



# From participation to empowerment: the case of women in community-based water management in hydrologically diverse southwest coastal Bangladesh

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Received: 22 July 2023 / Accepted: 10 January 2025  
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## Abstract

Women's participation in water management institutions (WMOs) is seen as a vehicle for women empowerment and gender equity. However, the extent of women's participation is variable over space, mediated by social, religious, and ethnic variables. Moreover, mere participation and membership do not guarantee women's active involvement in decision making and hence does not necessarily empower them. Whether women have the authority to opine on water management aspects and have them reflected in management and implementation decisions is more important for empowerment. In this paper, we investigate opportunities for women's empowerment via participation in WMOs in water insecure southwest coastal Bangladesh. Using qualitative research tools and methods, we examine the extent and nature of women's participation in WMOs and the factors that affect the level of participation in varying hydrological settings. Drawing upon important empowerment indicators across the domains of agency, resources, and achievement, we contend that a set of contextual variables encompassing both socio-political as well as natural processes influence women's effective participation and empowerment outcomes. If participation would be translated into empowerment will depend particularly on the positions women hold in the WMOs and to what extent the positions are influenced by other powerful members of the community. The study clearly shows empowerment is achievable through intensive water security programs to ensure women's effective participation, supported by leadership enhancing programs, and to ensure fair selection in the WMOs by breaking the stereotypes of elite influence. Institutional coordination through inclusion of women's empowerment team in the mainstream government or non-government institutions is important to facilitate, monitor and evaluate women's empowerment activities. Apart from the local power structures, socio-political context, and institutions, it is important to pay attention to geographical locations with diverse water security concerns. Well-maintained and functioning water control structures against complex and difficult environmental stresses provide opportunities for high empowerment. Lastly, frameworks for measuring empowerment in relation to water resources management are useful in that they allow systematic examination of different drivers and impact pathways for important empowerment dimension and prioritization of areas for interventions.

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**Keywords** Community · Water management · Women · Empowerment · Coastal Bangladesh

## 1 Introduction

Community based water resources management has gained increasing traction in rural areas across the world because of negative impacts on social equity caused by large scale government interventions (De Stefano, 2010; Jacobs et al., 2016; Laituri, 2020; Meinzen-Dick & Zwartveen, 1998; Sultana, 2009, 2015). Women's participation in such community-based water management organizations (WMOs) is seen to help improve the efficiency of management and sustainability of the WMOs, with more unbiased and fruitful outcomes in the form of better compliance with rules, enhanced fund collection, better maintenance of water supply systems, and progressive function of the committees. Women's participation is viewed as a vehicle for improved outcomes for both men and women, especially for women empowerment and gender equity (Clement & Karki, 2018; Mommen et al., 2017; Kholif & Elfarouk, 2014; Carrard et al., 2013; WWAP, 2012; Fisher, 2006, 2008; Agarwal, 2001; Cleaver, 1998; Meinzen-Dick & Zwartveen, 1998; Van Koppen, 1998; Wijk-Sijbesma, 1998; Moser, 1989). Women's membership and participation in community-based water management forums facilitates integration of women's needs and knowledge, enhancing their status and voice in governance, strengthening their bargaining position as resource users within households and communities, and thus improving their confidence, self-reliance and leadership skills (Kilsby, 2012; Aladuwaka & Momsen, 2010; Joshi & Fawcett, 2001; Agarwal, 2001; Meinzen-Dick & Zwartveen, 1998; Van Koppen, 1998; Wijk-Sijbesma, 1998).

However, mere participation and membership do not guarantee women's active involvement in decision making and hence do not necessarily empower them. This may result from a situation termed as 'tokenism' by Arnstein (1969), in her typology of 'a ladder of citizen participation', wherein voices do not have any effect and hence do not lead to any change. This contrasts with the level of 'citizen power' at the higher end of the participation ladder, wherein participation is about citizens having more power to negotiate and change the status quo, and their voices are heard and responded to. Whether women have the authority to opine on water management aspects, based on own priorities and interests, and have their opinions reflected in management and implementation decisions, is to be seen as an important criterion for their empowerment (Joshi & Fawcett, 2001; Kilsby, 2012). This depends many a times on the positions women hold in the WMOs and if the positions are influenced by other powerful members or not (Dewan et al., 2014). Many countries, including those in South Asia (e.g., Nepal, Bangladesh, Sri Lanka and India), have adopted policies or practices to have quotas (e.g., 33% in Nepal, and 30% in Bangladesh) in the water management groups to be filled up by women (Meinzen-Dick & Zwartveen, 1998; MoWR, 2001; Sultana, 2015). However, the achievements in terms of women's participation in water management related decision-making process have been mixed, with institutions still tending to be male dominated, reinforcing existing power relations (Khandker et al., 2020; Sultana et al., 2022).

Access to water and land related resources is an important dimension for women's empowerment, which varies in different geo-hydrological settings. This is influenced by the spatio-temporal dynamics of hydro-social and socio-political relations, as a consequence of modifications in water's natural flow and availability due to anthropogenic interventions

(Linton & Budds, 2014; Ruj et al., 2022). The hydro-social landscape often promotes inequality, with enhanced conflicts between the social elites and the marginalized people. Empowerment of the marginalized people, including the women, will require minimization of these conflicts. Water insecurity in the form of lack of suitable options for water supply, and exposure to hazards and disasters make women more vulnerable, reducing their coping and adaptation capacity (Md et al., 2022; Sultana, 2015). Investment in water security programs around community management is viewed to help women's empowerment as improvement of water supply and access leads to saved time, which women can use in productive work and thus have increased control over income. Besides, water security programs targeting improved value chain leads to economic empowerment, contributing to women's agency and enhanced leadership in community-based organizations (Clement, 2012; Clement & Karki, 2018).

In Bangladesh, community-based water management is still not equitable for women from all classes (Afroz et al., 2016; Agarwal, 2001; Ashrafi & Rahman, 2018; Cornwall, 2001; Dewan et al., 2015; Sultana, 2009). The situation is more compounded in the coastal area because of high water insecurity stresses, resulting from higher physical vulnerabilities due to multiple hazards and disasters, such as cyclonic storm surge, fluvio-tidal flood, salinization in soils, river water and groundwater, riverbank erosion, and waterlogging, as well as higher socio-economic vulnerabilities, including lower education, higher poverty, less livelihood opportunities and weaker communication infrastructure (Nicholls et al., 2016). Besides, the hydro-social cycle has been prominent in the coastal zone; polderization (tidal floodplain areas being embanked all around) since 1960s in the coastal zone led to major alteration of land use practices, with brackish shrimp farming by large shrimp cultivators gradually dominating the farming practices in the southern parts, taking advantage of saline river water and controlled hydraulic conditions. Although the large-scale shrimp farming declined in the last decade, the conflicts between the social elites and the marginal farmers still exist (Abdullah et al., 2017; Islam & Tabeta, 2019; Naz & Buisson, 2015; Parvin et al., 2015).

A number of previous studies found frequent domination of rural male elites in WMO executive committees in Bangladesh preventing participation of general people (e.g., Dewan et al., 2014; Nowreen et al., 2011; Rahman et al., 2009), while improved situations were found in some areas where gender awareness training had led to increased confidence in women engaging as active executive committee members in the WMOs (Dewan et al., 2014; EKN and BWDB, 2011). A high variability in the forms of participation of men and women in the WMOs was observed, prompting the call for generating more evidence on whether participation is representative of and accountable to all social groups, along with the roles, responsibilities, and power of women members in the WMOs and the factors affecting them (Clement, 2012).

While previous studies provide evidence of women not becoming empowered as desired because of their limited roles in decision-making process in the WMOs, there is a gap in understanding of how different socio-political and water insecurity factors act together in different hydro-social settings to influence women empowerment. In this paper we consider these aspects while investigating women empowerment in participatory community-based WMOs in the southwest coastal zone of Bangladesh. We examine the extent and nature of women's participation in water management groups and the factors that affect their level of participation and hence empowerment in the process. We particularly examine, through qualitative research, the pathways of empowerment in varying hydrological settings, and attempt to quantify women empowerment based on a framework, drawing upon important empowerment indicators, in relation to availability of and access to resources linked

to their water related activities, capacity and process of decision making through effective participation in WMOs, and well-being outcomes generated through participation such as enhanced economic growth, leadership skill, autonomy and mobility. We contend that a set of contextual variables encompassing both socio-political as well as natural processes influence women's effective participation and produce empowerment outcomes. Apart from the local power structures, socio-political context, and institutions, it is also important to pay attention to geographical locations with diverse water security concerns, and what targeted water security programs can reduce them.

