( $n = 1$ ) Gender ( $n = 1$ ) Gender & development ( $n = 1$ ) Sustainability ( $n = 1$ ) Sustainability & development ( $n = 2$ ) Social Work ( $n = 1$ )
Methods	Qualitative ( $n = 11$ ) Quantitative ( $n = 1$ ) Mixed methods ( $n = 15$ ) Review/Synthesis ( $n = 4$ ) Not defined ( $n = 3$ )
Study scope	Single case ( $n = 7$ ) <4 cases ( $n = 6$ ) >20 cases ( $n = 11$ ) Unknown ( $n = 11$ )
Gender lens (Sometimes framed in combination e.g. Roles & responsibilities and vulnerability ( $n = 8$ ))	Roles & responsibility ( $n = 18$ ) Vulnerability ( $n = 11$ ) Empowerment ( $n = 6$ ) Political ecology ( $n = 4$ ) Feminism ( $n = 3$ ) Social constructivism ( $n = 2$ ) Gender mainstreaming ( $n = 1$ ) Gender equity ( $n = 1$ ) Gender-based violence ( $n = 1$ ) Political economy ( $n = 1$ ) None ( $n = 5$ )

gender equity (Mukherji & Kumar, 2021). Further, Asian and sub-Saharan African countries are predominantly low- and middle-income countries, where higher urban population densities combined with poorer access to services means that more people are at risk from climate-induced disasters and related changes. While this may explain biases towards these regions, it does not explain the paucity of gender-focused urban water adaptation literature in South America.

Adaptation strategies extracted from the literature fell into three water-related areas – water collection, sanitation, and flooding – with a fourth cross cutting theme of participation and leadership (Table 2). Within these overarching themes, specific adaptation responses were further categorised as improved infrastructure (WaSH and flood-mitigation), water storage and water supply (water collection), and ecosystem restoration (flood mitigation), as per the focus of WGII in this 6th assessment cycle of the IPCC. These latter categories were used to assess strength of evidence for specific SDG5 targets (see Table 3).

Our review shows that variations exist in the degree to which interlinkages between adaptations to water insecurity and natural disaster-risk management and the individual



