



SPATIAL ASPECT OF THE WASTEWATER MANAGEMENT SYSTEM: A CASE STUDY OF KHALISHPUR, KHULNA

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Abstract

The urban wastewater management system is one of the most important infrastructures for an urban residential area and any kind of infrastructure has some spatial considerations. The conventional centralized wastewater management system is an enormous structure that generally fails to address the needs of residential areas for the collection and disposal of domestic wastewater from on-site sanitation. The decentralized management system is a promising but challenging option due to its spatial aspect i.e., specific areas required for implementation. This paper explores the grounds of wastewater mismanagement associated with the spatial aspects. For this purpose, research has performed a spatial analysis of Khalishpur, a residential area of Khulna city of Bangladesh. Two sample tissues in ward 12 were selected based on diverse spatial configurations. The study was led through an area survey, local people's interviews, and Key Informant Interviews. Several maps, sections, and supporting drawings were developed based on the survey data to explicate the problems of wastewater management systems influenced by spatial aspects. Finally, this research has tried to find out the indicators of wastewater mismanagement aligned by spatial features. That will be helpful for the authority of area planning and wastewater management in combined to develop a wastewater management system focusing on the spatial aspects.

Keywords: Spatial, residential area, wastewater management

Introduction

Telmo (2002) described that infrastructure for sanitation and wastewater management is one of the major aspects of an urban area that leads to a healthier life. Some areas had conventional wastewater management technologies like centralized sewerage systems, that are outdated (Sharmin, 2016). Dong et al. (2012) noted that there is considerable spatial variability in the factors that affect urban drainage performance including urban catchment characteristics. Domestic wastewater that discharges without treatment and blockage of drainage causes wastewater overflow during the rainy season that causes contaminated water into local

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drinking water and waterways (Parkinson & Tayler, 2003; Iribarnegaray et al., 2018; Massoud et al., 2009). From Al-Muyeed (2017) & BORDA (2017) it is clear that the decentralized management systems, which fulfill their duties to treat the wastewater before disposal, have some specific construction guidelines with some area required which is dependent on the volume of wastewater. Area planning without wastewater management faces difficulties to manage wastewater (Kamal et al., 2008 & Laugesen, C. H. ; Fryd, O. ; Koottatep, T. ; Brix, 2010). This paper explores the spatial aspects that create constraints on wastewater management in a residential area.

Materials and Methods

Khalishpur housing, ward 12 of Khulna City Corporation (KCC) (Figure 1), is the first planned residential area of Khulna. In 1961, this area was planned with spatial consideration for the wastewater management of every housing block (Figure 2) but 75% of total plots were developed without all necessary facilities (Hossain, M., 2004 & Chaudhury, A. H., 2010). As a result this area is struggling with wastewater management problem for many years. But this area of planning has strong potential to manage wastewater. Here different types of tissue with different width's alley, between house blocks with dedicated space for wastewater management, faces wastewater management problem. As an old planned residential area with the problem and for the spatial aspects, this area has been selected for case study.