## 2 Theoretical underpinnings

### 2.1 Concepts of empowerment

The theoretical approaches to examining empowerment have mostly focused on the concepts coined by Kabeer (1999), such as 'agency', which refers to the capacity to make decisions in areas of women's personal lives and health, as well as access to 'resources' (medium through which agency is exercised) and 'achievements' or results (outcome of agency). The relationship between agency, resources, and achievements has formed the foundation of most definitions of empowerment (Gressel et al., 2020). Ibrahim and Alkire (2007) provides a review of definitions and concepts of empowerment in terms of these three aspects, provided by different scholars from early 90's to late 00's. Empowerment has been conceptualized in the contexts of being able to make own and effective choices which were previously denied to them; social inclusion leading to collective action, ownership, control and expansion of productive assets; being aware of the power dynamics in the socio-political environment; developing skills and capacity for gaining reasonable control over their lives, and challenging forms of approaches which are inequitable and deny marginalized people to participate in, negotiate with, influence control and hold accountable institutions that affect their lives.

### 2.2 Measuring women's empowerment

Women empowerment has been measured using a variety of composite indicators or indices; however, several complexities have affected its systematic evaluation, which stemmed from multi-dimensionality and context specificity of women's empowerment process, difficulty in measurement due to the inherent complexity of the empowerment process, and inadequacy of indicators used at different scales (e.g., national, community or household scales) in capturing relational aspects of empowerment across different areas of life or dimensions (Gressel, 2020; Roy et al., 2017; Alkire et al., 2013; Malhotra and Schuler, 2002). Most conceptual frameworks have relied on three main components, i.e., agency resources, and achievements, as proposed by Kabeer (1999), or variants of these three. Examples include use of internationally comparable indicators at the individual, community and national levels by Ibrahim and Alkire (2007), Women's Empowerment Index (WEI) designed to measure progress in the multi-dimensional aspects (agency, income, leadership, resources, and time) of women's empowerment at the individual level (Hunger Project, 2015; Nkwake et al., 2017), Women's Empowerment in Agriculture Index (WEAI) to measure the empowerment, agency, and inclusion of women in the agriculture sector, and its subsequent extension to other sectors (Gupta et al., 2019; IFPRI/USAID, 2012), and

the Empowerment in Water, Sanitation and Hygiene Index (EWI) designed by Dickin et al. (2021) to measure agency, participation and empowerment in the water and sanitation sector (WASH), comprising of indicators at individual, household, and societal levels.

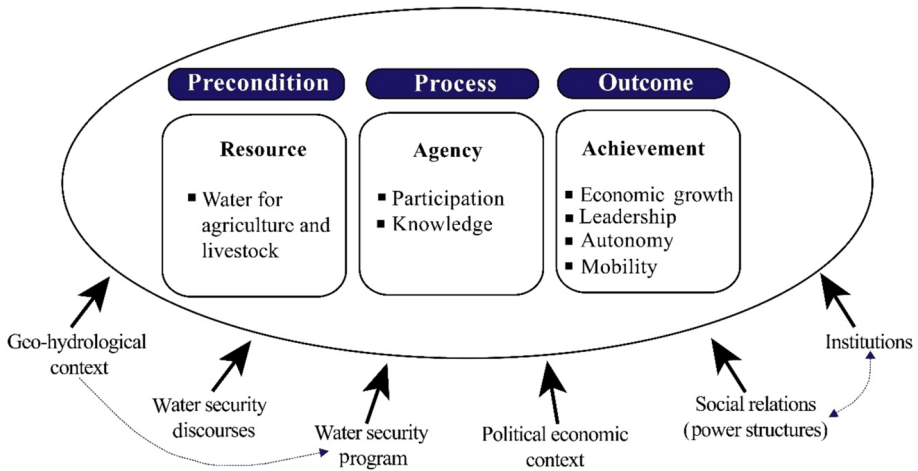
### 2.3 Conceptual framework

For this case study, we adapt the women's empowerment framework proposed by Kabeer (1999) and subsequently adapted in several studies (Clement & Karki, 2018; Leder et al., 2017; Sinharoy et al., 2018) in understanding women's empowerment processes and mechanisms via engaging in water resources institutions. According to Kabeer (1999), the ability to exercise choice incorporates three dynamic inter-related dimensions: Resources, Agency, and Achievements. A priori for empowerment process to begin with is for them to have access to 'resource'. Resources are the medium through which agency is exercised and include: (i) human resources such as schooling attainment, skill development, and self-efficacy; (ii) social resources such as participation in organizations, access to peer networks, and access to role models outside the family; and (iii) economic resources or material assets such as earnings, property, and land. 'Agency' refers to the capacity and process of decision making, with women attaining skills and being able to negotiate and articulate their choices and preferences. 'Achievement' is considered as the results or well-being outcomes.

While using this framework, we contend that understanding or measuring empowerment via women's involvement with water resources and their roles and engagements in water management needs to be viewed as contextual, as identification of issues and solutions would need to be led by women engaging in the process, and women empowerment interventions need to be in alignment with the specific context and informed by context-relevant vulnerabilities faced by women (Cornwall, 2016; Kabeer, 2005). Thus, we consider a set of contextual variables, adapted and modified from Clement and Karki (2018), as shown in Fig. 1, which simultaneously affect women's empowerment, with a particular focus on geo-hydrological context and water security concerns as well as measures, including structural, non-structural and institutional interventions.

Community based water security programs have created a pathway for empowering women. In general terms, the community-based water management organizations (WMOs) are usually formed in different locations beside water streams, increasing mobility among the rural communities. Water availability from these streams or canal network linked with the stream defines the resources for women, and access to these resources is to be assessed from physical, social-economic, and socio-political contexts. Women can develop their capacity through participation in WMOs meetings (being members of WMOs), playing key roles in the decision-making process and operation and maintenance (O&M) of the water control infrastructures, having access to knowledge and a platform for knowledge sharing, and attending training programs and skill development activities. Achievement could be in the form of development of leadership skills and skills in relation to livelihoods, economic growth through numerous WMO activities, increased mobility through going outside for WMO's tasks, and development of autonomy in the process.

However, several variables would mediate the processes and mechanisms around attaining these three important components of women's empowerment. *Institution* is considered as both formal and informal, tacit and written rules and norms that define different forms of social interaction. *Water security discourses* refer to the processes that define actions of certain actors. We considered how discourse affects the design of water security programs



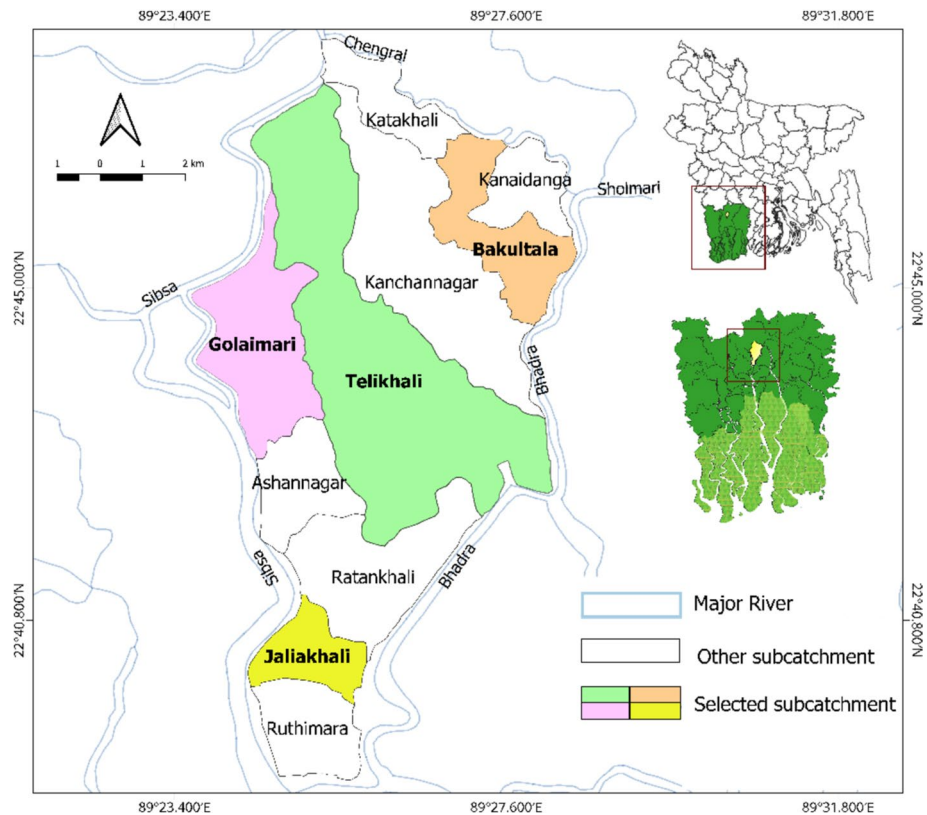
**Fig. 1** Conceptual Framework of women's empowerment via participation in WMOs [Adapted and modified from (Kabeer, 1999) and (Clement & Karki, 2018)]. The framework relies on three major components: resource (availability of and access to freshwater resources for agriculture and livestock, which are the principal water related activities of women); agency (capacity and process of decision making through effective participation); and achievement (well-being outcomes via enhanced economic growth, leadership skill, autonomy, and mobility). A set of contextual variables influence the empowerment components across socio-political, institutional and water security domains

