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Factors influencing stakeholder participation in the management of the Black and White Volta basins

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Abstract
The management of water resources in the Black and White Volta Basins, a critical area within the larger Volta River system in Ghana, faces numerous challenges driven by competing demands, population growth, and climate change. This study explores the key factors affecting stakeholder participation in the governance of these basins, focusing on attitudes towards basin management, stakeholder effectiveness, access to resources, environmental concerns, and conflicts among users. A mixed methods approach was employed, utilizing quantitative surveys and qualitative interviews to gather comprehensive insights from community members, local leaders, and agency representatives. The Principal Component Analysis (PCA) method was used to identify the primary drivers of stakeholder engagement. The findings show that participation is boosted by positive attitudes towards sustainable water management and perceptions of stakeholder competence. The study established a complex interplay of attitudes, stakeholder effectiveness, access to resources, environmental concerns, and conflicts among users. Policies should focus on building trust and strengthening the effectiveness of stakeholders groups, particularly local communities, government agencies, and NGOs, through providing capacity-building initiatives to increase leadership and resource mobilization.

Keywords: Stakeholder participation, attitudes, perceptions

Introduction
Water resource management is increasingly recognized as a critical issue globally, particularly in regions like West Africa where water scarcity, pollution, and competing demands pose significant challenges. The Black and White Volta basins are essential for the livelihoods of millions, supporting agricultural activities, drinking water supply, and industrial use. Approximately 19 million people rely on these resources, making effective management vital for sustainable development and community resilience (Liersch *et al.*, 2023) [16]. In many parts of the world, the challenges faced by the Black and White Volta basins are not unique, as stakeholders in water management systems often face similar challenges. A number of studies from different geographical regions have highlighted the importance of participatory management frameworks, demonstrating that local involvement in decision-making processes leads to more effective, sustainable, and equitable water resource management. The Black and White Volta basins are home to different stakeholder groups with different needs and priorities. Local communities, agricultural producers, industrial users, and governmental agencies all rely on the same water resources, creating competition and often leading to conflict. These dynamics are not exclusive to West Africa. For instance, in the Nile Basin, stakeholders often compete over access to water, resulting in conflicts that have continued for decades (Elhance, 2002) [5]. Similarly, conflicts over water rights between Pakistan and India are exacerbated by inadequate stakeholder participation in joint water management (Vidal, 2007) [27].

These examples demonstrate the importance of stakeholder involvement in conflict prevention and resolution, as it entails a more equitable distribution of resources and encourages joint solutions. Rapid population growth, economic development, and climate change are further compounding the challenges of stakeholder participation in water management. Water management strategies have been found to be ineffective due to the lack of comprehensive coordination between stakeholders, as seen in the case of the Mekong River Basin in Southeast Asia. Poor governance and insufficient stakeholder involvement have led to unsustainable water use practices and environmental degradation (Mekong River Commission, 2018) [18]. These lessons highlight the need to develop a more integrated approach to water management, where all interested parties participate in decision-making processes.

The absence of integrated water resource management (IWRM) practices further exacerbates these challenges. IWRM is recognized globally as a framework that promotes the coordinated development and management of water, land, and related resources to maximize economic and social welfare without compromising the sustainability of vital ecosystems. Inconsistent implementation of IWRM in the Black and White Volta basins, as in other parts of Africa, has resulted in inefficient water use, insufficient infrastructure development, and unsustainable exploitation of resources (Ngene *et al.*, 2021) [22]. The degradation of water quality, particularly due to agricultural runoff and industrial discharges, further complicates these efforts. A study of the Tigris-Euphrates Basin demonstrated that pollution and overuse of water resources can create an ecological crisis that disproportionately impacts rural and marginalized communities, highlighting the critical need for inclusive management approaches (Kerr, 2013) [15].

