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UTILIZATION OF URBAN WASTE WATER FOR AGRICULTURAL PURPOSE: A CASE STUDY OF RANHOLA CENSUS TOWN, DELHI

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RESEARCH ARTICLE

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Abstract

Across the world, particularly in the developing world, the pace of urbanization growth has put the tremendous pressure on the existing water source. The waste water produced from cities are putting extra pressure on water supply chain by polluting the existing fresh water sources and even ground water in some cases. The study tries to explore the best practices of waste water management in urban centers across the world. The study also tries to present the current status of management of waste water in Delhi including their treatment and further utilization. At last, the study tries to analyze the role of waste water in livelihood generation using case of agriculture in peri urban areas of Delhi. The finding reveals that in many urban centers across the world waste water are treating their waste water ranging from 10% to nearly 100% and the treated water is being used for cultivation as well. However, Delhi with exploding pollution and increased demand of water has only managed to treat 54 % of total waste water produced in the city. The study concludes that waste water from the cities, when treated properly, can be profitably used for irrigation purposes in peri-urban areas of mega cities, thus strengthening the livelihood of cultivators in these areas and at the same time minimizing the demand of fresh water through this practice.

Keywords: *Urbanization, Waste water management, Peri urban, Livelihood generation, Agriculture*

Introduction

There are numerous outcomes of human actions, one of those are generation of wastes. It is one of the unavoidable by-products which get generated at each level and in every sphere of human activities. Looking at the levels of generation, it can come at the time of extraction, processing of raw materials, even at the consumption of raw material, final products, intermediate products, and from consumption of products at each level (Glossary of Environment Statistics, 1997). The very concept of waste is dynamic. A material that is a complete waste for someone can become a resource for other i.e. this output is not without purpose. In the current scenario of exploding population, urbanization, industrialization and huge commercialization etc. have made people to think upon this issue. Several definitions of waste management put forward by concerned institutions, still need of a more appropriate, sustainable definition to change the perception of seeing this by-product as resource-rich non-waste (Pongracz & Pohjola, 2004).

In this study, current scenario of liquid waste (wastewater) produced in urban areas has been taken into consideration. Waste water is a non-conventional source of water and has non-potable quality but this by-product is gaining importance as an alternative of fresh water for numerous usages considering a check on its negative impact on environment and on human health. Numbers of people are dependent on this alternative source of water. Many of them belong to the urban poor who are engaged in agricultural activities for livelihood as well as for attaining food security (Davis, Richard; Hirji, Rafik;, 2003). Especially in peri-urban and urban localities of low-income countries, people prefer to use waste water as they find it difficult to get unpolluted water and fully treated waste water. The extent of use of wastewater is so high that share of area irrigated with unsafe water is probably ten times larger than the area using treated water (Drechsel & Evans, 2010). This by-product is not merely an issue of managing water resource; it influences various spheres of human lives as well as nature. Over 80% of waste water is released to the environment without treatment globally which creates a huge ecological challenge ((WWAP (United Nations World Water Assessment Programm), 2017). If dealt with it in an integrated way, wastewater irrigation has a great potential. It would be needed to ensure a sustainable system for nutrient management, important information to be available to each stakeholders, and for fulfilling these aspects multidisciplinary approach is needed. Use of wastewater for irrigational purpose is a reality which cannot be denied or banned practically. There is only one thing that would be better followed is to treat the used water properly, which will help in obtaining a sustainable lifestyle and good quality of environment.

Given the scenario of rapidly increasing urbanization, industrialization and other dimensions demanding water, a holistic study of challenges and opportunity related to wastewater is needed.

The aim of this study is to assess the reuse boon and challenges of wastewater and get an idea about economic benefits. To fulfill the aim of this study a specific area has been selected: Ranhola Village (which has now been converted into Census town).

Newspapers and magazines' articles showing importance of this non-conventional source of water: In the current scenario, high demand of water and research on getting sustainable alternatives for fulfilling this demand, huge number of research as well as articles of such kinds can be found. Some of the articles from various newspapers and renowned periodicals have been mentioned here to develop an understanding on water demand in Delhi city. Key words selected (special mention given to water condition in Delhi) from articles of newspaper, periodicals, magazines and other websites:

1. Focusing on water scarcity	Delhi running out of water, in search on water alternatives (Biswas, Tortaiada, & Saklani, 2017). Consciousness on water (Venkatesh, 2018)
2. Focusing on alternative source of water	Cleaning up sewage must (Adak, 2018) (PTI, 2015). Recycling, the answer needed (Venkateshwaran & Singh, 2017)
3. Looking for Innovative use of already used water	Wastewater treatment, irrigation, better alternative to think upon (Niyogi, 2017). Smart and efficient alternative (Sengupta, 2015). Sustainable option; Future food through used water (Caucci & Meyer, 2019)

Objectives: To understand the dynamics of waste water management in urban space

1. To understand the history of wastewater and its use in urban spaces.
2. To understand the dynamics of waste water management in Delhi.
3. To see the role of entrepreneurship surrounding waste water in order to understand the scenario of agricultural practices within an urban framework.