and women's empowerment processes by legitimizing certain actors, practices and institutions while rendering others abnormal, illegal, or invisible. *Water security programs* affect women's empowerment, particularly by enhancing women's access to resources and agencies. *Social relations* are shaped by social variables such as ethnic and/or religious background and social norms. *Geo-hydrological settings* include natural availability of resources and how they are impacted by environmental hazards and disasters. *Socio-political context* reflects the existing power relations in the community, prompted by elite or political dynamics.

### 3 Study area

#### 3.1 Location

The study was conducted in Polder 29 (area encircled by embankment all around) (see Fig. 2), about 75 km north of the Bay of Bengal, covering an area 80 km<sup>2</sup> in five unions (Tier-4 administrative boundary) under Dumuria and Batiaghata Upazilas (sub-districts) of Khulna district, in the southwest coastal zone of Bangladesh. The unions are further divided into 77 mouzas (Tier-5 administrative boundary), providing home to an estimated 17,000 households with a total population of 58,000 (BBS, 2012). The study area is surrounded by tidal rivers on all sides, directly fed by the oceanic tides, and is embanked along the rivers with the provision of drainage structures (sluice gates) to protect the floodplain from saline tidal water inundation and hence improve agricultural productivity.

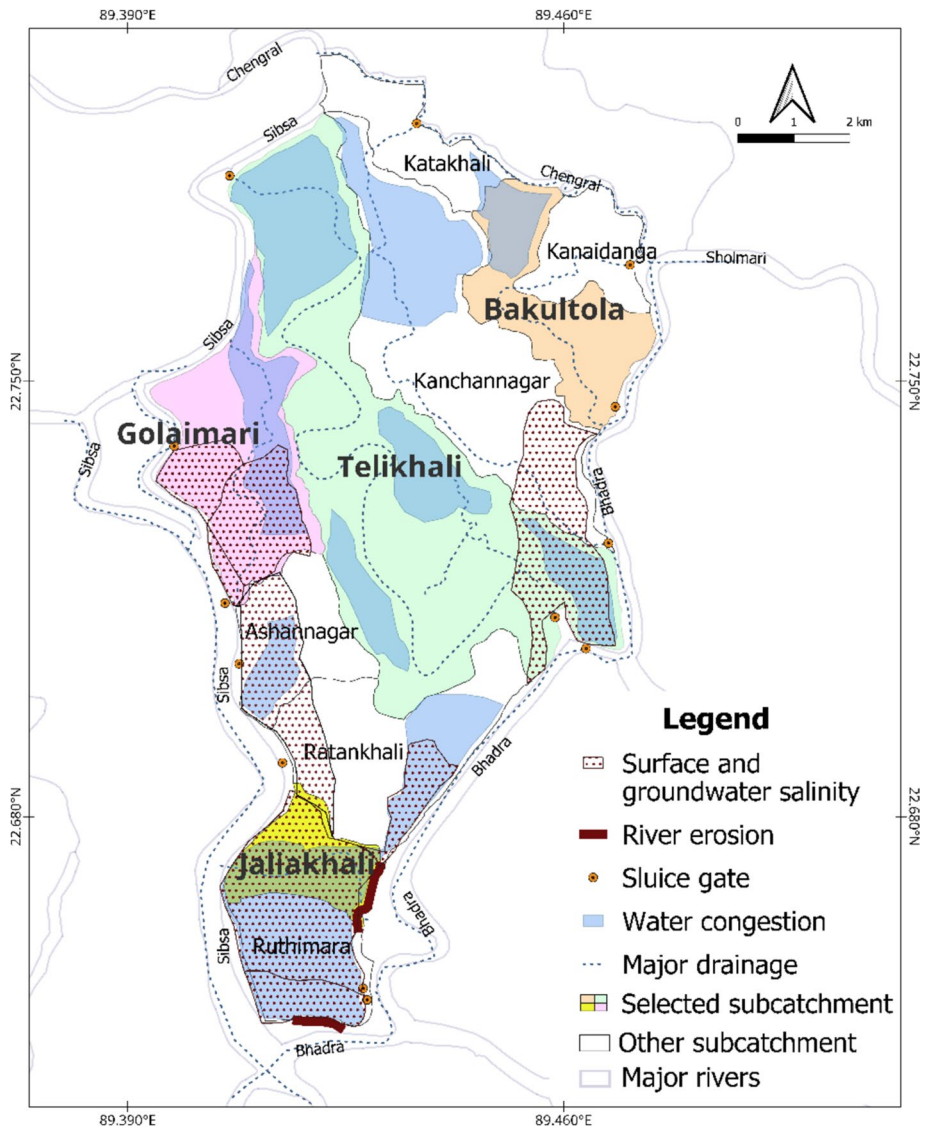


**Fig. 2** Study area in in Khulna district represented as Polder 29, which includes 10 drainage sub-catchments. Four sub-catchments, shown in color, were selected for deep-dive field investigation

Khulna is one of the most vulnerable coastal districts in Bangladesh to environmental hazards, namely saline water intrusion in rivers and groundwater and associated salinization of soils, riverbank erosion, tidal inundation, and cyclonic storm surge, which substantially impact the life and livelihood of the people. Socio-economic vulnerability in the form of high poverty incidence and wealth inequality makes it harder for the people to cope with the stresses. Figure 3 presents a composite hazard map and a number of socio-economic parameters for the study area. As per the 2011 national census, groundwater is the main source of drinking water (about 96%) in this polder, apparently because of high salinity concentrations in surface water sources (BBS, 2012).

### 3.2 Heterogeneity in livelihood and vulnerability to hazard

Polder 29 can be divided into 10 drainage catchments (see Fig. 2) in accordance with the runoff drainage network including canals and drainage regulators/ sluices (Blue Gold, 2016). Field reconnaissance visits and focus group discussions (FGDs) at different locations revealed contrasting geo-hydrological and associated water insecurity characteristics across the catchments. In consideration of similarities and differences, the catchments can be grouped into four categories.



**Fig. 3** Composite hazard map of Polder 29 (prepared from secondary information and primary field data)

### High water stress

Jaliakhali, Ruthimara and Ratankhali sub-catchments (category A) have suffered from riverbank erosion and embankment breaching for at least two decades, resulting in loss of agricultural lands, aggravated by saline tidal flooding and sand carpeting onto the floodplains. Erosion has forced many households to relocate on the stable part of the embankment. High river salinity has rendered moderately to highly saline soils. Besides, many drainage canals are silted up or obstructed by shrimp ghers, causing waterlogging. Salinity in both shallow and deep aquifers has substantially limited drinking water supply. Land use



includes mostly saltwater shrimp farming, exploiting saline river water, and some freshwater shrimp farming in the northern parts (Ratankhali), with better availability of fresh water.

#### **Medium water stress**

Asannagar and Golaimari catchments (category B) are also free from erosion and flooding but are beset by salinity and drainage congestion hazards. Besides, they suffer from canal siltation and loss of hydrological connectivity, especially in the downstream areas, due to encroachment in drainage canals by the shrimp farmers. The land use pattern in these two catchments include freshwater shrimp farming in the upstream and saltwater shrimp farming in the downstream. While groundwater is saline everywhere in the shallow aquifer, the deeper aquifer is saline in Assanagar and mostly fresh in Golaimari catchment.

#### **Low water stress**

Telikhali, Kanchannagar and Katakali sub-catchments (category C) are relatively free from riverbank erosion, flooding and salinity hazards, with less problem of groundwater salinity. However, water management becomes an issue because of canal siltation and hence loss of hydrological connectivity resulting from encroachment and flow obstruction in drainage canals for aquaculture. In contrast to the southern catchments, land use in these areas is dominated by mostly agricultural lands and some mixed farming practices.