**Table 2.** Synthesis of adaptation strategies and gender linkages.

Theme	Adaptation Strategy(s)	Gender Linkages <sup>a</sup>	References
Water Collection	Supply augmentation post-disaster (tubewell, pond and filter, saline purification and rainwater harvesting plants)	Positive (5.1): technologies implemented, reduced water-fetching burden; Negative (5a): supporting social arrangement for operation and maintenance could not overcome existing limiting factors for women's participation.	Alam & Rahman, 2019 Alam & Rahman, 2019
	Supply augmentation (greywater reuse; rainwater harvesting), storage, water conservation	Positive (5.1): improve supply and efficient use to reduce burden; Negative (5.1): gendered responsibilities still exist	Buechler, 2016; World Bank, 2015 Buechler, 2016
	Supply augmentation (rainwater harvesting)	Negative (5.4): create social justice issues because middle class can afford systems that impoverished women cannot; Positive (5.1): reduction of middle class dependence on municipal supply can free up water for those who depend on it.	Button, 2017 Button, 2017
	Access to water (infrastructure)	Positive (5.1): increase school attendance; income generation; empowerment Positive (5.2): reduce domestic violence, sexual violence. Negative (5.2): inadequate supplies in informal settlements and peri-urban increase risk of violence.	Castañeda Camey et al., 2020 Castañeda Camey et al., 2020 Castañeda Camey et al., 2020
	Supply augmentation (tap local springs), storage, water rationing	Positive (5.1): reduced collection burden; Negative (5.1): devolution of responsibility from public sector to household (and women) and resultant household tradeoffs.	Eakin et al., 2016 Eakin et al., 2016
	Supply augmentation (water reuse/recycling)	Positive (5.1): work burdens more evenly distributed during floods.	Fauconnier et al., 2018
	Supply augmentation (alternative poor quality sources)	Negative (5.1; 5.3): Use of polluted water sources; travelling further for water (maladaptation and harmful practice).	Gambe, 2015; Shrestha et al., 2019; Singh and Singh, 2015; WaterAid Canada, 2017
	Access to water	Positive/Negative (5.1; 5.4): Men fetch water during extreme scarcity, but women still spend more time than men;	Gambe, 2015; Su, et al., 2017
	Water storage	Positive (5.5): during scarcity women become more involved in management of boreholes/water allocation. Negative (5a): Women choose not to invest in water improvements as do not own property and could be taken away from them.	Hofmann, 2017 Hofmann, 2017
	Access to water (infrastructure)	Positive (5.1; 5.3): enhance adaptive capacity through increased education and employment opportunities, improved health.	Kher et al., 2015
Access to Sanitation	Supply augmentation (fog harvesting)	Positive (5.1): decreased physical and social burden; improved health.	Lucier & Qadir, 2018
	Natural disaster impact on water supply	Negative (5.1): women's responsibilities increase with decreasing water availability.	Sugden et al., 2014
	Home Gardens	Positive (5a): improve adaptive capacity, reduce climate risks, increase income-generating activities and therefore empowerment.	Woronecki, 2019
Access to Sanitation	Education	Positive (5.1): education empowers management roles and increased sanitation and hygiene practices.	Pouramin et al., 2020
	Maladaptation	Negative (5.2): In the absence of proper sanitation facilities, women risk increased violence to find privacy.	Pouramin et al., 2020; UN, 2015, 2017, 2018; WaterAid Canada, 2017
Flood Risk	Flood proof housing	Negative (5.1): women's workload increased with post-flood construction; Negative (5a): Informal settlements not part of formal development policies.	Dangol & Carrasco, 2019 Dangol & Carrasco, 2019
	Climate resilient spaces	Positive (5a): focus on climate resilient strategies in spaces inhabited by women (e.g., home versus public spaces); urban women have more access to financial resources and therefore more power.	Jabeen, 2019
	Early warning systems	Negative (5.1): do not receive early warnings directly despite role in disaster response.	Kafle, 2017; Mustafa et al., 2015
	Flood management (settlement protection)	Positive (5a): positively impact women's livelihoods through reduced impact on living space and income sources.	Reckien et al., 2017
	Ecosystem-based adaptation (mangroves, canals)	Positive (5.5) / negative (5.1): can enhance women's empowerment and engagement, but also place increased water burden on women.	Richerzhagen et al., 2019
Participation & Decision-making	Role of women in environmental conservation for flood risk reduction	Positive (5.5): Women's empowerment and institutional change to facilitate participation; women's leadership enhances watershed sustainability	Asteria & Herdiansyah, 2020; Singh, 2018
	Role of women in flood response	Positive (5.5): Women's roles recognised as equal to men's.	Dangol & Carrasco, 2019
	Role of women in shared water governance	Positive (5.5): leadership valued; meaningful role in planning; interacting with women facilitates benefits for women.	Fauconnier et al., 2018
	Role of women in early warning systems	Positive (5b): opportunity for gender sensitive messaging and delivery mechanisms; Positive (5.5): women and girls' empowerment through gender representation.	Kafle, 2017; Mustafa et al., 2015; Tanjeela & Rutherford, 2018 Kafle, 2017; Mustafa et al., 2015; Tanjeela & Rutherford, 2018
	Role of women in water supply maintenance	Positive (5a): maintenance responsibility leads to changes in leadership roles for women.	Lucier & Khadir, 2018
	Increased knowledge of adaptation strategies	Negative (5.1): increased burden to manage water for household.	Magesa & Pauline, 2018; Richerzhagen et al., 2019

<sup>a</sup>+ve – positive benefits from adaptation strategy(s); -ve – negative benefits from adaptation strategies (i.e. maladaptive).

**Table 3.** Interlinkages between and the individual targets of SDG 5.

SDG5 targets Adaptation strategy	5.1 End discrimination	5.2 Eliminate violence	5.3 Eliminate harmful practices	5.4 Value unpaid work	5.5 Ensure participation	5.6 Ensure reproductive rights	5.a Undertake reforms	5.b Enhance use of tech	5.c Adopt sound policies
WaSH	10	6	5	4	8	0	0	0	2
infrastructure									
Increasing supply	5	1	1	1	0	0	0	0	0
Storage strategies	5	0	0	0	0	0	0	0	0
Disaster response	4	0	0	3	0	0	0	4	4
Flood	5	0	0	1	4	1	5	1	3
management (infrastructure)									
Ecosystem restoration	0	0	0	0	0	0	1	0	0