Research Methodology

Database and Research Design: The paper is based on both primary and secondary data. Secondary data has been taken from different sources to build up an idea about India and about Delhi. Those sources are; Central Pollution Control Board Reports, United Nations population divisions, data from Delhi Jal Board (DJB) report, various newspapers and periodicals' articles. Primary level data have been collected from *Shafipur Ranhola* Census Town regarding use of waste water for irrigational purpose. During the field survey, 20 samples (households) were taken into consideration, found into their field during their working period in field. Random sampling was chosen in collecting sample.

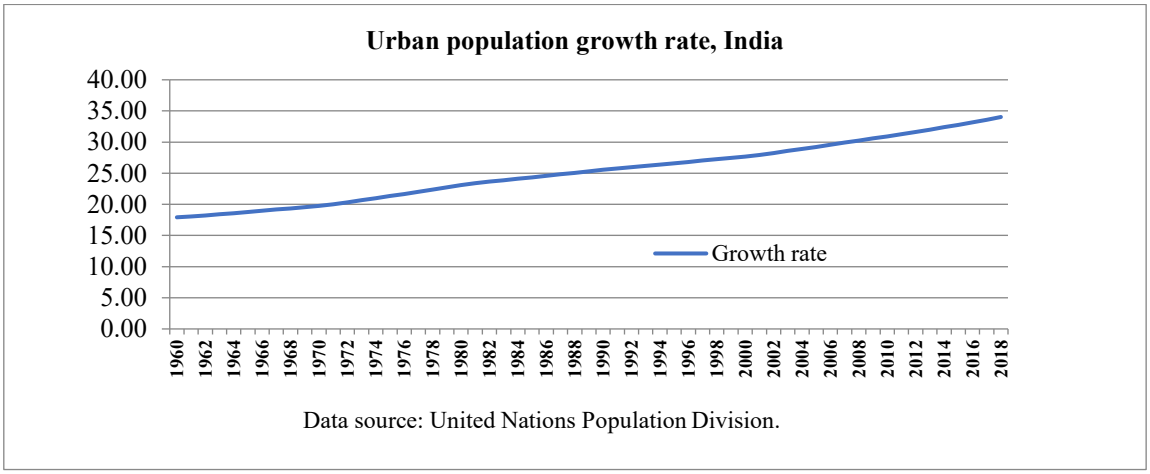
Results and Discussions

(a) Historical Background of wastewater and its use in urban spaces: Use of wastewater is an ancient practice, though it has not always been properly managed or thought of in this way. Awareness about the wastewater use has evolved with the history of mankind. With increasing population growth, urbanization and consequently increasing burden on available water resources, it became necessity to think about alternative like such (Jaramillo & Restrepo, 2017). Discussion about effective management and disposal of all kind of waste generated in urban centers has been one of the central issues over the years globally. Germany started using waste water extensively as early as 1887 though they were using it since very early (Gupta & Gangopadhyay, 2006). Paris was one of the large cities who started irrigating peri-urban fields with wastewater. During 1870-80s, Paris reached its maximum extent of using wastewater (Tzanakakis, Koo-Oshima, Haddad, Apostolidis, & Angelakis, 2014). In Bulgaria, this by-product has become a reliable source for water crisis condition. If it is treated properly before using it, it will be a boon for human civilization (Petrov & Kathijotes, 1996). Usage of wastewater for irrigation purpose is an open question though it is being used and acknowledged as an important alternative to freshwater in many regions of the world. One of the serious concern is; it is being used unguided, unplanned and vastly in untreated form. Countries like Ghana, Bolivia and Tunisia are using this by-product like other low-income countries (Huibers, Seghezzo, & Mels, 2006). In East Kolkata wetlands, use of solid and liquid wastes has been taking place since decades. Horticulture and aquaculture have mainly been experimented with this. This non-conventional source has now been confidently considered as fertilizer and nutrient rich medium for agriculture and aquaculture. This alternative of fresh water has given a hope even to the urban planner and they have started to experiment with this means in sanitation and infrastructure planning (Gupta & Gangopadhyay, 2006). About 10% of generated wastewater globally is used for irrigational purpose, whereas its utilization is as high as almost cent percent in the urban areas such as Santiago (Chile) and in Mexico City. If the residual water is from domestic sewage then it contains human excreta, urines and it works as nutrients, reducing the need of chemical fertilizer (Gupta & Gangopadhyay, 2006).