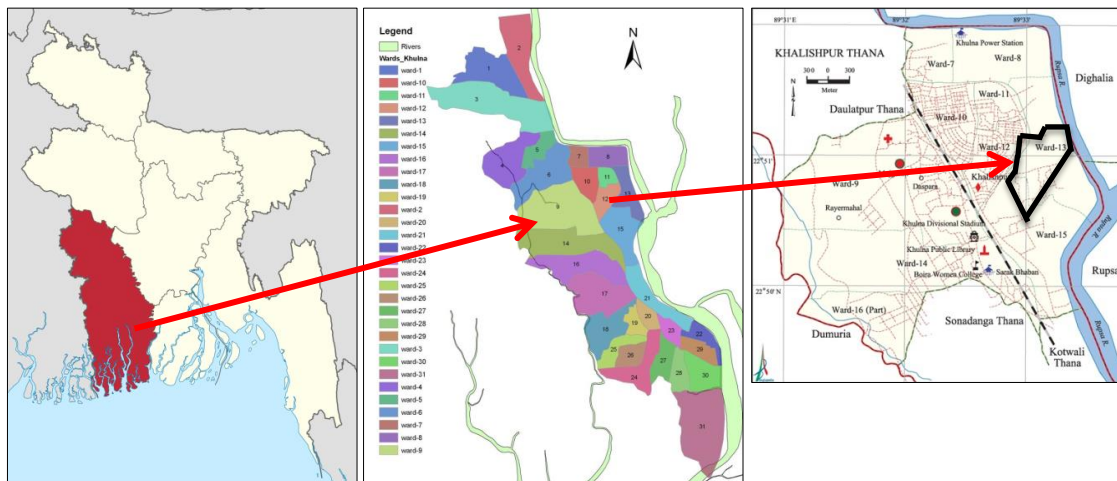


Figure 1. Map showing the location of the study area (ward 12).
(Source: Khulna Division Wikipedia)

This study initially finds out the present scenario of wastewater management system in the selected area. Relying on a case study approach, mainly data has been collected through an in-depth survey. It started with spatial mapping. The following methods were used:

Observation was the main method of data collection and sampling was simple and random. Through observation, this research was able to gather background information on the housing and have collected information on the current water supply and sanitation situation and practices throughout the entire studied area. Observations have been transferred into ward level, housing level and house block-level mapping, built environmental drawings layout and include photograph interpretation. Primarily interview has been conducted with respondents from the habitants of the selected area through face to face. Interviews with wastewater management authority personnel have been conducted in their own office with open-ended semi-structured



Figure 2. Map of Khalishpur housing ward 12. (Source: SNV -An international development organization)

questioners. These interviews have been recorded in mobile as audio files and transcribed in the Bengali language first and further transcriptions have been translated into English, which areas of interviews have seemed important to generate maps, spatial mapping and to identify themes. These interviews also have helped during observation of area drains condition and to identify the primary discharging location of wastewater.

Here tissue was selected in ward 12 according to the alley width in between house blocks, in which there has drainage system for wastewater disposal from the year 1961 but is now used as waste dumping space (Figure 3). From SNV this study found that there are 6 house blocks with 10 feet wide alley, 3 house blocks with 8 feet wide alley, 13 house blocks with 7 feet wide alley, 36 blocks with 6 feet, and 6 house blocks with 5 feet alley. On the north side of this ward, most of the alley width is below 8 feet (Figure 4b). The detailed analysis of collected data from observation, interview, and spatial mapping has explored the spatial problem of the wastewater management system of the selected residential area. This spatial map is addressed here as a problem map of (Figure 4b). A block with 8 feet wide and 300 feet long alley with 30 house blocks has been analyzed in detail and 30 respondents have been interviewed (Table 1).

Table 1. Sampling for data collection and sample size (Source: author)

Data collection method	Sample	Sample selection method	Respondents
KII	Area School teacher, Local doctor, older inhabitants (man and woman), local sweeper,	random	(1-12)
KII (over the phone) and face to face	Ward councilor, SNV, KCC, water aid, DWTS expert.	Pre-selection, convenience	(13-21)
Interview	Area people (in both tissue)	Random	(22-30)

This research has shown the location of the in-between alley of house blocks and draws the existing wastewater management problem. Color code has been used to understand every component of the problem map of Khalishpur residential area (ward 12) (Figure 4b). Here KII of different sectors has also played an important role. Other data has been collected from the area planning. To find out the influencing factors behind the management problem, the study of present wastewater management scenario, present practice or the area people and interviews guide a lot.

In this study information gathered from the area, people have been triangulated with local government people, non-governmental organization (NGO) personnel, and Khulna City Corporation (KCC) key person. Information gathered from KII has been triangulated with secondary data sources. Overall information about wastewater mismanagement has been triangulated from the KII. In this clarification, this study has tried to attach comments and experiences of the area people and key persons.