#### **Very low water stress**

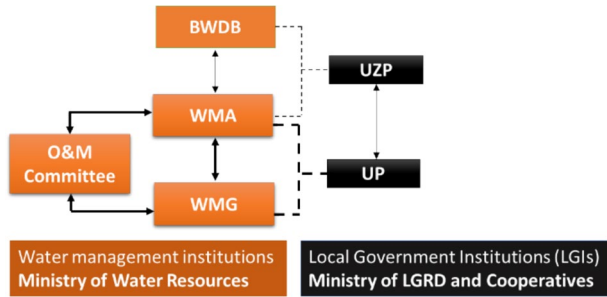
Land use in Bakultala and Kanaidanga sub-catchments (category D) is dominated by small scale freshwater shrimp farming. These areas suffer from drainage congestion to some extent due to canal siltation and lack of hydrological connectivity between the drainage canals and floodplains. These areas are free from natural hazards and drinking water supply constraints.

### **3.3 Community-based water management**

The community-based water management has evolved in Polder-29 in the same way as it did in other areas of coastal region. Bangladesh Water Development Board (BWDB) implemented 'Integrated Planning for Sustainable Water Management' (IPSWAM) program during 2003–2014 following the 'Guidelines for Participatory Water Management (GPWM)' (MoWR, 2001) via stimulating the transfer of responsibilities of O&M to the WMOs, and engaging communities in sustainable socio-economic development activities. This involved community mobilization, formation of clusters of new water management associations at different levels, and structural rehabilitation (mainly regulators/ sluices and drainage canals) (Dewan, 2012; Dewan et al., 2014; Silva, 2012). After IPSWAM, the Blue Gold program of BWDB took over the functionality of the WMOs in selected areas, including Polder 29 (Blue Gold, 2016).

The GPWM specifies water management in three tiers: (i) Water Management Group (WMG) at the lowest tier, i.e., for each small hydrological or social unit (para/village/Mouza); (ii) Water Management Association (WMA) for the mid-level for each subsystem of the project, and (iii) Water Management Federation (WMF) at the apex level of the project (see Fig. 4). Each WMO (i.e., at all 3 tiers) comprises either an elected Management Committee, if registered, or an Executing Committee if un-registered, consisting of 12 members for the former and 11 members for the latter, with at least 30 percent to be represented by women. The tasks and responsibilities include: (i) for WMGs: O&M of the infrastructure, maintaining liaison with the implementing agency, LGIs and NGOs; (ii) for WMAs: preparing budgets, resolving conflicts or issues referred to from WMGs,

**Fig. 4** Institutional structure for water resources management in Polder 29



and liaising with implementing agency; and (iii) for WMFs: liaising with implementing agency, coordinating the functions of various stakeholders in water management, and preparing annual crop production plan, O&M plans and other production plans prepared by WMAs. Representatives from the Local Government Institutions (LGIs) (Union Parishad, Upazilla Parishad, and Zila Parishad) would be advisors of WMG, WMA and WMF and through their respective standing committees would facilitate and coordinate assistance to the concerned WMOs.

The WMAs are expected to coordinate with the O&M subcommittees, formed by the Blue Gold officials comprising of representatives of several WMGs in a single sub-catchment for operating sluice gates and for water allocation through canals between agriculture and fisheries. Such informal management bodies had existed before, known as ‘Beel committee’, formed by BWDB even before the GPWM was introduced and implemented. Its prime mandate in the catchment was defined with respect to the drainage sluice or regulator and their O&M, with the help of a gate operator, locally known as “Khalashi” (Blue Gold, 2021; Blue Gold, 2019). Although this informal body has disappeared in many places, they still exist in some places in the coastal area (Blue Gold, 2021; Blue Gold, 2019), including Polder 29 (Source: KII with BWDB official), albeit with a different composition, dominated by local interest groups, with sluice gates or regulators illegally leased out to them.

## 4 Methods

### 4.1 Investigation of pathways of women empowerment

We examined the pathways of empowerment in varying hydrological settings through qualitative field research. Four sub-catchments (Jaliakhali, Golaimari, Telikhali and Bakultala), one each from the four water stress categories, as explained in Sect. 3.2, were selected for deep-dive investigation. The hypothesis was that the severity of water stress and functionality of water structures play an important role in shaping the ‘access’ component of women’s empowerment. All documented data regarding the composition of the WMOs and the structures were collected from the Blue Gold project officials. The secondary data regarding members of all WMGs of Polder 29 were analyzed in Microsoft Excel in order to find out women’s position in the executive committee.

A set of qualitative data collection tools were used in field investigation, which included a total 22 Focus Group Discussions (FGDs), 21 Key Informants interviews (KIIs) and 42 In-Depth Interviews (IDIs), over a period from October 2019 to January 2020. The

participants were purposively selected for their direct involvement in in-polder water management. Besides, this study also used data from the quantitative household survey (2103 households in 77 Mouzas) conducted under the REACH project (<https://reachwater.org.uk>) between December 2017 and March 2018 in Polder 29, administered with a broader aim to characterize water security risks in the polder.

Among the 21 KIIs, 13 KIIs were done with the Blue Gold projects officials (including the gender coordinator), officials from district BWDB office, and members of the Union Parishad. The rest 8 KIIs were conducted with the women members of the executive committees of the WMGs with a view to obtaining their views about their roles as water managers, their empowerment status, and their challenges and opportunities. All the KIIs lasted for 45 min to one hour, and interviews were recorded with the participants' consent. Among the 22 FGDs, 14 FGDs were conducted with the WMG members in the study area, including both male and female, to learn about issues around community-based water management. The rest 8 FGDs were conducted with the female members of the WMGs from the selected sub-catchments, including those from the executive committee and the general committee. The 42 IDIs were conducted with the women of the WMGs, including general and executive committee members, with a particular focus on deriving estimates of selected indicators for women empowerment. These qualitative data collections covered both the upstream and downstream of each selected sub-catchment, with a view to capturing the hydrological diversity and associated complexities within the sub-catchment that may influence women's empowerment process.

Ethical permission was taken from the participants before conducting each session. The qualitative information was recorded using a tape recorder. The recordings of the FGDs, KIIs and IDIs were documented, and a set of transcripts were prepared. Later the transcripts were further analyzed using a thematic content analysis approach (Braun & Clarke, 2006), which offers versatility in discovering and analyzing qualitative data. The research used an inductive technique, which allowed themes to emerge immediately from the data. For theme analysis, the transcribed data were read and reread to extract deep immersion in the dataset. During this step, notes were collected to capture thoughts and prospective areas of interest related to the study questions, allowing for a thorough knowledge of the contents of each transcript. Following familiarization, initial codes were created manually with Microsoft Excel. The transcribed data were rigorously examined. Key parts related to women's empowerment indicators and other relevant contents were identified and emphasized using various color codes. Following the end of the manual data coding process in the Microsoft Excel, the information were arranged code-wise in Microsoft Word. Based on similarities and patterns found in the data, each code was grouped into a prospective theme. For example, "earning" or "income" was categorized under "achievement". To confirm the themes' authenticity and applicability, they were peer reviewed by the co-researchers.

## 4.2 Quantification of women's empowerment

We note that because of the dynamic nature of the empowerment processes and the changing relationships between the components, it is more practical to evaluate the various components rather than the empowerment process as a whole. Nevertheless, we attempt to get an overall assessment of women's empowerment across different geo-hydrological contexts via a Women's Empowerment Index (WEI), with a view to emphasizing the need for potentially different water security interventions for gendered outcomes in different contexts. We used a total of 7 indicators under three domains (following Kabeer, 1999), shown

in Table 1. The indicators were selected based on previous literature but were corroborated and finalized via FGDs and KIIs. As mentioned earlier, the scores for individual indicators of the WEI were derived from the 42 IDIs conducted in the four selected sub-catchments. A pairwise comparison was also made with the participants in the IDIs for prioritizing the indicators as well as the domains, i.e., for assigning importance weights to the domains and indicators.

At first, individual empowerment indicators (IEIs) were assessed based on the individual scores. Normalization of the indicators was done using the minimum–maximum scaling method to ensure comparability among different indicators. This process converted each indicator to a scale of 0 to 1. For instance, if the woman has control over her income, she gets 1 in the autonomy indicator, or if not, she gets 0. Similarly, each woman was individually scored according to the indicator, and then for each woman, a total score for all the indicators was computed. In addition, each dimensional score was computed by aggregating the indicators within that dimension.