targets of SDG5 have been explored in the literature reviewed. Table 3 displays the spread of literature linking the nine SDG5 targets to the six adaptation strategies identified by WGII. The numbers in the table reflect the number of studies found, or strength of evidence, that links each target to each strategy. Emphasis to date has focused on WaSH and gender and on SDG5.1 (ending discrimination), with recognition of the links between poor access to WaSH and gender-based violence (SDG5.2). While this makes sense given sex and gender requirements for WaSH and the significant gendered impacts associated with lack of access to WaSH, the lack of literature addressing the linkages between the other five adaptations and eight SDG5 targets is stark, since it is also likely that these are linked. For example, one study has identified an association between drought and early childhood marriage (SDG5.3) (Castañeda Camey et al., 2020). Further research that is specifically focused on adaptation with an SDG5 lens is arguably likely to identify more interlinkages. Conversely, achievement of SDG6 with a specific gender lens can contribute to achieving other SDG5 targets, such as target 5.5 (effective and equal participation in leadership) and 5.c (sound policies and legislation for equality and empowerment).

### 3.1. Water collection

Adaptations related to the gendered roles women hold in regards to water collection are prevalent in the literature. Innovative urban adaptations include alternate water supplies and storage techniques such as small-scale water harvesting (World Bank, 2015), fog water collection (Lucier & Qadir, 2018), increased water storage capacity (Alam & Rahman, 2019; UNEP, 2016), greywater recycling (Lucier & Qadir, 2018) and upcycling water by flushing toilets using dirty laundry water (Gambe, 2015). These storage techniques and alternate water sources alleviate the physical and social burden of water collection on women and girls (UNEP, 2016). They can also have positive impacts on addressing discrimination against women and girls and providing social benefits such as gender equality and empowerment (Woroniecki, 2019). Specifically, small scale water harvesting systems have significant consequences in freeing up women's time for productive activities such as small scale agriculture, thereby increasing nutritional intake for them and their families (Lucier & Qadir, 2018; WaterAid Canada, 2017; World Bank, 2015).

Adaptive behaviours to water scarcity include women travelling farther distances (Sugden et al., 2014) or through dangerous terrain (Shrestha et al., 2019) to find water, fetching water at odd hours of the day (Castañeda Camey et al., 2020), or using unsafe water given a lack of accessible alternatives (Gambe, 2015). In situations of water scarcity, not only do women's household management responsibilities increase (Magesa & Pauline, 2018; Sugden et al., 2014; Tanjeela & Rutherford, 2018), but so does overall time spent fetching water (Eakin et al., 2016; Kher et al., 2015; Shrestha et al., 2019; Tanjeela & Rutherford, 2018). These behaviours not only impose physical health burdens (Lucier & Qadir, 2018), but increase the risk of women experiencing domestic, sexual, and physical violence (Castañeda Camey et al., 2020; Gambe, 2015; Shrestha et al., 2019; Sugden et al., 2014).

Adjusting gender roles within families also emerged as an adaptive strategy to combat water challenges (Singh & Prakash Singh, 2015). For example, men's participation in water collection in Zimbabwe and China increased to improve household water-fetching efficiency (i.e. time spent and distances covered) (Gambe, 2015; Su et al., 2017), and increased in India to protect women from experiencing sexual violence (Singh & Prakash Singh, 2015). Further, greater access to water has reportedly reduced incidents of child marriage in Kenya (often used as a strategy to reduce household economic stress) (Castañeda Camey et al., 2020), reduced domestic disputes (UN, 2017), and provided women and girls with more time to pursue activities related to social gatherings (Shrestha et al., 2019), income-generation, and education (Alam & Rahman, 2019).

### 3.2. Access to sanitation

Women and girls face critical challenges when it comes to accessing appropriate sanitation and hygiene. Inaccessible or lacking facilities restrict women and girls from participating full-time in work duties or in education. For example, in Bangladesh, more than two thirds of women factory workers lose six days of work per month because of a lack of safe places to change and dispose of their menstrual pads (Pouramin et al., 2020). These circumstances are exacerbated during times when natural disasters, particularly flooding, compromise facilities and sanitation materials become unavailable (WaterAid, 2017). Conversely, in Zambia, it was found that the provision of sanitation facilities and water reduced course repetition and school dropout rates for girls (UN, 2018).

