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Monitoring Water Quality Based on Community Perception In the Northwest Region of Bangladesh.

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Abstract

Water bodies are one of the essential components of the urban community. The pollution of surface and groundwater bodies will significantly hamper the ecosystem and reduce environmental sustainability. Rajshahi city stands beside the river of Padma and one of the primary sources of freshwater in Bangladesh's northwest region. Rapid urban growth of Rajshahi city in the last few decades causes several environmental problems, pollution of surface water, and groundwater. The study examines and maps the ground and surface water quality of Rajshahi city based on community perception using Geographic Information System (GIS). Finally, considering the viewpoints given by the community people and city officials, the study proposed useful strategies to control water pollution and ensure an integrated water resource management (IWRM) plan for Rajshahi city. Based on a structural questionnaire, 300 samples were obtained from 30 wards of with a 95% confidence level and 5% confidence intervals. Along with, two focus group discussions (FGD) and 20 key informants, interviews (KII) were conducted to control water pollution and develop strategies for IWRM plan. The result indicates that groundwater is iron contaminated, and more than 80% of the respondents ensure this water creates skin and hair diseases. Moreover, the supply water treated from the Padma River, which is regularly contaminated with residential and commercial waste materials, household sanitation waste and so on. Proper monitoring systems and awareness in the community level will significantly help to minimize this problem. The city authority, policymakers, and urban planners need to ensure water quality management awareness through the campaign, workshops, education, and regular monitoring. The research will help policymakers to identify effective strategies for ensuring sustainable IWRM plan for this growing city.

Keywords: water quality, community perception, surface water, ground water and water management.

I. Introduction

Access to safe drinking water plays a significant role in the development of a nation's stable position. For improving the public health of a country, water also plays an important role. Due to rising populations, water use has been increasing day by day. In Rajshahi City, RWASA (Rajshahi Water Supply & Sewerage Authority) supplies water to serve the needs of water consumption through a Rajshahi City Corporation (RCC) distribution infrastructure. Rajshahi WASA was founded in 2013 in order to overcome the water crisis. But WASA is incapable of providing water of good quality. Although, contrary to the perception of the population, the quality is diminishing due to some circumstances. So, many water-borne diseases are affecting the inhabitants of this area. The World Health Organization (WHO) reports that water containing multiple kinds of impurities from various sources causes different types of waterborne diseases, and every year millions of people suffer from these diseases due to impure water resources. Moreover, consumers worry about the consistency of water. To determine the various issues with water

quality, the primary purpose of this research is mapping the ground and surface water quality of Rajshahi city based on community perception collected from questionnaire survey (QSs), focus group discussion (FGDs), and key informant interviews (KIIs). Additionally, The study also proposed effective water quality management techniques by ensuring an integrated water resource management (IWRM) system for Rajshahi city.

II. Material And Methods

Study Area Profile

The Rajshahi City Corporation (RCC) is located on the Padma River coasts in the northwest region of Bangladesh (Fig. 1). The RCC area is divided into 30 Wards (Ward is the lowest level of administration in the Bangladesh city corporation area) and is densely populated with a total population of 926,000 in 145,482 households (8900 people/ km^2). The water supply and management system in the city is now regulated by the Rajshahi Water and Sanitation Authority (RWASA) and provides 72 million liters of groundwater a day out of the existing 135 million liters of demand. Here, population increases day by day, and by 2020 demand will climb to 165 million liters, which will account for just 36% of the overall water supply. (RDA 2002; Ali 2016)