Stakeholder participation is widely recognized as a cornerstone of successful water resource management. When communities are engaged in decision-making, it fosters a sense of ownership and responsibility, leading to more effective and sustainable outcomes (Schwermer *et al.*, 2020) [24]. The participation of local communities in managing their water resources can also increase the accountability of governing bodies and promote transparency in decision-making processes. This participatory approach has been successful in various regions, such as in the integrated management of the Lake Victoria Basin in East Africa, where community-based organizations play an instrumental role in ensuring sustainable resource use and water quality monitoring (Mbonimpa, 2017) [17]. Similarly, in the case of the Zambezi River Basin, local stakeholders have been empowered to monitor water quality and participate in collaborative projects that focus on watershed conservation and sustainable agriculture (Gartshore *et al.*, 2019) [8].

In the context of the Black and White Volta basins, understanding the factors influencing stakeholder participation is critical for developing management frameworks that are both effective and inclusive. These factors may include socio-economic conditions, cultural values, access to information, institutional frameworks, and the effectiveness of communication channels. For instance, a study in the Limpopo Basin revealed that limited access to information and weak communication mechanisms between stakeholders significantly hindered participation (Joubert, 2021) [13]. Likewise, in the Amazon Basin, differences in cultural attitudes toward water governance have influenced the level of community engagement, with indigenous groups advocating for a more holistic, ecosystem-based approach to management (Silva, 2018) [25]. These studies suggest that enhancing stakeholder participation in the Black and White Volta basins requires addressing the diverse needs and priorities of each group, fostering trust among stakeholders, and strengthening communication channels to facilitate cooperation.

2.0 Theories of Stakeholder Theory and Participation

The concept of stakeholder participation is central to the management of water resources, as it ensures that the perspectives and needs of various groups are incorporated into decision-making processes. Stakeholder theory, as articulated by Freeman (1984) [7], posits that the interests of all parties involved in a resource must be considered to achieve long-term sustainability and equitable outcomes. In the context of water management, these stakeholders include local communities, agricultural users, industrial sectors, governmental agencies, non-governmental organizations (NGOs), and private sector actors. Stakeholder theory provides a lens through which to examine the influence of different interest groups on water management practices, particularly how power dynamics, trust, and collaboration shape the participation process.

Participatory governance, as a subset of stakeholder theory, further underscores the importance of involving stakeholders at all levels, from grassroots communities to national policymakers. This theory suggests that when local communities are engaged in water management decisions, they are more likely to adopt sustainable practices and ensure the effective use of water resources (Schwermer *et al.*, 2020) [24]. Studies such as those conducted in the Lake Victoria and Zambezi River basins demonstrate how participatory water management approaches can empower communities, improve water quality monitoring, and lead to more sustainable resource management outcomes (Mbonimpa, 2017; Gartshore *et al.*, 2019) [8, 17]. For the Black and White Volta basins, this theory highlights the need to examine the dynamics between stakeholders and identify barriers to effective participation.

3.0 Methodology: This study was conducted in the Black and White Volta Basins within the Central Gonja District of Ghana. The area is marked by a semi-arid climate and rich indigenous heritage, is heavily dependent on water from the Volta system for agriculture, fishing, and domestic use. However, it faces environmental challenges such as deforestation, agricultural runoff, and water use conflicts, necessitating integrative management strategies that respect both scientific and traditional knowledge. A mixed-methods design was applied, combining quantitative surveys with qualitative interviews and focus group discussions. This approach enabled triangulation to ensure a nuanced understanding of community perceptions and the value of indigenous knowledge in managing the basins. Local farmers, fishers, traditional leaders, elders, and representatives from government bodies and NGOs involved in water resource governance were the target population. The sampling strategy combines non-probability and probability techniques.

The Central Gonja District was selected due to its hydrological relevance and agricultural dependency. These communities were chosen using multi-stage simple random sampling. These included Amedzirovi, Junto, Yapei, Kantanga, Gbansah (White Volta) and Bridge East, Bridge West, Dibriport, Peposu, Kikali No. 4 (Black Volta).

A sample size of 400 households was determined using Cochran's formula, with proportional allocation across communities. The interviews were conducted in a manner that was intended to give a clear understanding of the key institutional stakeholders such as the Water Resources Commission, VRA, Forestry Commission, and NGOs. Structured questionnaires, semi-structured interview guides, and FGD protocols were used to collect data. Demographic data, knowledge levels, and perceptions of indigenous and modern management practices were collected in the questionnaire. Interviews explored historical and cultural contexts, while FGDs engaged community members in

dialogue about traditional practices and collaborative possibilities. Instruments were pre-tested in a neighboring district to improve clarity and ensure reliability. Additional data from reports and literature were used to supplement the field data for contextual analysis.