Additionally, in India, the provision of latrines in schools saw girls' enrolment increase more than boys (UN, 2018).

Climate disasters, particularly flooding, have the potential to destroy WaSH facilities; this has implications for both women and girls as well as community health. For example, adaptive behaviours in response to the loss of latrines due to flooding place women and girls at greater risk of experiencing gender-based violence as well as leading them to adopt unsanitary behaviours that increase the likelihood of source water contamination (UN, 2018). This emphasises the need to consider climate resilient and gender-sensitive WaSH infrastructure when it comes to adaptation interventions. Indeed, climate proofed infrastructure in general, including houses, are evidenced to reduce health risks of lower-income women (Ajibade et al., 2013). Relatedly, WaSH for menstrual hygiene management is recognised as a public health challenge and a form of discrimination against women and girls, but no explicit links to climate change have been made. Consideration of gender-related WaSH requirements in emergency shelters is essential to reduce adverse health impacts associated with water-related disasters (Alam and Rahman, 2019).

Engaging women in pre- and post-disaster response is also critical. Adaptation programmes that focused on women's early and continuous engagement in disaster awareness and response had a positive impact for women and girls in the community. Specifically, this included: women raising awareness of appropriate responses to disaster warnings (women and girls in the home taking shelter or evacuating to cyclone centres); improving women's understanding of local climate change problems; and, enhancing interest in involvement among women through greater inclusion of women-specific issues and visibility of other women's engagement (Tanjeela & Rutherford, 2018).

### 3.3. Participation in decision making

Adaptations can enhance women's participation in the public sphere and build opportunities for decision making. In flood-prone areas of Bangladesh, there is increased gender representation in dissemination of warnings in urban areas as compared to rural areas. In urban regions, female volunteers engaging in disaster work, including early warning, rescue and relief work, are positively received by the community even when working alongside male volunteers. Female participation has created space to address women-specific issues, and volunteer work has made more women knowledgeable about the consequences of climate change (Tanjeela & Rutherford, 2018). However, mitigating flood risk in the absence of male members doubly burden women who have to balance their household duties along with flood prevention activities (Dangol & Carrasco, 2019). Thus, even when women's leadership and knowledge is accepted and deemed equal to men, their unpaid domestic work is not recognised and therefore not taken into account when women adopt additional climate adaptation roles. In Colombia, for example, assessing social costs and benefits of ecosystem-based projects demonstrates a trend towards women's empowerment that is associated with a commensurate increase in women's work burdens (Richerzhagen et al., 2019).

Disaster risk management systems, such as Early Warning Systems, also lack a gender lens and engagement of women (and other marginalised groups) in design, and related decision-making processes (Zia & Wagner, 2015). For instance, flood risk communication and dissemination in Pakistan is highly gendered and women are often the last to receive flood-related news, are unable to understand communications relayed in national languages, and are unable to move to a safe place outside of their homes without the permission of male household members (Mustafa et al., 2015).

### 3.4. Maladaptation

Adaptation options are temporal in nature. It can be argued that if the adaptation option has a short-term characteristic, then in the long-term that option can become maladaptive, and have negative impacts on future development trajectories. For instance, adaptation options at the local level have largely focused on building low-cost infrastructure such as check dams and small water storage structures. Such initiatives may not necessarily contribute to long-term adaptation needs and reducing future risks (Vij et al., 2019). Given that these adaptation strategies are not being assessed for future and long-term climatic changes, such policies and strategies may in fact aggravate water insecurity (Eekhout et al., 2018) and add to women's burdens. Thus, when combined with gendered water roles, financial dependency and decision-making at the household level, women can become further disadvantaged.

Certain domestic water management techniques employed by women to cope with water scarcity and insecurity can also prove maladaptive. These include: prioritising water resources such as using piped water for drinking, using saltwater for washing, and local natural water for bathing (Magesa & Pauline, 2018); forgoing food to reduce water use and to ensure that the rest of the family is sufficiently fed (Pommells et al., 2018) or altering household and personal hygiene tasks (Magesa and Pauline, 2018); and, water rationing (Eakin et al., 2016), which can lead to similar consequences as water shortages depending on how much rationing occurs. This may not be problematic if transitions to more appropriate and sustainable adaptation strategies are possible over the medium- and long-term. However, this is not always the case, particularly for the impoverished who are unable to afford many adaptation strategies or those who do not own their own homes (Kher et al., 2015). For example, in Mumbai, India, the installation of rainwater-harvesting technologies has increased the resilience of middle-class communities to water supply shortages. However, this has resulted in normalising state-supplied water scarcity, which in turn disadvantages female domestic workers who live in informal settlements and depend on state provided water resources (Button, 2017). Markedly, findings from 13 studies across India, Nepal, Mexico, Bangladesh, Zimbabwe, Tanzania, China, and three from studies covering multiple regions and countries, suggest that adaptation options had moderate to severe maladaptive consequences for women. As such, many behavioural changes undertaken by women and girls in response to scarce water resources, and lack of sanitation and hygiene facilities,