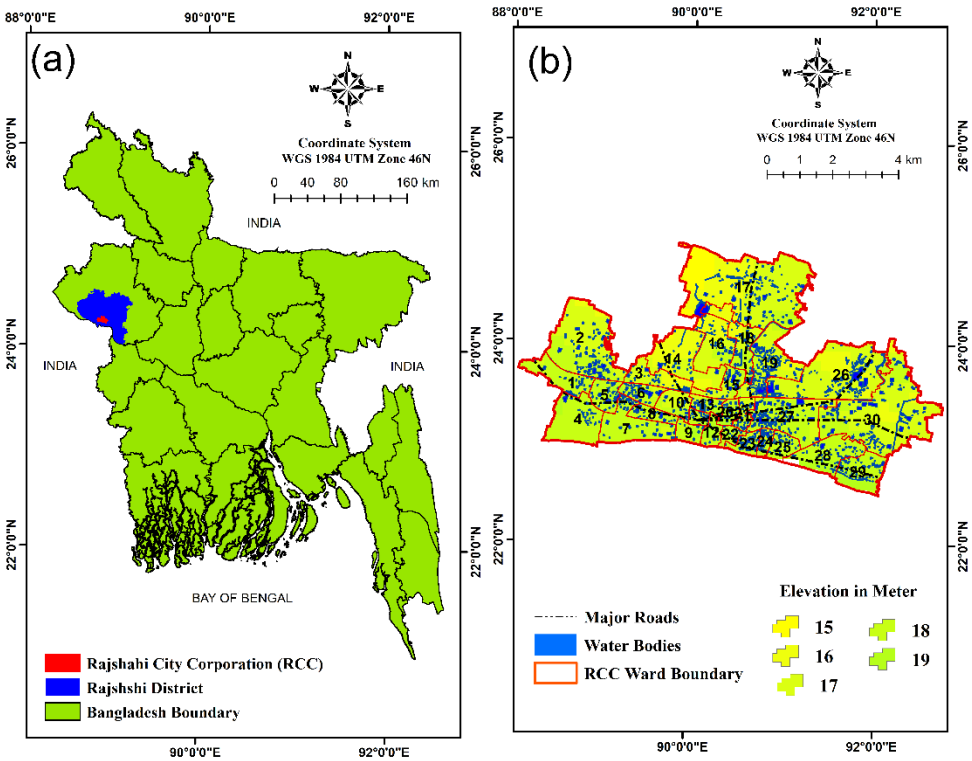

Figure 1: Location map of the study area a) RCC in Rajshahi district and Bangladesh b) Water bodies, road network and ward boundary of RCC

Description of Data

This study deals with primary data collected from QS, FGDs, and KIIs. A structured questionnaire was prepared for collecting 300 samples from 30 wards with 95% confidence level and 5% confidence interval to map the water quality scenarios in different wards of RCC. Additionally, two FGDs and 20 KIIs were executed for the preparation of IWRM plan for Rajshahi City.

Mapping in GIS

The collected data for QS were used for mapping the quality of surface and groundwater and overall groundwater depth in different wards of RCC. The collected data is organized in Microsoft Excel for ward wise water quality mapping. The data transfer into the Arc GIS platform and mapping is performed based on the response received from different wards of RCC during the QS.

III. Result and Discussion

Socio-Economic Characteristics of the Respondent

Table 1: Description of the respondent socio-economic characteristics

Parameters	**Information**									
Gender	Male					Female				
	206					94				
Age	<10	11-20		21-30	31-40		41-50		51-55	>56
	38	7		46	80		86		30	13
Material status	Unmarried					Married				
	91					209				
Income	0	<10000	11000-20000	21000-30000	31000-40000	41000-50000	51000-60000	61000-70000	71000-80000	>80000
	105	22	46	53	34	21	9	3	3	4
Work Status	Employed					Unemployed				
	211					89				
Education Status	Masters/ PHD/Honors		SSC/HSC		Secondary		Primary			No education
	132		70		26		28			44
Occupation	Business		Service		Home Maker		Student		Worker	Others
	69		115		49		49		7	11

According to QSs, 44% of samples are post-graduate, 23.333% are higher secondary graduates, 18% are primary and secondary graduates, and the rests are uneducated. Around 57.6% of individuals' incomes are in the range of less than 20,000 BDT (including 35% of students without sources of income). 38.33% of people have been involved in service work and the rest of the occupations are business, homemaker, student, workers are 23%, 16.33%, 16.33%, 2.33%, respectively (Table 1).

Mapping of Groundwater quality

Mapping of groundwater level revealed that maximum wards in RCC area facing groundwater level between 100 to 120 feet (Fig 2). More than 58% areas of RCC is facing very bad availability of groundwater, followed by 25% and 9% areas are bad and moderate situation (Fig 3).