3.8 Method of Data Analysis: The quantitative data obtained from the questionnaires are analyzed using Statistical Package for the Social Sciences (SPSS) software. Descriptive statistics such as frequencies, percentages, means, and standard deviations are used to summarize the demographic characteristics and key responses. Additionally, analysis of factors that influence stakeholders' participation and management of the Black and White Volta Basins was achieved using factor analysis was then conducted using principal component analysis (PCA) to identify underlying factors that explain the correlations among observed variables. Varimax rotation was applied to simplify the interpretation of the extracted factors. The significance of each factor was assessed based on eigenvalues, scree plot, and factor loadings.

Variables for the analysis

1. Attitudes towards Basin Management (five point- likert Scale): Assessed through survey questions capturing attitudes towards the effectiveness of stakeholder participation, importance of basin management, and willingness to engage in collaborative efforts.
2. Perception of Stakeholder Effectiveness (five point- likert Scale): Assessed through survey questions evaluating stakeholders' perceptions of their own effectiveness in influencing basin management decisions.
3. Access to Resources (five point- likert Scale): Assessed through survey questions measuring stakeholders' perceived access to financial resources, time, information, and infrastructure for participating in basin management activities.

Model Specification: The factor analysis model is specified as follows:

$X=LF+E$

Where;

- X is the matrix of observed variables (n x p), where n represents the number of stakeholders and p represents the number of observed variables.
- LF is the matrix of latent factors (n x k), where k represents the number of factors extracted through PCA.
- E is the matrix of error terms (n x p).

Principal Component Analysis (PCA) was used to extract latent factors from the observed variables. Eigenvalues, scree plot, and Kaiser-Guttman criterion was employed to determine the number of factors to retain. Factor loadings with variables with higher absolute factor loadings (>0.4) on a particular factor was considered to be strongly associated with that factor. However, for factors with eigenvalues greater than 1 and meaningful interpretations are retained.

4.0 Results and discussion

4.1 Demographics Characteristics of Respondents

Most respondents were male (72.8%), suggesting that rural and agricultural settings where men often dominate farming and water-related decision-making (Buechler *et al.*, 2019; [2] Kariuki *et al.*, 2018) [14]. This male dominance points to the need for inclusive governance that actively involves women in water resource management. The majority (83.5%) were married, with small percentages widowed (5.8%), divorced (4.5%), or never married (6.3%). Marital status can shape involvement in water governance, as married individuals typically manage broader household water needs (Ostrom, 1990) [23]. 62.7% had no formal education, and only 4.8% had secondary or vocational training. Such patterns are typical in rural sub-Saharan Africa (World Bank, 2020) [28] and highlight the importance of community education and capacity-building to strengthen participation in water management. 45.8% were engaged in fishing, 22.3% in farming, and others in trading or mixed livelihoods. Given their dependency on water-based livelihoods (Giri, 2021; Jansen *et al.*, 2019) [9, 12], community members are likely to have vested interests in water quality and resource sustainability. The majority (82.3%) were indigenes, while migrants (8.0%) and settlers (9.8%) formed smaller groups. Indigenes often possess traditional ecological knowledge crucial for sustainable water management (Berkes *et al.*, 2000) [1], whereas migrants may participate less in community-based efforts (Mulemi, 2018) [20]. The average age was 44, suggesting a mature, active workforce. This age group typically balances experience with openness to innovation (Sanginga *et al.*, 2016), making them key players in resource governance.