during climate change events have divisive outcomes. They either fail to achieve, or undermine progress towards achievement, of both SDG5 and SDG6, given the inextricable linkages between both goals.

#### 4. On the gaps in climate change adaptation and Sustainable Development Goals: concluding discussion

The rapid review methodology and analysis of 34 documents point to several key highlights which are significant for understanding how achievement of SDG5 can be facilitated or hampered by current approaches to climate change adaptation. First, there is no disputing the interconnections and overlaps between SDG5 and SDG6. Gender-determined roles in domestic water management and women's health needs make women vulnerable to water insecurity and lack of access to appropriate WaSH facilities. These roles and responsibilities further create challenges to multiple targets of SDG5, such as ending discrimination (5.1) and eliminating violence (5.2) against women and girls, and recognising and valuing unpaid domestic work (5.4) such as water fetching and management. The evidence reviewed in this paper demonstrates the benefits of engaging women in WaSH decision-making and management, and the fact that lack of women in these roles perpetuates WaSH and water-related inequalities (Fauconnier et al., 2018).

Access to WaSH has been proven to confer particular benefits to women, including improved physical health, reduced risk of domestic and sexual violence, and empowerment. However, a significant point for consideration that emerges from this rapid review is that, in the absence of gender mainstreaming in development programming, many adaptations can be associated with negative impacts for women and girls. For instance, lack of consideration of menstrual hygiene management and short-term coping strategies, such as reducing hygiene activities or eating less food, can become maladaptive over the long-term. Conversely, when women are empowered through education, training (Tanjeela & Rutherford, 2018), or are placed in decision-making roles (Fauconnier et al., 2018; UN, 2018), equitable outcomes of WaSH interventions and successful infrastructure design are observed. These include supply augmentation to reduce the burden of water fetching (Alam & Rahman, 2019; Button, 2017), enhance kitchen gardens (Buechler, 2016), and reduce gender-based violence (Castañeda Camey et al., 2020). Culturally responsive capacity building of women through WaSH interventions also improves community health outcomes such as alleviating diarrhoea (Alam & Rahman, 2019), reducing prevalence of respiratory tract infections, and improving community hygiene practices in the long run (Pouramin et al., 2020).

Second, literature on disaster-risk reduction also shows how women's participation in the public sphere can be enhanced through community involvement and build opportunities for decision making (Fauconnier et al., 2018; Tanjeela & Rutherford, 2018; UN, 2018). Consequently, in order to advance gender mainstreaming in urban water adaptation strategies, it is essential to give women equal rights to resources and services (5.a), empower women through enabling technologies (5.b), and adopt policies and legislation

that promote gender equity (5.c). Notably, this rapid review shows a deficit of literature establishing interlinkages between adaptations and the last indicator of SDG5 (Table 3), which is to adopt and strengthen sound policies and enforceable legislation for the promotion of gender equality and the empowerment of all women and girls at all levels. Further, this rapid review highlights the need for gender sensitive dissemination of disaster warnings as little practical research exists demonstrating promising gender-sensitive communication practices or proven strategies, particularly for urban settings. Although studies have highlighted the importance of women in responding to disasters (Kafle, 2017), literature from Asia suggests that they may be prevented from receiving early warnings, whether because of the messaging itself or because they do not inhabit the spaces and places traditionally associated with early warning systems. Even when women's groups are mobilised for early warning systems, disaster alert messages are often not gender sensitive, and the manner in which they are disseminated – through radios and mobile phones – are not accessible to women (Kafle, 2017). More research in this area could focus on direct connections between technological adaptations and enhancing the use of enabling technologies, in particular ICT, to promote women's empowerment (SDG5.b).