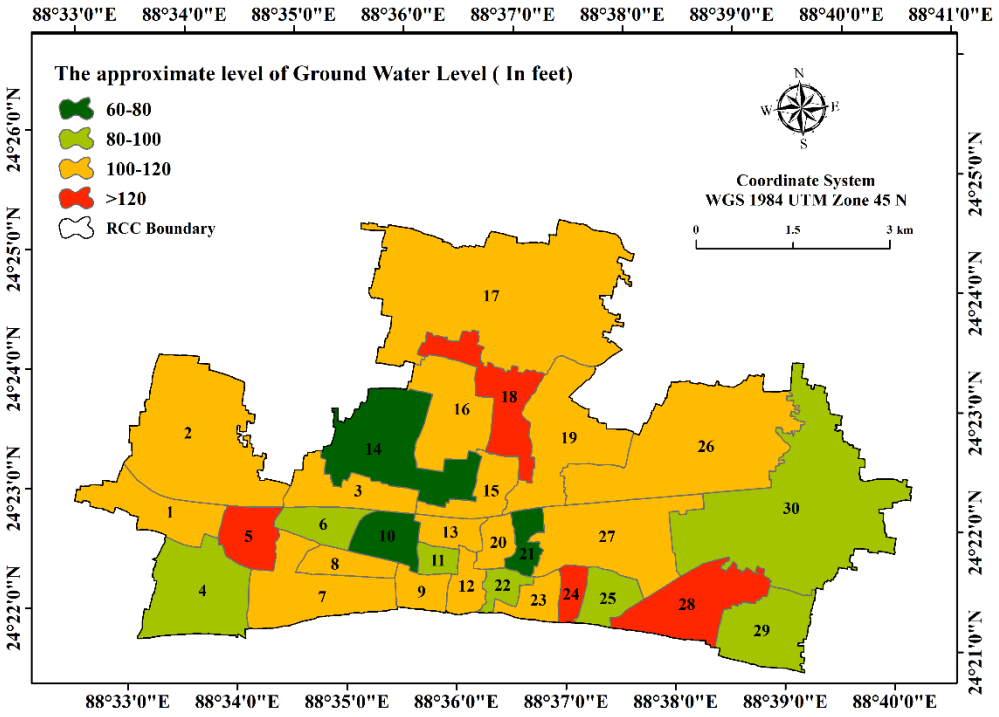

Figure 2: Ward wise groundwater level in RCC area based on community perception

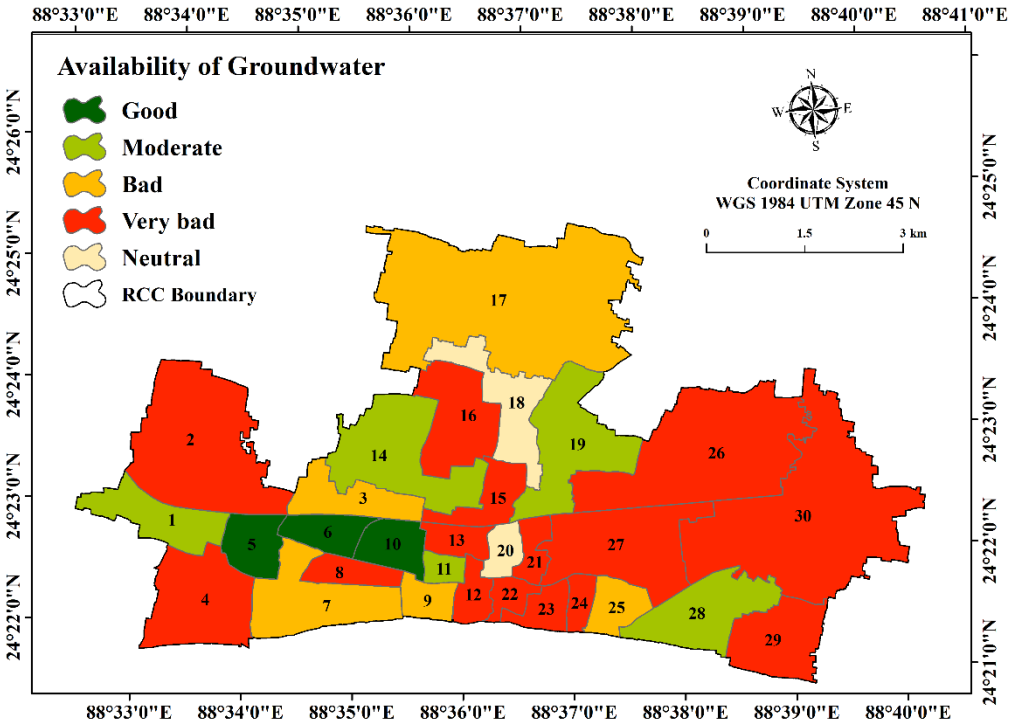

Figure 3: Ward wise groundwater availability in RCC area based on community perception

Mapping of Surface water quality

The mapping of surface water quality also represents very extreme iron contamination in 35% areas