(b) Understanding the dynamics of waste water management in Delhi: It is explicit (Graph-1) India has been changing into urban place gradually and continuously. Approximately one third (34%) of total population of India is residing in urban places and by 2030, 40.76% of total population of India would be residing in urban areas (World Population Report, 2007).

Infrastructural development of all kinds is not keeping pace with urbanization and has checked the economic growth severely.

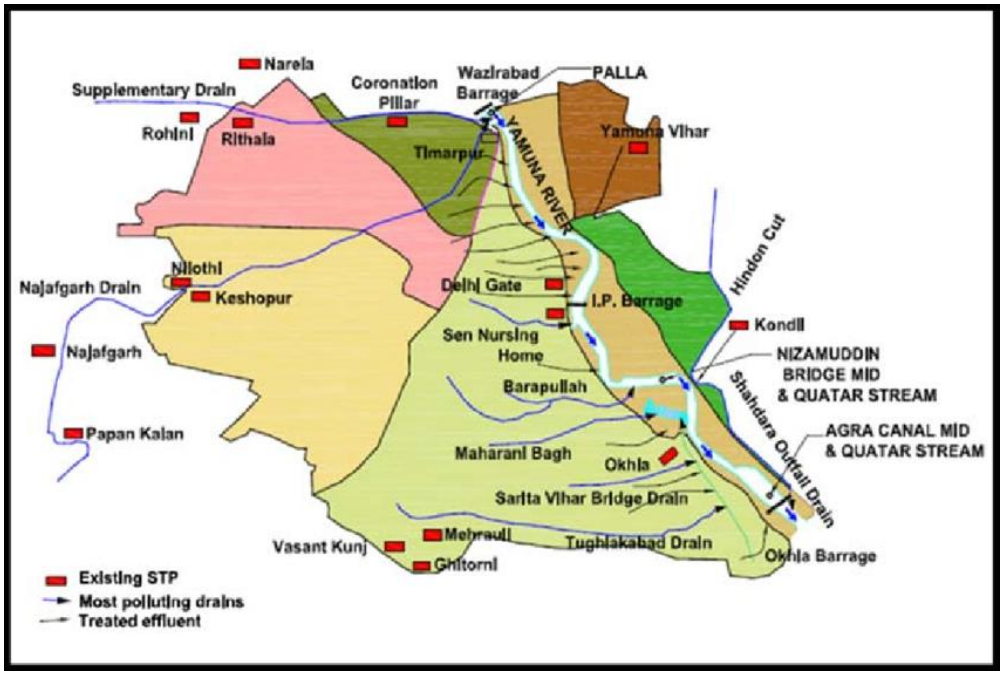
Graph-1: Urbanization in India



Data source: United Nations Population Division.

From the graph-1, increasing demand of water from various spheres such as household, industry, energy is explicit.

Water quality status in Delhi stretch of River Yamuna: Since maximum urban centers of India are organically emerged or not planned properly, infrastructure naming municipal sewer system is not completed successfully and sewage gets discharged directly into surface water body contaminating it severely. The average annual rainfall in Delhi is 611 mm. but due to decreasing availability of permeable surfaces; rainwater also get diverted into sewers or in storm water drains. According to (CPCB, 2009), industrial waste and domestic sewage have been the major cause of deterioration of water quality of water sources. It can be understood through the water quality of river Yamuna, especially of its stretch in Delhi (Table-1). Data show that all the four stations of river Yamuna located in Delhi have Biological Oxygen Demand (BOD) much above than 3 miligrams per liter(mg/l), making the water unfit for using it as potable water. From the data table it can be observed that the pollution loads at different stations situated in Delhi are highly variable, depending on its location in the city. The pollution level observed increasing gradually as the stations passing through the city. Station of river Yamuna which is at the entering point of Delhi has been observed with the minimum pollution level with minimum biological oxygen demand, highest dissolved oxygen and the lowest fecal coliform level of all the stations taken. Intensity of pollution of the last station of river Yamuna can be understood through the fact that fecal coliform of this station is 18408 times higher than the maximum limit set by CPCB for a safe water. The regulatory standards have been seen by the state pollution control boards which are further linked to CPCB.