After computing the individual scores, group assessments were conducted for women from each of the sub-catchments using the following equation (Roy et al., 2017):

$$WEI = W_e + W_n(D_a) \quad (1)$$

Where, WEI = Women Empowerment Indices.

$W_e$  = % of women with adequate empowerment.

$W_n$  = % of women without adequate empowerment =  $(1 - W_e)$ .

$D_a$  = % of domain in which disempowered women have adequate empowerment.

## 5 Results

### 5.1 Women's access to water resources and associated challenges

#### 5.1.1 Functionality of water control structures

The use of water by the women in the study area does not end in drinking, cooking, and cleaning. They feed their livestock and water the home garden, which requires a considerable amount of water. Hence, freshwater availability is an important issue for those who sell eggs, chickens, cows, goats, and vegetables from home gardens. Moreover, many women work in their own agricultural land and those who are destitute work in agricultural fields as laborers, suggesting important irrigation water needs for these women. Functionality of water structures, such as sluice gates, regulators, piped inlet structures, and drainage cum irrigation canals, thus are important determinants for women's access to water.

It was found that the sluice gate of Sahash Joikhali WMG in Telikhali sub-catchment (see Fig. 2) had not been functioning for a considerable amount of time, and most of the inlets and outlets were found broken. The irrigation inlet and outlet structures were designed and implemented under the Delta Development Project (DDP) during the entire 1980s (1981–1991). The DDP had focused on rehabilitation of the physical infrastructure, including sluice gates, and construction of additional structures such as irrigation inlets (to allow water in during high tide), complemented by local stakeholders' participation in selecting sites for the structures (Dewan, 2012). Some farmers themselves broke the inlet structures after the DDP, without realizing the importance of the structures. This resulted in drying up of the agricultural area, with farmers dependent on surface water irrigation

**Table 1** Domains and indicators considered in assessing Women's Empowerment Index (WEI)

Domain	Indicators	Description	References
Resource	Sufficient water resources	Sufficient water from pond, river or other resources for fisheries, livestock, and agricultural purposes	Sharaunga et al., 2019
Agency	Participation (membership + decision-making)	Getting membership in WMOs and sole or joint decision making regarding WMOs' activities	Ashrafi & Rahman, 2018
	Knowledge sharing	Women's access to the information shared in training and meetings organized by WMOs	Ashrafi & Rahman, 2018
Achievement	Economic growth	Earning money from agriculture, livestock, and fisheries	Ashrafi & Rahman, 2018; Sraboni et al., 2014
	Leadership skill	Whether women are active members of WMOs who can speak comfortably in public, and also can lead WMOs' small projects like canal excavation	Alkire et al., 2013; Sraboni et al., 2014
	Autonomy	Making their own life choices such as starting own business, sole or joint control over own income, for example purchasing stuff using own money	Ashrafi & Rahman, 2018
	Mobility	Freedom of movement such as whether women are allowed to go to places (market, healthcare, WMOs' meeting) outside the community	Ashrafi & Rahman, 2018

facing water shortage, and in the low-lying areas experiencing water congestion. The monitoring and maintenance of the structures were meant to be done by the O&M subcommittee; however, it was not strong enough (also weakened by lack of funding) to counter the local powerful groups who focus on their own interest.

### 5.1.2 Impact of hazards

Access to freshwater is one of the major concerning issues when it comes to women empowerment. Freshwater accessibility leads them towards productive use of water for better living. As the Gender Coordinator from the Blue Gold program put it,

If they (women) can control water, they can improve their livelihoods.

Low surface water salinity in sub-catchments, such as Bakultala and Golaimari (see Fig. 2), makes it easier for the women to get fresh water from the canals. In contrast, in southern areas such as Jaliakhali sub-catchment (see Fig. 2), the problem of high salinity in both shallow and deep aquifers is compounded by saline tidal water inundation, which makes even pond water saline. Households are forced to buy fresh water for drinking from water vendors, paying \$0.24 for a 20-L gallon. As most of the households are poor, many somehow manage to pay for water for drinking purposes but cannot afford to do so for livestock and for watering home vegetable gardens. As they use saline water instead, their hardship grows even further; the livestock cannot survive in most cases and vegetables do not grow well in saline water. Moreover, women who work in agricultural fields as laborers and who are share-croppers (i.e., who take lease in others' land for crop cultivation) face trouble if surface water is saline, which is compounded by high salinity concentration in both shallow and deep aquifers.

On the other hand, riverbank erosion frequently causes land loss and forces many households to relocate on the stable part of the embankment in Jaliakhali sub-catchment. Erosion also causes loss of productive land for agriculture and livestock farming and disrupts economic growth as well, which are important determinants of women's empowerment.

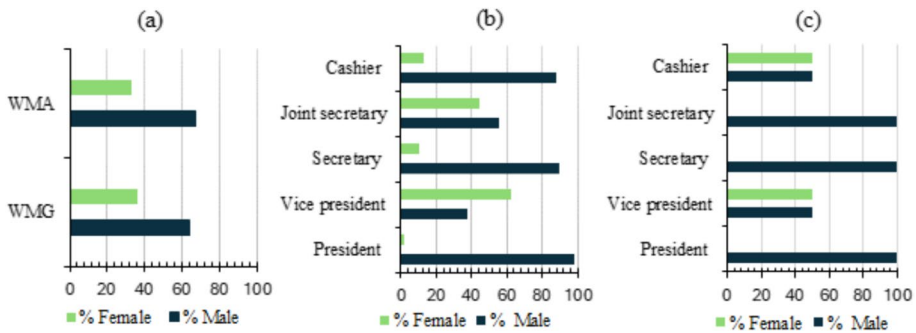
### 5.1.3 Elite pressure

Water allocation via gate operation of the sluice gates is controlled by the politically powerful people who bring in saline water through the gates for saltwater shrimp farming. This negatively impacts the adjacent croplands, substantially reducing the yields, as saltwater increases soil salinity. As males dominate the major positions in the WMGs and comprise 100 percent of O&M subcommittee members, women have no or very little say in water allocation decisions.

## 5.2 Women's agency

### 5.2.1 Memberships in WMOs and participation

At present, there are 56 WMGs in Polder 29 under 2 WMAs (consisting of 23 WMGs at Bakultala sluice and 33 WMG at Chotchatia sluice) with 10 sub-catchment O&M subcommittees for water management (Source: KII with Blue Gold officials). Membership in WMOs and their positions in the committees have been one barrier in women's empowerment, as reflected in Fig. 5. It was found that WMG members were selected by an ad-hoc



**Fig. 5** Women's participation in WMOs in Polder 29: **a** Proportion of total male and total female in 56 WMGs and 2 WMAs; **b** percentage of male and female holding key positions in 56 WMGs; **c** percentage of male and female holding key positions in 2 WMAs (Source: Blue Gold, 2016)

committee which was formed from local elites, LGI representatives and a representative from the BWDB. While most of the WMGs were found to have 30 percent female representation among the total general members and 10 percent female representation among the Executive Committee members, in alignment with the GPWM, the 10 percent key positions given to the women are mostly the positions of Vice-President or Joint Secretary, while positions of President, Secretary and Cashiers/ Treasurers are mostly dominated by males (91%).

This is similar to the general picture in Polders under the Blue Gold Program, which promoted more women in key positions in WMGs (President, Secretary, and Treasurer), using at least 7% as a target. The proportion of women in these positions increased from 6.4% in 2015 to 10.2% in 2021 in Khulna and neighboring Satkhira districts, with the same representing overall 9% among 511 WMGs in Khulna, Satkhira and Patuakhali districts. However, the proportion of female presidents was still small (17 out of 511), while women were better represented as treasurers (95 out of 511, or 19%) (Blue Gold, 2021). The major deterrent in Polder 29 is the fact that selection of the female members in the executive committees was influenced by the local elites in most cases, with the male elites choosing their spouses in those positions, and women elected in the Executive Committee of WMGs being mostly the relatives of the President or Secretary of the WMGs.

## 5.2.2 Women's exclusion as water managers

Community-based water management is based on the theory that communities will manage their resources by themselves as their lives are dependent on it. It was found that the women who work in agricultural field or are directly involved in fishing have better understanding of demand management and allocation of surface water and would work more dedicatedly as water managers. They spend most of the time in agricultural fields or in canals for fishing and for agricultural works like cleaning grass, sowing, and cleaning lichen from canals. When the female joint secretary of the Sundar Mahal WMG was asked if there was any irrigation problem in their area, she did not respond; however, one woman from the general committee replied,

Don't ask her about this. She does not know anything. Ask me. I spend most of the time in the field and I know what the problems are.