Results and Discussion

Status of wastewater management system in Khalishpur residential area:

To understand the current wastewater management system to every type of existing alley conditions between house blocks have observed in detail and documented on a map of ward 12 (Figure 4b). During field surveys it accessibility provision in the master plan of this housing, were dumped with solid waste (Figure 3). There are different widths in-between alley, three types of drains, and two wastewater discharging points in the Bhairab river as shown in the problem map of ward 12 (Figure 4b). All waste and wastewater are being discharged into was observed that the in-between space of house blocks, dedicated for wastewater management with the drain



Figure 3. Two types of studied spaces between building plots. (Source: author)

directly (Figure 4a). At first from the household toilet to the in-between alley or drain, then from alley to housing or area drain. And finally, from the city drain to the river (Figures 4a&4b). As a result, all the wastewater is discharging directly or indirectly into the river.

On the other hand, from KII, it has been known that, the drains were piped drain to discharge the wastewater only. But often the pipe of these piped drains were been blocked by solid waste like all household and kitchen waste, menstrual pads and cloths, everything is being through by these pipes (respondent 7, 15, 23-27). The cleaner cannot reach through these long pipes every time (respondent 28,29). That's why the wastewater can't go through the pipe and all users suffer a lot. As a result, the users have broken the pipe to be relieved from this blockage permanently (respondents 11,12,14). So, the piped drain nowadays is used as an open drain.

Planning for wastewater management in Khalishpur residential area:

Based on the aim of this research, the selected area for the study has been analyzed to explore the wastewater management problem. This ward has been classified into two types of tissue based on the wastewater management system (Figure 4b). Though because of the previous management system, the alley width is different but both areas' scenario is the same now. Here the block between roads 122 and 123 has been selected as a sample block that has 8 feet wide alley. This block chooses as a sample block because 8 feet is the intermediate width of all alleys. Block's detailed spatial analysis has been given below.

Space between house blocks with a piped drainage system:

"Our drains were clean before. But sometimes the wastewater from our household and toilet did not go through the drainpipe because of blockage. As a result, our toilet became overflowed several times with wastewater. We did not get the cleaner at the emergency time and the cleaner also could not clean the pipe properly. So, to rid of this problem we broke down the drain pipe. And then our household and toilet waste and wastewater are directly discharged into the drain without any hazard. But now a day's our drains are again got blocked by dumped waste. It seems more difficult to solve." school teacher (respondent 07- Saidur Rahman)

At the time of the master planning of Khalishpur residential area, this area was dedicatedly considered the space between house blocks for the drainage system to manage wastewater (KII). Comparatively the alleys are wider in the southwest part of ward 12. The drains were piped with a connection to every house block's toilet and the pipe was open to the main drain. The pipes were only for toilet wastewater. But the habitats of these house blocks continued through the kitchen solid waste, menstrual pads, and cloths through these pipes (respondents 10,13). As a result, it became blocked. SNV has similar findings. Rather than stop this practice, the inhabitant has broken down these wastewater pipes (respondents 05,12). Also, dump solid waste from the kitchen window over the drain (respondent 13). As a result, this potential space for wastewater management becomes a backyard grubby space (Figure 3).



Figure 4a. Wastewater discharge points into the water body and the Bhairab River. (Source: author)