followed by a moderate and neural condition in 6% and 5% areas respectively (Fig 4). As iron contamination is noticed in maximum wards of RCC, 55% areas demonstrate very bad supply water quality followed by 25% bad and 14% moderate scenarios (Fig 5).

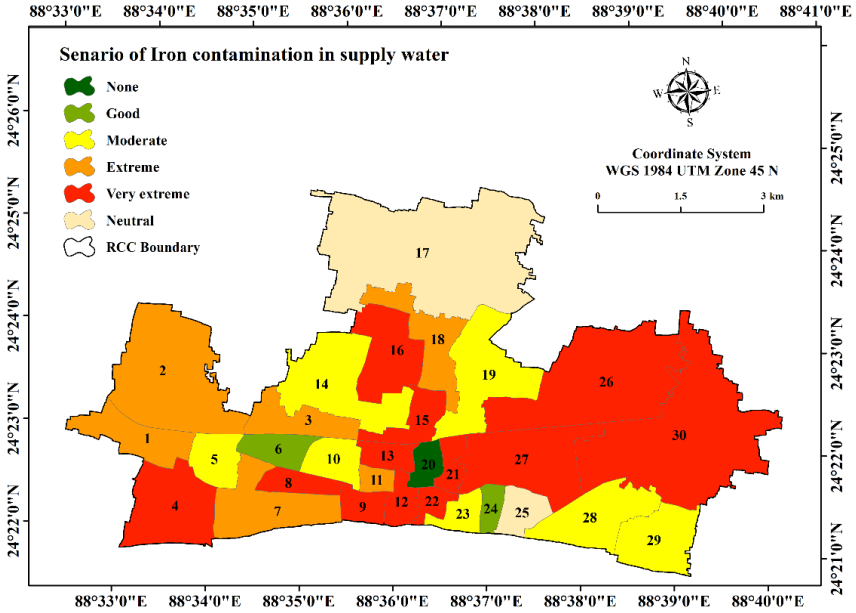

Figure 4: Ward wise iron contamination of supply water in RCC area based on community perception