In contrast, some other general female members of WMGs were found to be deeply knowledgeable regarding water related problems in their areas. They spoke very clearly and eagerly about the committee activities and water issues. They claimed:

We work hard as laborers in the agricultural field. Just because our skin is sun-tanned, we were not considered in the executive committee. The ad-hoc committee found us not presentable.

The main decisions in the committee meetings are taken by elite males, no matter whatever posts they belong to. The joint secretary position has been mostly ornamental with no major roles, with the positions being filled by the spouses of elite males who do not participate actively in any decision making. In sum, women who are elected in key positions like the Vice-President, the Secretary, or in some cases the Cashier, are in many cases completely ignorant about their tasks and responsibilities, and they have no interests in water management issues and WMGs' activities.

For example, the Joint Secretary of Akra WMG in Jaliakhali catchment is a female, and a tailor by profession. When asked about her position in the committee during the FGD, she appeared to be completely ignorant of what position she was holding, and she had no interest in water related work as it had very little relevance to her livelihood. Her position was influenced by her husband, a local elite, holding a key position in the committee. In several instances, the female spouses of local elites were included in the committee with a goal for them to be nominated for local government elections. This was clear from a female member of a union parishad (UP),

I used to be the joint secretary of Sarafpur WMG. At the beginning I was not interested in being on the committee, but my husband and the school teacher encouraged me to do so. They said if I can be in the WMG, I can be elected in the local election as a UP member. As a result, right now I am the UP member of Sarafpur union.

The O&M subcommittee, the unofficial body formed by BWDB (via Blue Gold project) to work with the WMGs, had poor coordination with them in many cases. Moreover, no woman was found in any O&M subcommittee. This is contrary to the more general picture as evaluated by Blue Gold project, which indicated that among the 511 WMGs surveyed, 17% were women in the O&M subcommittees, who were involved in cleaning khals, in excavation of field channels and in repairs of embankments (Blue Gold, 2021). In Polder 29, major conflicts have stemmed from the control of sluice gates and the drainage canals, with the WMGs yet to get control of sluice gates in several sub-catchments and the LGIs and local powerful groups getting involved in leasing the sluice gate and canals. All this implies that the female farmers and fishers have limited access to decision making in relation to irrigation, but rather are dependent on the decisions made by the O&M subcommittee, or in many cases the beel committee, headed and owned by the local elites. The impact has been more profound on widows and helpless women, whose demands for water mostly remained unfulfilled, with less income from farming, compared to the other women who work with their husbands and sons.

### 5.2.3 Positive impact of inclusion

The positive impact of women's inclusion in WMGs and playing key roles is exhibited well in Kanchannagar WMG, where women held 10 positions in the committee. The committee



was found to be vibrant and very active in conducting regular meetings and collecting funds, led by an efficient female President in Binita Mandal. As Binita Mandal reflects:

The males are not interested in participating in community meetings. They are very lazy. I own a grocery shop and handle household work. I still manage to work and participate in all activities of the WMG. The other women of our WMG are also very regular and active in the meetings. The funds are collected by woman, and they are good at it.

#### **5.2.4 Microcredit or water work: the lost focus**

Strong WMGs form the basis for effective and sustainable water management and ultimately overall polder development (Blue Gold, 2014a, b). A village is considered the best organizational unit for a WMG, as it represents a relatively homogeneous group of households or families that have some cohesion among the different stakeholder groups, with elements of “social control” and “confidence and trust”. The spontaneous development of saving and micro-credit groups as part of the WMG development has been seen as the result and evidence of this conducive environment. In sum, WMGs are thought to be strong and cohesive, having trust for savings, microcredit, income generating activities and business development (Blue Gold, 2014a, b).

While engagement of WMGs in micro-credit activities is important for the sustainability of the WMOs, water management in several cases in Polder 29 has not received as much attention as the economic activities did. This lost focus on water management has left many WMG members unaware of their roles and responsibilities in terms of water management, and many WMGs are locally known as only micro credit business entities. Successfulness of WMGs in many cases is not measured by how excellent water management is, but rather by how much funding has been generated through micro credit business. This has also impacted the women members, with many women attending meetings with only the interest of saving. The capacity development training programs run by the implementing agencies have had limited success in raising awareness of the vision of forming WMOs.

Because of lack of coordination between WMGs and O&M subcommittees, the funds generated by the WMGs are also less frequently used for O&M purposes. The funds for routine O&M are generated by the O&M subcommittees from the farmers and shrimp cultivators by providing them with water. Clearly, fund generation or allocation for O&M should be maintained as the prime mandate of each WMG, along with integration of income generating activities.

### **5.3 Women’s achievements**

#### **5.3.1 Importance of female entrepreneurship**

That if given adequate opportunities women can develop and demonstrate leadership role can be evidenced from the positive changes in them after mobilization of community work. The LCS (landless constructing society) projects can be viewed as a success story in this regard. Some WMGs were given canal digging and road cutting work under the LCS program. One of the WMG members took the lead in handling a project by collecting funds from the donor agency (i.e., BWDB), distributing works to the hired laborers

and completing the project in due time. In Golaimari sub-catchment (see Fig. 2), a canal of 8 km was fully dug by the female laborers and the whole project was handled by Kolpona Rani, who is the Vice President of Chotchotia WMG as well as the executive member of Chotchotia WMA. These types of projects have been implemented in some other sub-catchments as well and women who worked and handled responsibilities from the front demonstrated similar leadership skill. The knowledge, leadership skills and high level of confidence of Kolpona Rani were clearly reflected in her own words:

Women in our WMG are very punctual and hard working. They do not miss any WMG meeting, whereas the males are lazy, walk around doing nothing and do not come to the meetings. They don't bother about committee's activities.

### 5.3.2 Vulnerability due to illiteracy and religious beliefs

Literacy makes a person confident about speaking in public. Many women in the WMGs are illiterate. This makes them feel uncomfortable and uneasy speaking in the meetings. They are afraid of saying anything in public and get ridiculed or scolded on occasions by the male members if what they say are conceived as wrong by the males. A female respondent from Telikhali sub-catchment said:

I do not say anything in the meeting. I am illiterate; I may say something wrong. The male is more educated and knows better than me.

On the positive side, the implementing agencies ran some gender empowerment program during the IPSWAM period, in which women were encouraged to speak confidently in public and the males were asked to encourage them. In some areas the males are found not dominating at all, but rather are very supportive of the women while they spoke, especially in the Hindu dominated areas. But in some areas, for example in Sahash Modhypara of Telikhali sub-catchment where people are mostly from conservative Muslim families, males do not let their spouses speak to trainers in their absence even if the trainers are females. Their religious beliefs prevent them from encouraging the women to come out and speak in public. These women also took it for granted that males should decide everything, and it is not the norm to speak in public when her husband is already speaking there.

### 5.3.3 Capacity building initiatives

Capacity building of the WMOs regarding organizational, technical, and financial aspects is an essential component according to the GPWM (MoWR, 2001). The implementing agencies had run programs in some areas in Polder 29 during the IPSWAM project period, which also included gender empowerment training provided under the direction of the Gender Coordinator of the program. But later on during the Blue Gold program, trainings were principally provided on four aspects, which included O&M, Farmers' Field School (FFS), livestock rearing, and home gardening, but did not include any gender empowerment training per se. The training was organized in all the 10 sub-catchments and was given to some selected WMGs. The O&M training was given to all the members of the executive committee of the WMGs selected for training at the beginning of the Blue Gold Program. The FFS training included a follow up session in which the male spouses of the females were asked if the females shared their knowledge with the males regarding the trainings. The training would be considered effective if the females shared, otherwise a repeat training would be organized by the trainer team.

The training programs have in general improved rural females' skill in growing vegetables and livestock in saline conditions. The females grow vegetables at home in saline soil and sell them in the market. They earn on average \$175 per year by selling chicken, duck, eggs and vegetables, and \$350 per year by selling cows or goats. This has led to improved food security among households with enhanced calorie intake, who previously had faced food shortages because of flooding in agricultural fields and damage to rice paddies. One beneficiary of the trainings reflected:

I had to eat "ata ghoti" (flour boiled and diluted with water). I could not eat much and that is why I had gone to my father's home in another district.