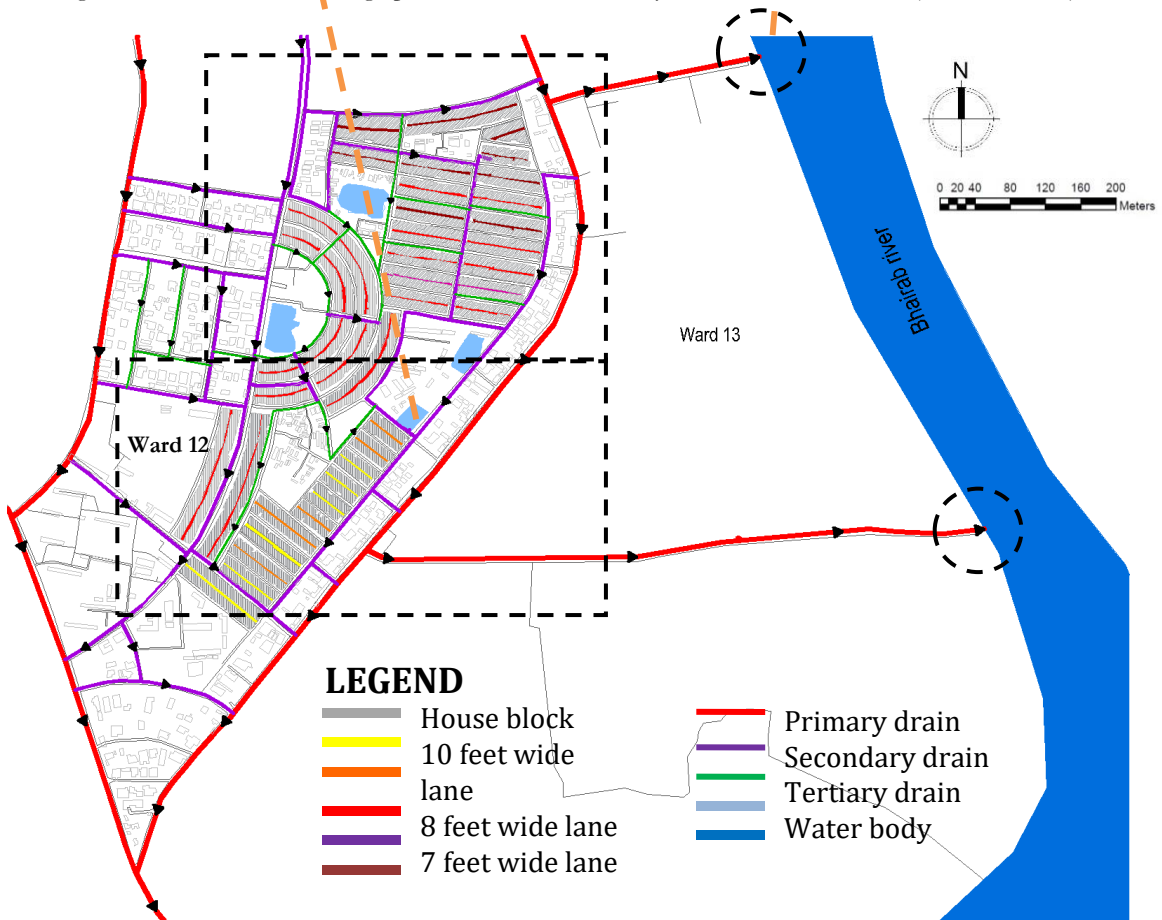


Figure 4b. Problem map of Khalishpur residential area (ward 12). (Source: author)

Here the blowup map of the south part of ward 12 is showing the wastewater flow from the sample block, in-between road 122 and road 123. From the rest of the blocks, wastewater is discharging directly into the river (Figure 5). A sample block is a block with an alley of 8 feet in width (Figure 6). This block is 300 feet long with 30 house blocks on both sides of 8 feet alley. This block is also connected with road 12 and road 131 (Figure 7).