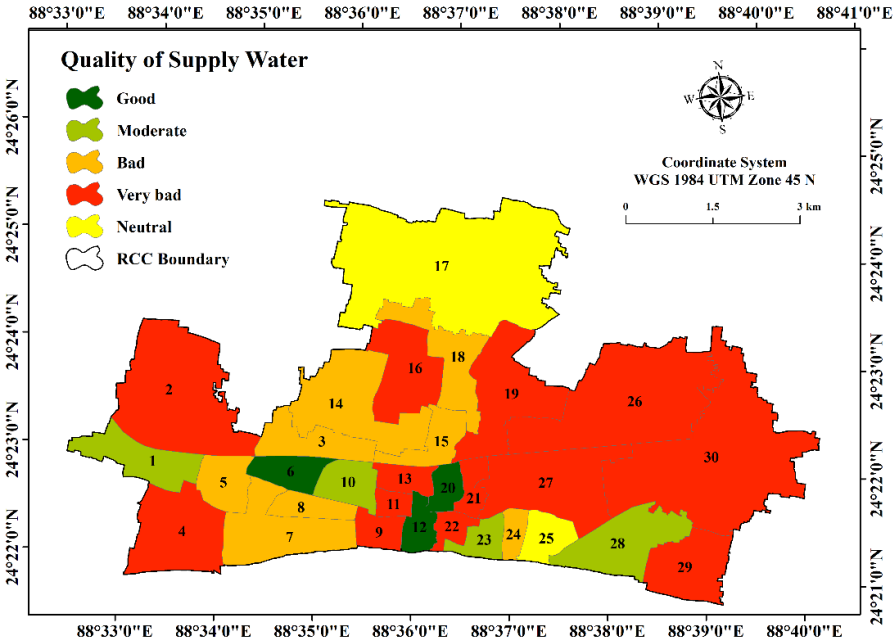

Figure 5: Ward wise supply water quality in RCC area based on community perception

Water quality scenario

Out of 300 samples collected in the study area, the majority of the users about 55% had claimed that the supply water quality was in very bad condition. About 90% samples show that the groundwater was iron contaminated and the rest of the samples taken from sources were free from iron. The public gets bad water quality in the morning. According to the survey, around 80.8% of the individuals used water filtration system as a purifying process.

Groundwater scenario

According to the questionnaire survey, more than 43% of the city contained 100 ft. to 120ft. of Ground Water Level. For this reason, about 58.3% of the areas are unable to provide consumers with groundwater. The availability of groundwater is very much poor during morning. Majority of the people about 76.7% used these groundwaters for household purposes such as drinking and washing clothes.

Water-related diseases in the study area

Approximately 85% of the users faced disease problem through the water. More than 80% of the respondents make sure that this water creates skin and hair diseases and also induces diarrhea, cholera, typhoid etc.

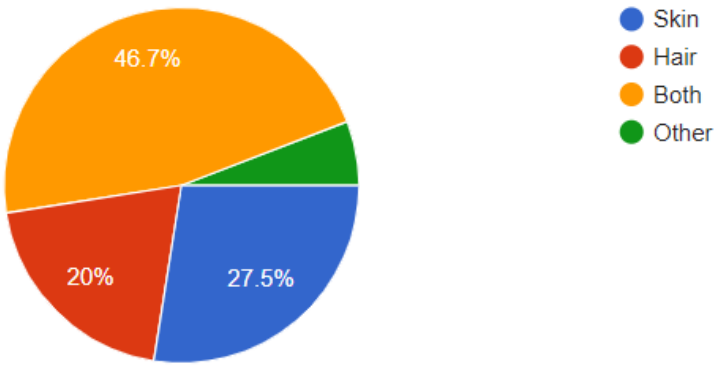

Figure 6: Percentage of water-related diseases

IWRM plan for Rajshahi City

For ensuring sustainable water resource management, IWRM plan is important. With the help of experts in a different field such as urban planning, land use, policymakers, and environment, useful recommendations are stated below for ensuring sustainable IWRM plan applicable for Rajshahi City.

Establish national goals and water policies

In Bangladesh, at the highest level of government, the national goals and water policies has been established when water-related problems become essential and need to be solved to attain public goals. To solve public problems such as the supply of fresh drinking water and water availability in the agricultural sector, policies are adopted. Different supervisory standards are exercised to control several kinds of pollutions and health policies correlated to water (Haque et al., 2012; Rasel et al., 2015). For the more significant outcomes of the water policies for solving the water-related problems, major changes in different sectors, especially in local government institutions, are needed. The policies will be more effective when there is excellent coordination among different ministries, agencies, other

alternatives (Bagheri & Hjorth, 2007; Rahaman & Varis, 2007; Yamout & Jamali, 2007; Smith & Jønch Clausen, 2015).