Another theme which emerges from the literature reviewed is that water-related adaptation interventions can have gender implications that perpetuate WaSH- and disaster-related burdens on women, unequal power dynamics in WaSH and water management decisions, and health disparities when social and cultural barriers are not considered (Button, 2017; Singh, 2018; Sugden et al., 2014; Tanjeela & Rutherford, 2018). Further, there are numerous studies in gender mainstreaming and development literature that demonstrate how 'doing gender' on paper looks good and ticks all the boxes, while in practice, strategies of empowerment and participation serve to reproduce gender inequality and further burden women (Batliwala & Dhanraj, 2004; Coles & Wallace, 2005; Cornwall et al., 2007; Jackson & Pearson, 2005; Mukhopadhyay, 2014). When women become the recipients of development projects, there is an almost singular focus on women as the bearers of development through their productive activities and 'perceived' rational capabilities. However, 'doing gender' (i.e. gender mainstreaming) does not necessarily mean engaging with the structural inequalities that create and perpetuate gender inequalities (Cairns et al., 2017). Consequently, adaptation literature could be enhanced by addressing how infrastructure-based adaptations can ease the labour burden rather than add to it. Additionally, literature remains squarely focused on women and gender inequalities. It is in fact crucial that climate change adaptation moves beyond this to encompass diversity in race, class, economic status, age, and ability, as these are fundamental elements that shape women's experiences and access to adaptation solutions and resources. If this intersectionality is not taken into account in climate change adaptations, there is a risk of homogenising women as a single category, as Carr and Thompson (2014) have found in an agrarian setting, leading to further ineffectiveness of adaptation strategies.

The achievement of SDG5 cannot rest on being a consequence of meeting other SDGs, specifically SDG6. To redress

this, SDG6 must take on appropriate SDG5 targets to ensure that gender mainstreaming is occurring alongside climate mainstreaming to protect and sustain urban water security and WaSH services once established. This requires transitioning from siloed approaches to either achieving universal WaSH as part of the development discourse *or* building and improving WaSH infrastructure as a climate adaptation strategy. It is argued that the understanding of climate resilient development pathways, envisioning a future where climate change adaptation and mitigation go hand in hand with sustainable development (Denton et al., 2014), need to integrate gender. Thus, while there are demonstrable evidence-based interlinkages between adaptations and women's empowerment, our rapid review shows that many of these interlinkages appear to be based on fragile, highly localised data, with a significant gap in evidence for many of the nine indicators of SDG5.

Finally, interlinkages between water insecurity, adaptation strategies, and eliminating harmful social practices (e.g. child marriage) have just started to be explored in the academic literature. Castañeda Camey et al. (2020) provide evidence that points to a decrease in the rates of child marriage when water is easily accessible, since families are no longer forced to marry off daughters to lessen their economic burdens. Similarly, indirect linkages between floods and increase in numbers of child marriage have been identified, as floods are often drivers of decreased economic status (Human Rights Watch, 2015).

This paper shows that, while gender has been considered in the climate adaptation and water (in)security literature, gaps still remain in our knowledge of co-benefits, and more importantly, anti-benefits, i.e. in terms of adverse health consequences and increased burdens for women and girls. These must be addressed moving forward, as empirical data is critical for evidence-based policy formulation and the studies reviewed fail to provide evidence required for investment in practice. Key areas where water-related urban climate adaptation literature could be enhanced include gendered benefits of climate-proofed WaSH infrastructure, gender sensitive early warning and disaster preparedness, a better understanding of how some adaptation strategies result in negative impacts for women and girls, and the roles of poverty-eradication, education, and leadership for women and girls in enhancing gender-sensitive adaptation. Further, strength-based approaches that recognise intersectionality are lacking, despite being essential to fully understanding and planning for the consequences of interlinkages between SDG5 and SDG6 in the urban context. Ultimately, gender- and climate-mainstreaming of WaSH and water-related disaster preparedness is crucial if we collectively want to envision and implement climate resilient development pathways to ensure water security. This is also essential to ensuring that benefits are conferred not only with respect to SDG5, but also the health of women and girls. As such, there is a critical need to generate targeted evidence identifying intersectionally-disaggregated, strength-based approaches to operationalising SDG5 and SDG6.

## Disclosure statement

No potential conflict of interest was reported by the author(s).

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