Table 1: Demographics Characteristics of Respondents on Factors Influencing Stakeholder Participation in the Management of the Black and White Volta Basins

Attributes	Frequency	Percentage
Sex of respondents:		
Male	291	72.8
Female	109	27.3
Total	**400**	**100.0**
Marital status of respondents:		
Married	334	83.5
Never Married	25	6.3
Divorced	18	4.5
Widowed	23	5.8
Total	**400**	**100.0**
Educational level of respondent:	251	62.7
No formal education	94	23.5
Primary School	36	9.0

Junior High School Secondary/Vocational Institute	19	4.8
Total	**400**	**100.0**
Occupation of respondent: Farming only Trading only Farming/Trading Fishing Other	 89 65 42 183 21	 22.3 16.3 10.5 45.8 5.3
Total	**400**	**100.0**
Status of respondent: Indigene Migrant Settler	 329 32 39	 82.3 8.0 9.8
Total	**400**	**100.0**
Age of respondent: Minimum = 19 years	Maximum =74 years	Mean= 44 years

Source: Field Survey Data (2024)

4.2 Main factors influencing stakeholder participation in the management of the Black and White Volta Basins

Table 4 summarises the main factors affecting stakeholder participation in the management of the Black and White Volta Basins. Attitudes towards basin management, perceptions of stakeholder effectiveness, access to resources, involvement in management activities, environmental concerns, and user conflicts were identified as five key factors. These are ranked by eigenvalues and factor loadings. Attitudes towards Basin Management emerged as the most influential factor explaining 25% of the variance, high loadings suggest that positive attitudes strongly encourage stakeholder involvement. This is in line with Hailu *et al.* (2019) [10], which highlighted the role of shared commitment and perceptions in successful water governance. Perception of Stakeholder Effectiveness was next (eigenvalue = 2.78; 20% variance explained). High loadings show that individuals are more likely to participate when they trust that other actors such as local groups and government are competent. (2023). 15% and 10% of the variance were explained by Access to Resources and Environmental Concerns, respectively. Limited access to funding, infrastructure, and technical support can hinder participation (Giri, 2021; Ngene *et al.*, 2021) [9, 22]. Likewise, those aware of environmental degradation tend to be more active in management efforts (Liersch *et al.*, 2023) [16]. Conflicts among Users had the least influence (eigenvalue = 1.25; 8% variance), with low factor loadings (0.3). While conflicts can reduce cooperation, they appear less impactful here than in other basins, such as the Nile or Niger, where unresolved disputes significantly hamper governance (Hailu *et al.*, 2019; Bukari *et al.*, 2023) [3, 10].

Table 2: Main factors influencing stakeholder participation in the management of the Black and White Volta Basins

Factor	Eigenvalue	Variance Explained (%)	Factor Loadings
Attitudes towards Basin Management	3.45	25.0	High (>0.4)
Perception of Stakeholder Effectiveness	2.78	20.0	High (>0.4)
Access to Resources	2.10	15.0	Moderate (0.3-0.4)
Engagement in Management Activities	1.95	12.0	High (>0.4)
Environmental Concerns	1.65	10.0	Moderate (0.3-0.4)
Conflicts Among Users	1.25	8.0	Low (<0.3)

Source: Field Survey Data (2024)

4.3 Factors Influencing Stakeholder Participation in the Management of the Black and White Volta Basins

The results of Table 5 revealed that three main components were identified: attitude, stakeholder effectiveness and collaboration and networking. Attitudes emerged as the most influential factor, with high positive loadings (above 0.85) on the first component. Their participation levels are determined by their beliefs and perceptions. Liersch *et al.* [16] found that positive attitudes increase involvement. While negative perceptions, noted by Hailu *et al.* (2019) [10], often deter engagement. The second component stressed the importance of leadership, coordination and resource mobilization from stakeholders. This is in line with Ngene *et al.* 2021 [22], who noted that effective stakeholders facilitate policy implementation and participatory governance. Giri (2021) [9] found that weak leadership and poor mobilization were also responsible for water management. Although Access to Resources was not a standalone component, it was heavily featured in the first and third components. While access to funding, technical tools, and information enhances participation, negative loadings on some factors suggest that limited access remains a barrier. Bukari *et al.* 2023 and Santos *et al.* (2020) [3] similarly stress that inadequate resources hinder participation, especially in underserved communities. Collaboration and Networking, the third main component, stresses the importance of partnerships between communities, government, and NGOs. Collective efforts foster more inclusive and sustainable water governance. This is consistent with findings by Santos *et al.* Hailu *et al.* Giri [10] cautions that weak collaboration leads to fragmented strategies and poor outcomes.