Safeguarding water availability and demand

Due to increase productive activities in Bangladesh, especially in the export sector, created a situation that makes the necessity to coordinate the pronouncement about the availability of water supply and water demand (Rahaman & Varis, 2007; Yamout & Jamali, 2007). This is because if water demand is higher than the availability of water supply, water scarcity will be created. This will directly affect human activities, especially industrial production, and it will create unevenness in a country's economy. For tackling these situations, formation of water market is needed for giving the indications about the scarcity of water through the water rights price (Yamout & Jamali, 2007). For supporting the improvement of the structure of water management in the agricultural sector and irrigation projects, formulation of "water fund" is also needed. Also, incentives like lesser jurisdictional security of water rights, water pricing reduction, and encouraging private and public organizations for investing in the improvement of water-use efficiency are the appropriate approach for maintaining water availability and demands in Rajshahi city area.

Ensuring sustainable water governance in Bangladesh

The IWRM plan cannot be achieved without proper governance of water resources. Water governance is the heart of how any country manages water. It is a mechanism by which different and sometimes competing interests in water can be balanced in the long-term interests of the nation's people. It is also a mechanism by which specific actors' harmful activities can be regulated to prevent damage to shared water resources and systems (Matsumoto, 2002; Bagheri & Hjorth, 2007; Rahaman et al., 2018). The Water Act 2013 is Bangladesh's latest and most important water policy. It accumulates content from previous water regulations and supersedes all previous water policies (Matsumoto, 2002; Rahaman et al., 2018). Several additional policies overlap and connect to the present Water Act such as the Disaster Management Act 2009, Integrated Small-Scale Irrigation Policy 2011, Coastal Development Strategy 2006, the Coastal Zone Policy 2005, National Policy for Safe Water Supply & Sanitation 1998, Environment Conservation Act 1995, National Forest Policy 1994, Groundwater Management Ordinance 1985 and the Forest Act 1927 (Loucks, 2000; Karim & Mimura, 2008; Rahman, 2010; Walmsley & Pearce, 2010; Mahmud et al., 2011; Chan et al., 2016; Chandra S. P. Ojha et al., 2017; Li & Qian, 2018). Mapping of cross-ministry connections and implementation responsibilities will help identify common scopes and start a dialogue on strengthening institutional ownership. Discussion is also needed on which institutions should be part of the Executive Committee of the Water Act (Mays, 2007; Rahaman & Varis, 2007; Chowdary et al., 2009; Sipes, 2010; Walmsley & Pearce, 2010). Greater collaboration and outreach between institutions would support much more vigorous enforcement of the present water-related policies. Institutions could conduct a scope analysis across different departments to identify and reconcile contradictions and assess potential opportunities for closer collaboration and support. Although institutional functioning is key to implementing good water governance, there are a few other aspects that arose from FGDs and KII feedback that are directly felt as barriers to implementation on the ground. Some are connected to monitoring, while others are about the specific application of penalties for non-compliance.

GIS Modelling for Integrated water resource management plan

Nowadays, location and logical specific activities, modelling using advanced technologies such as geographical information systems (GIS), remote sensing (RS), global positioning systems (GPS) and various other location and logical sensing technologies with changing degrees of accurateness and exposure have become very widespread and common exercise (Jiang & Yao, 2006; Chowdary et al., 2009) . Using various logical conditions, GIS offers flexibility for analyzing the spatial data empirically (Forslund et al., 2009; Bhowmick et al., 2014). Rajshahi city authority can easily apply GIS modelling using several thematic layers (drainage network, soil, elevation, slope, and LULC data) to identify spots that are flexible and potential or inflexible and narrow for surface and groundwater potential zone. GIS modelling will create a hydro-geomorphological map, which is one of the significant parameters for planning location

and area-specific activities for identifying suitable water potential zone (Karim & Mimura, 2008; Karimi et al., 2008; Savenije & Van der Zaag, 2008; Chowdary et al., 2009; Aziz & Khodakarami, 2013).

IV. Conclusion

This study aims to estimate the supply and groundwater quality based on community perception and proposed IWRM plan for Rajshahi city. The study reveals that, most of the wards in RCC area facing severe problems regarding groundwater level and iron contamination in supply and groundwater. From the FGDs and KIIs, some effective measures are coming out like establishing water policies, constructing more powerful water governance, safeguarding the available water resources and use of latest technologies like GIS modelling in water monitoring and pollution control. The study will be helpful for city officials and policymakers in identifying water-related problems in different wards of RCC area and develop effected water management plan for mitigating the problems.

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