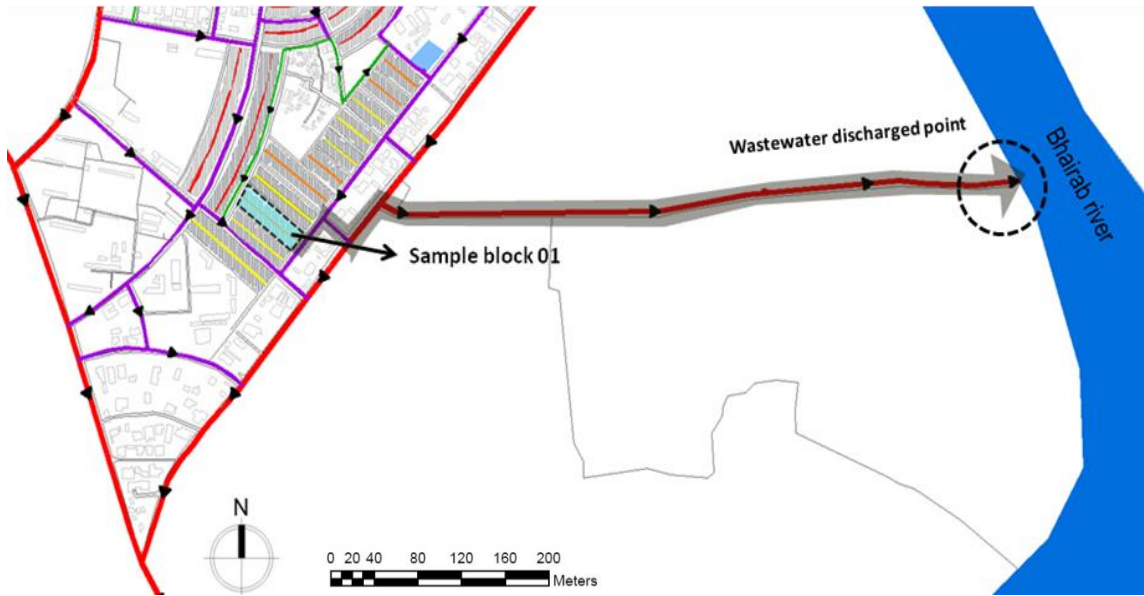


Figure 5. Wastewater flows from the sample block to the water body (Bhairab river). (Source: author)

The detailed plan and spatial state of the sample block have shown in (Figure 8) with photographs. Here all house's toilets are directly connected with the in-between 8 feet alley (Figure 8). At the northwest end of the alley, there was tried to stop people from throwing solid waste in this alley by a bamboo fence but people had broken down the fence and continued throwing west. As a result, the alley is blocked by solid waste and wastewater is flowing over (Figure 8).

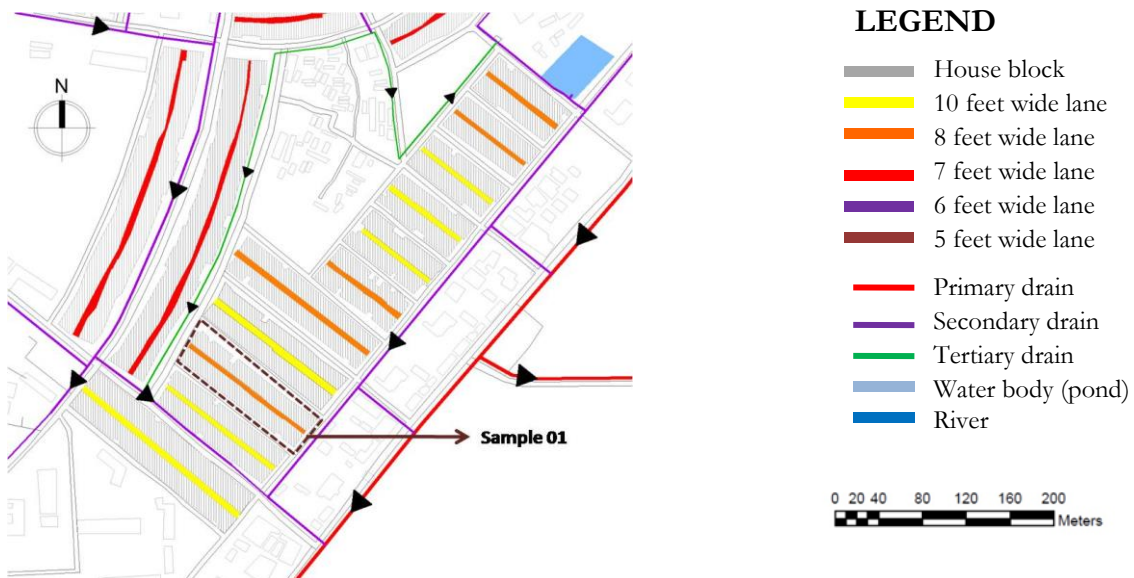


Figure 6. Wastewater flows from the sample block to the water body (Bhairab river). (Source: author)

On the other hand, the southeast end also has a bamboo fence. In this part people have not broken the fence rather they are dumping the solid waste on road 12 beside the endpoint of the alley. So, this end of the alley is comparatively dry and wastewater is going thrown aside by the alley (Figure 8).