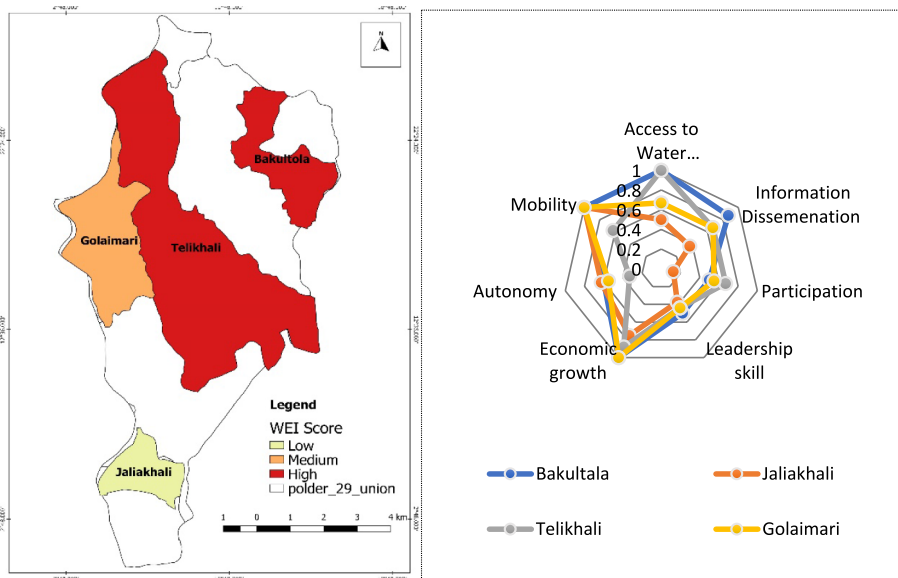
However, there have been some limitations as the livestock and home gardening trainings were given to randomly selected females, rendering many women with poorer background and inflicted by environmental hazards (e.g., salinity intrusion) deprived of the opportunities. For example, women received training in some areas where water problems are not so severe, like in the upstream of Telikhali sub-catchment (the participants even received \$1.2–2.4 per person), while training was limited in Jaliakhali and Golaimari Sub-catchments (see Fig. 2), which suffer from considerable salinity hazard. Women in these areas had expressed their needs earlier as they belong to very poor families and their family incomes largely depend on livestock rearing and home gardening.

## 5.4 Women empowerment across diverse hydrological settings

It is clear from Sects. 4.1 and 4.2 that the indicators and contextual variables, as selected in our conceptual framework (see Fig. 2) indeed have played important roles in shaping women's empowerment. Across the three domains of agency, resources, and achievement, local power structures, socio-political context, and institutions are important factors, and so are geographical locations with context specific water insecurity concerns.

Water issues vary across different hydrological conditions, which directly or indirectly affect different components of women's empowerment, as theorized by the WEI. The four selected sub-catchments have different land use, hydrological and hydrogeological characteristics and are associated with water insecurity stresses in the form of water quality constraints and hazard and/or disaster effects. These, in turn, affect access to water resources and WMG activities linked with water resource use and management, which include hazard management via regular O&M activities and well-maintained water control structures, and agriculture, livestock rearing and home gardening activities of the women. We try to capture how different indicators of empowerment (as discussed in Sect. 3.2) are influenced by varying characteristics of the sub-catchments, as illustrated in Fig. 6.

Women's empowerment is found lowest in Jaliakhali sub-catchment, which is an outcome of combination of multiple factors. It is the most saline prone area, where agriculture is particularly challenging due to salinity both in surface water and groundwater. Crops cannot grow well because of moderately high soil salinity. The empowerment score for access to water resources is thus very poor. There are some saltwater shrimp farming practices, which are largely owned by local elites and politically powerful groups, with the lion's share of profits going into their pockets. There are few shallow tubewells (STWs) and rarely any deep tubewells (DTWs) indicating the trouble women face even in vegetable gardening and livestock rearing due to salinity. This has been the reason for very limited improvement in economic growth. This sub-catchment is also affected by riverbank erosion and tidal flooding. Water management is particularly challenging here, and with most of



**Fig. 6** Women empowerment across diverse geo-hydrological contexts: **a** Women Empower Index estimated for selected sub-catchments **b** Change in women empower indicators

the WMGs inactive, female farmers lead a hard life. They do not hold important positions in the committees and the positions they hold are influenced by local elites. The women also did not receive enough training although they had expressed their desires for the same.

The Golaimari sub-catchment is found to be an area with moderate level of women empowerment. The water insecurity stresses are comparatively less in Golaimari compared to Jaliakhali sub-catchment. While surface water salinity prevails in some parts of the area, the other parts are free from salinity issues, thus allowing the women to get fresh water from the canals. However, the area suffers substantially from problems with canal siltation and low irrigation facility. The WMGs are comparatively more active in Golaimari, with better female participation in important positions in the committees, with an example of a woman Vice-President in one WMG also holding membership in the WMA, as discussed in Sect. 5.1.1. Engagement of women in canal digging and road cutting work under the LCS program in some WMGs (e.g., Chotchotia WMG) contributed to confidence building and enhancement of leadership skills. However, women in other WMGs were not found to be actively participating in WMG activities, and hence leadership skill and participation are overall on the lower side. But women are very mobile in this sub-catchment and are involved in income generating activities, contributing to high economic growth for them.

The Telikhali Sub-catchment, on the other hand, is an area where women's empowerment appeared to be high. The area suffers from less salinity problem, reflected in the presence of comparatively large number of DTWs and STWs, resulting in high empowerment score for access to water resource. Women's economic growth is found to be a dominant indicator in Telikhali, as freshwater is available, and women are actively engaged in vegetable gardening and livestock farming at their homes. Most of the women actively participate in WMG meetings; however, women of Hindu religion are found more active in decision-making process in WMGs than Muslim conservative families, who do not like to take leadership role, especially when their spouses are in the committees, and hence lack

sufficient leadership skill. This has meant that their autonomy and mobility are lower than the women in the other catchments.

In the Bakultala sub-catchment, empowerment ranges are found to be very high, as many WMG committees are highly active. The WMG committees are constantly monitored by the Apex level institutions like BWDB. The WMG members have received all kinds of training from the implementing agencies, and women have higher skills in carrying out organizational activities. Moreover, most WMGs in Bakultala have regular coordination with Blue Gold project officials. However, while the women in Bakultala in general actively participate in the training programs, they are less found in participating in decision making activities. This has meant that the overall leadership and participation are not satisfactory in this subcatchment.

## 6 Discussion: challenges and opportunities for women empowerment

The research findings clearly suggest that women empowerment under community-based water management is influenced by several contextual variables, linked to hydro-social and socio-cultural settings, water security dimensions, and governance structure. This is in alignment with the conceptual framework we presented in Fig. 1. It follows that women empowerment interventions need to be aligned with context-relevant vulnerabilities faced by women. As argued only in few studies (e.g., Clement & Karki, 2018; Kevany & Huisingh, 2013; Sultana, 2015), it is important to pay equal attention to gender and power relations as well as geographical locations with diverse water insecurity stresses. Women's empowerment is contingent upon a combination of factors, and the relative strength or weakness of these factors will determine if their participation remains a case of 'tokenism' or will be uplifted to the level of 'citizen power', as defined by Arnstein (1969) and previously observed by Dewan et al. (2014), or will rotate in the spectrum between the two levels.

This study reinforces the argument offered in previous studies (Dewan et al., 2014; Khandker et al., 2020; Meinzen-Dick & Zwartveen, 1998; Sultana, 2015; Sultana et al., 2022) that mere participation does not necessarily empower women, because of male dominance in decision making and elite influence. In our study, we did not find women's participation to have reached the level of 'citizen power' in any of the sub-catchments we studied, with the level of participation understood to be somewhere in between 'tokenism and 'citizen power'. However, there are some examples of WMGs where women were found to be able to raise their voices and have them reflected in water management decisions, hence resulting in wellbeing outcomes. This insinuates that this may be achievable in other areas with the required and favorable conditions ensured.

The study gives some answers to the questions raised by Clement (2012) and Clement and Karki (2018), which are about representativeness of the disadvantaged groups in the WMOs, the role, responsibility and power of women members in the WMOs, the factors affecting their power, and the impacts on the water use and livelihoods of the non-member women. The study clearly shows that several barriers may prevent women's participation in the WMOs from being translated into effective participation, i.e., having their priorities and opinions reflected in water management decisions. One barrier is the lack of fair selection of female members who are actively involved in water related activities, with local elites having their spouses playing ornamental roles in management decisions. Fair selection of female members for important committee positions, who work in agriculture and/or

fisheries and hence are more interested in water management, may help lessen the barrier. This is likely to pave the way for greater and more active participation of women in the WMG activities, with women who are in actual need being brought into the empowerment process. The other barriers include lack of awareness among women of the purpose and importance of the WMOs that limit their participation, cultural and religious barriers, lack of confidence due to low education level, and difficulty in finding sufficient time because of substantial workloads in the households.