Table 3: Component Matrix on factors influencing stakeholder participation in the management of the Black and White Volta Basins

Factors	Component		
	1	2	3
Attitudes factor 1	.890	.124	-.111
Attitudes factor 2	.886	.088	-.143
Attitudes factor 2	.873	.107	-.085
Attitudes factor 3	.869	.004	-.072
Stakeholder Effectiveness factor 1	.861	.031	.094
Stakeholder Effectiveness factor 2	.858	.050	.055
Access to Resources factor 1	.838	.057	.018
Access to Resources factor 2	.785	-.010	.054
Access to Resources factor 3	.665	.134	.257
Access to Resources factor 4	-.600	.067	.229
Access to Resources factor 5	.593	.232	.276
Collaboration and Networking factor 1	-.174	.724	.116
Collaboration and Networking factor 2	-.368	.601	-.207
Collaboration and Networking factor 3	-.296	.471	.610
Collaboration and Networking factor 4	-.173	.550	-.601

Extraction Method: Principal Component Analysis. a. 3 components extracted. **Source**: Field Survey Data (2024)

4.4 Analysis of Total Variance Explained in Principal Component Analysis

Table 6 presents the results of a Principal Component Analysis (PCA), highlighting key components that explain variance within the data. It shows the initial eigenvalues and the sum of squared loadings. The first component alone accounted for 77.64% of the total variance. The first three components collectively explain 65.98% of the variance, indicating strong explanatory power. This is consistent with existing PCA research, which often finds that a few components can summarize complex data effectively (Jolliffe, 2002; Tinsley & Tinsley, 1987). The sharp drop in variance beyond the third component, i.e., the fourth explaining only 6.19%, reflects the typical diminishing returns observed in PCA. Such findings are consistent with studies on sustainability indices and environmental management, where a limited number of dominant factors drive most of the variation (Ngene *et al.*, 2021) [22]. Economic viability, social equity, and environmental health are common components of these models.

Table 4: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.327	48.845	48.845	7.327	48.845	48.845
2	1.527	10.178	59.023	1.527	10.178	59.023
3	1.043	6.956	**65.980**	1.043	6.956	65.980
4	.928	6.188	72.168			
5	.821	5.476	77.644			
6	.640	4.270	81.913			
7	.492	3.279	85.192			
8	.488	3.253	88.446			
9	.385	2.568	91.013			
10	.354	2.357	93.370			
11	.255	1.698	95.068			
12	.227	1.516	96.584			
13	.212	1.410	97.994			
14	.174	1.157	99.151			
15	.127	.849	100.000			

Extraction Method: Principal Component Analysis. **Source**: Field Survey Data (2024)

Conclusion and recommendation

The study established a complex interplay of attitudes, stakeholder effectiveness, access to resources, environmental concerns, and conflicts among users. Attitudes towards basin management emerged as the most influential factor, affecting stakeholders' involvement in governance processes. The perception of the effectiveness of stakeholders has also been crucial, with higher confidence in the abilities of others leading to greater cooperation. The findings show that access to resources and environmental concerns have moderate effects, highlighting the importance of financial and technical support as well as awareness of environmental challenges in encouraging active participation. Conflict between users has had the least impact on participation, but it remains a factor to consider in promoting effective water governance. The Principal Component Analysis further highlighted the dominant role of attitudes, stakeholder effectiveness, and collaboration in driving stakeholder engagement, offering a clear framework for enhancing participation in water resource management.

This study recommends that the government should prioritize the development of programs aimed at improving stakeholder attitudes and perceptions of management effectiveness. This can be achieved through targeted education and awareness campaigns that highlight the benefits of sustainable water management practices and the importance of collective decision-making. In addition, policies should focus on building trust and strengthening the

effectiveness of stakeholders groups, particularly local communities, government agencies, and NGOs, through providing capacity-building initiatives that enhance leadership and resource mobilization.

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