Table 2. Present condition of wastewater management in Khalishpur residential area (ward 12) according to the key aspects. (Source: author)

Key aspects	The present condition in the case
Planning (spatial)	<ul style="list-style-type: none"> • Have dedicated space with accessibility provision but dumped with solid waste. • Spaces are too long comparing the width.
User	<ul style="list-style-type: none"> • People are habituated with direct discharge followed by their previous generation. • All people through solid waste into the open space between house blocks.
Governance	<ul style="list-style-type: none"> • Lack of governance of central and local govt.
Infrastructure	<ul style="list-style-type: none"> • Drains are damaged and blocked. • No specified dustbin. • Roads are higher than building plinths.
Maintenance	<ul style="list-style-type: none"> • Piped discharge connections are failed and no cleaning provision.



Figure 7. Google view of the sample block between road 122 and road 123. (Source: Google earth pro)

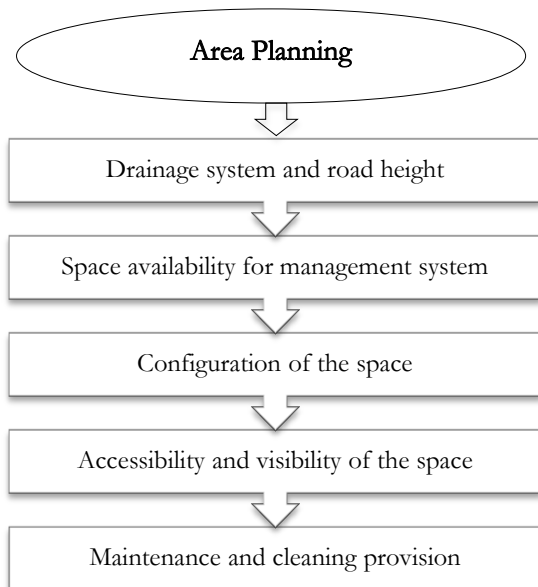
Some understanding of the management system of the area can be drawn. This research has sought out some key aspects and influencing factors that control overall wastewater management. The basic key aspects are planning, user, governance, infrastructure, and maintenance, (Table 2). Planning on the focus of spatial aspect is the most important factor. Along with planning, users and the governance of the total management system, infrastructure for the management and its maintenance also play a great role to manage wastewater. Here the present condition of the selected case has been shown according to these key aspects.

From the above analysis here sought out the influencing factors of wastewater management of a planned residential area shown in the Flow chart 1. These all factors have somehow related to spatial aspects.



Figure 8. Housing map between roads 122 and 123 (sample block) with a piped drainage system. (Source: author)

Flow chart 1. The grounds of wastewater management problem associated with the spatial aspects in a residential area. (Source: author)



Conclusion

The main conclusion derived from the present study is that the people of the khalishpur residential area are habituated to the present wastewater management practice and they face their daily problems in their own way. This study sought out the key aspects of the wastewater management problem of the site area through a tremendous analysis. Also, list out the influencing factors related with spatial aspects. The overall study has derived that the spatial aspect is a major indicator of wastewater management problems. Spatial consideration for wastewater management in the area of planning can be a smart solution to solve wastewater management problems. But there needs further study. The authority of area planning and wastewater management combined will be beneficial if they consider the influencing factors and the key aspects to develop a wastewater management system.

Considering these grounds, associated with the spatial aspects, master plan of a residential area could integrate a wastewater management system with the aim of effective wastewater management.

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