Hydrological setting is an important factor determining the achievement of women's empowerment via creating an enabling environment. The inequality in empowerment process resulted from both natural processes and anthropogenic activities leading to strong hydro-social dynamics, which were considered important determinants in previous studies (e.g., Linton & Budds, 2014; Ruj et al., 2022). Freshwater availability is reduced due to salinity intrusion caused by tidal floods, and agricultural land is also under risk. The saltwater shrimp farming practices largely owned by local elites and politically powerful groups cause enhanced salinization of soils in adjacent lands through seepage. Additionally, flooding and damage to fisheries and agricultural land ensue from riverbank erosion, while the availability of freshwater for fishing and agriculture is constrained by clogged rivers and canals.

Access to water resources is a pre-condition for empowerment process, with interventions against rising surface water salinity, riverbank erosion, tidal flooding, and river and canal siltation being the pre-requisites. In this regard, water security programs need to address protection against these types of hazards, via monitoring, maintenance and rehabilitation of the embankments, excavation of canal and riverbeds, and maintenance of water control structures like inlets and outlets of the sluice gates to control water flow between inside and outside of the polder. Conflicts often are associated with non-functionality and/or inappropriate design and operation of water control systems, and hence maintaining functionality of water management infrastructure system has been considered an important requirement for minimizing conflicts between different livelihood groups and between the elites and marginalized people in the southwest coastal zone (Murshed & Khan, 2009; Rahman & Salehin, 2009; Sultana et al., 1995). This study shows that operation of the water control structures needs to be free from the influence of local elites or powerful groups interested in serving the interests of few, but be managed by mechanisms within the WMGs, thus optimizing benefits for all. In sum, water control structures in poor condition hinder women's empowerment process, while well-maintained and functioning water control structures against complex and difficult environmental stresses provide opportunities for high women's empowerment.

Clearly, knowledge exchange is one of the major pathways for increasing women's livelihood skill as well as boosting their confidence and leadership skill as an individual. As was previously stressed by Clement and Karki (2018), this study clearly showed that boosting confidence and leadership skills of women can be greatly aided by livelihood training as part of water security programs, such as those provided under the Blue Gold program (e.g., FFS), as well as other gender awareness initiatives. Women were found to be more economically empowered and highly competent in fields for which suitable trainings were provided, while women knew less about how to raise cattle better and other income-generating activities in places where training was insufficient. Additionally, these programs have the potential to address the barriers originating from traditional cultural beliefs, including the dominance of men over their female spouses, and the prevalent undermining of women's individuality. As found in this study, this also promotes women's greater mobility and autonomy and enhances their confidence to take an active role in society. Leadership

skills are also developed with the help of training provided by the implementing agencies. These findings echo the observations made in few earlier studies, which emphasized the utmost importance of women's leadership, in some cases a necessary condition, to overcome male-dominance and gendered inequalities for women in the WMOs to be empowered (Adams et al., 2018; Imburgia et al., 2020; Mandara et al., 2017). The WMOs need to have generation and/or allocation of funds for O&M, along with the overall development and income generating activities, including microcredit, to facilitate the process. This study clearly revealed the importance of having women with leadership skills in important positions of the WMOs for women to have stronger voices, with better opportunities for self-empowerment and contributing to better project outcomes.

In addition, we cannot disregard the fact that development activities like industrialization, improvements made in road network, and the growth of market and medical facilities are indirectly fostering accessibility to contemporary information. A better road system facilitates communication, which helps to provide training facilities and greater coordination with the apex level institutions; a market allows for business growth; and enhanced medical facilities open chances for access to greater information on health and lifestyle.

## 7 Conclusions

The efforts by water project implementers in Bangladesh towards women empowerment are considerable and have contributed to moderate to high levels of empowerment in some areas, while low empowerment prevailed in areas beset by water insecurity issues and contributed by socio-political, hydro-social, and governance processes. Multiple factors collectively influence the empowerment of women. Across the three domains of agency, resources, and achievement, a set of contextual variables encompassing both socio-political as well as natural and hydro-social processes influence women's effective participation and empowerment outcomes. In other words, local power structures, socio-political context, and institutions are important determinants and so are geographical locations with context specific water insecurity concerns. Whether participation would be translated into empowerment will depend particularly on fair selection of female members who are actively involved in water related activities in important positions in the WMOs, to what extent the positions are free from elite influence, awareness among women of the purpose and importance of the WMOs, cultural and religious barriers, and the level of women's confidence. In most cases, a large proportion of women engage in livelihood activities involving agriculture, livestock husbandry, and fisheries, which are contingent upon sustainable water supply and freshwater resources. The varying hydrological conditions in different areas play an important role in influencing women's empowerment. It principally affects 'access', an important dimension of women's empowerment. Water insecurity resulting from unavailability of resources (due to salinity intrusion, tidal/ storm surge flooding, water congestion, and riverbank erosion), varies with space and have differential impacts on access. This is exacerbated by saltwater shrimp farming by local elites or powerful groups having control on the hydraulic intervention and operation of water control structures.

Thus, an important policy relevant key message is that considering context specific hydrological and hydro-social barriers or challenges while designing water security programs will be of utmost importance for creating an enabling environment for women's empowerment process. The Blue Gold project of the government exemplifies that empowerment of women via participation in community-based water management

is achievable through intensive water security programs with a focus on gendered outcomes, by ensuring the required and favorable conditions in terms of socio-political and natural systems context. It will require ensuring fair selection of women in the influential positions in the WMOs by breaking the stereotypes of elite influence (an essential aspect or a pre-requisite), supported by leadership enhancing programs, and well-maintained and functioning water control structures (e.g., embankments, regulators or sluice gates, and drainage and/or irrigation canals) against complex and difficult environmental stresses. There is no denying that lack of water restricts both financial and social empowerment. Under these conditions, the water security interventions undertaken by non-government organizations (NGOs) and government organizations (GOs) are becoming increasingly intertwined with the process of women's empowerment. Numerous initiatives have already been taken to empower women through improved water security, enhanced knowledge, and enhanced livelihood skills. Institutional coordination through inclusion of women's empowerment team in the mainstream government or non-government institutions is important to facilitate, monitor and evaluate women's empowerment activities.

Moreover, the study clearly shows that carefully designed water security interventions can create a byproduct in the form of acceleration of the empowerment process by disseminating information about the social status of women, while doing away with male dominance in order to do justice for women for the betterment of society. The study also demonstrates that empowerment measurement tools can be very useful for gaining a detailed understanding of the process and its associated drivers and stressors, as well as for identifying and prioritizing intervention areas. They can potentially assist in identifying crucial areas for continued development initiatives. In line with the observation of McLafferty (2002), delineation of empowerment indexes along with different component domains and indicators with the help of visual tools such as the Geographic Information Systems (GIS) can emphasize the significance of spatial context, or the anchoring of women's experiences and interactions in time and space and help identify priority interventions across different geographical regions for policy makers. Future studies can focus on further development and refinement of such empowerment measurement tools, with inclusion of context specific indicators and variables which may be different in other settings. This study suggests an uninterrupted institutional mechanism, with the help of a women's empowerment team included in the mainstream government or non-government institutions, to continuously monitor and evaluate the women's empowerment activities. This will be particularly important during the period after the completion of the projects (such as Blue Gold in this case), with limited monitoring or mentoring of the WMOs by the project authorities thereafter. This should be studied in depth across different socio-hydrological settings in the coastal area.

**Acknowledgements** This document is an output from the REACH: Improving Water Security for the Poor project, which is a nine-year program (2015–2024) led by Oxford University with an international consortium of partners and funded by UK Aid from the UK Foreign, Commonwealth and Development Office (FCDO) for the benefit of developing countries (Program Code 201880). However, the views expressed, and information contained in it are not necessarily those of or approved by FCDO, which accepts no responsibility for such views or information, or any reliance placed on them.

**Funding** The Funding was provided by UK Foreign, Commonwealth and Development Office (FCDO), Program Code 201880

**Data availability** The data will be made available upon request.



## Declarations

**Conflict of interest** No real or perceived financial conflicts of interest for any author. No affiliations for any author that may be perceived as having a conflict of interest concerning the results of this paper.

**Ethical approval** Not applicable.

**Consent to participate** Informed consent was obtained from all sources included in the study

**Consent for publication** Not applicable.

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