Source: adapted from (Mandal, Upadhyay, & Hasan, 2010)

Table-1: Water quality of Yamuna River measured at various locations

Water quality criteria of river Yamuna, 2016				
Station Name	**State Name**	**Dissolved oxygen (mg/l)**	**B.O.D. (mg/l)**	**Faecal Coli form (MPN/100ml)**
		Avg.	**Average**	**Average**
		>4 mg/l	**<3 mg/l**	**<2500MPN/100ml**
Yamuna at Wazirabad	Delhi	9.3	5	12100
Yamuna at Nizamuddin	Delhi	1.5	25	2713000
Okhla Bridge (Inlet of Agra Canal)	Delhi	1.1	26	2720500
Yamuna at Okhla A/M of Shahdara Drain	Delhi	0.9	36	46020000

Source: Central Pollution Control Board (CPCB ENVIS, 2016)

To get the rough idea about, minor drain surrounding Ranhola, pollution level of Najafgarh drain which is the main source of the channel passing nearby Ranhola census town is taken into account. Average biological oxygen demand of even Najafgarh drain at Wazirabad before confluence to river Yamuna is 45.5 mg/l (CPCB;, 2015)way higher than the standard limit of 3mg/l.

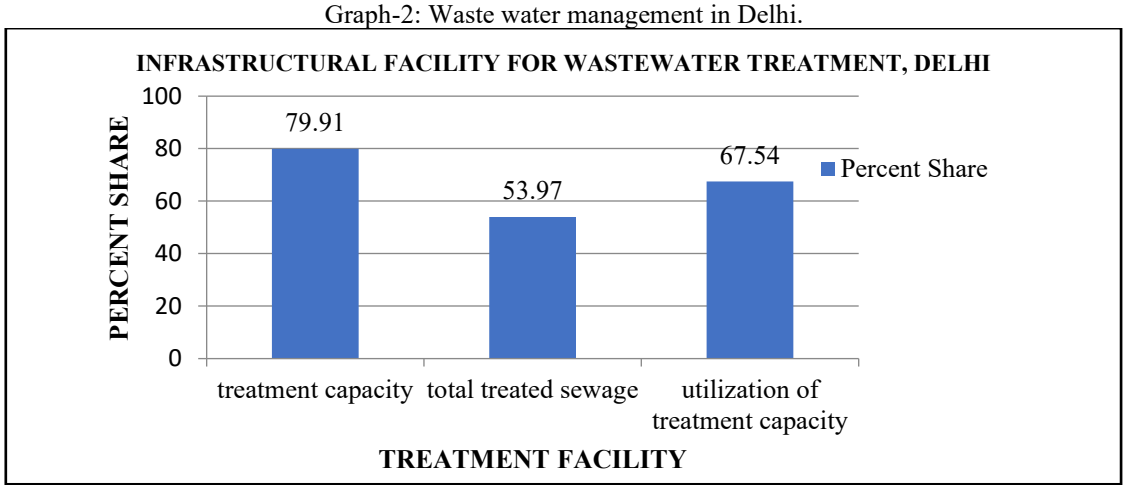
Infrastructure backing wastewater management of Delhi: Infrastructure of sewage and wastewater treatment is not keeping pace with wastewater generation consequently discharge of polluted water into natural waterways. A major constrain is in terms of feeding the cities for which food supplies have to be brought from distant rural areas, with increased food prices (Hanjra & Qureshi, 2010). The assessing quality of wastewater is difficult due to lacking infrastructure to keep record of discharge. Quality of wastewater is a major issue as discharge comprising domestic, industrial and effluents of other forms and that too not separately accounted for (Heggade, 1998). Lack of infrastructural development for wastewater management in Delhi is not hidden. As the urban areas of India facing challenges for fresh water as well as of managing wastewater. It has been tried to investigate the wastewater generation, treatment and through it; assessing sanitation coverage and sewage treatment scenario of Delhi. Delhi with 41 Sewage Treatment Plants having overall treatment capacity of about 545 Million gallon per day is insufficient in cleaning all the wastewater generated in city as the total generation of Delhi is exceeding 600 MGD. Since demand has grown, City water supply has increased over the years and that too is arranged from distant sources inducing more wastewater generation. Waterways are polluted due to sewer ending in streams, non-networked wastewater discharge indiscriminately contributing tremendously. Following is the broad picture:

Table-2: Waste water production and treatment in Delhi

	in MGD (Million Gallon Per Day)			% Share
Total Sewage generated	680		Treatment capacity	79.91
Treatment Capacity	543.4		Total treated sewage	53.97
Actual sewage treated	367		Utilization of treatment capacity	67.54

Source: Delhi Jal Board

Graph-2: Waste water management in Delhi.



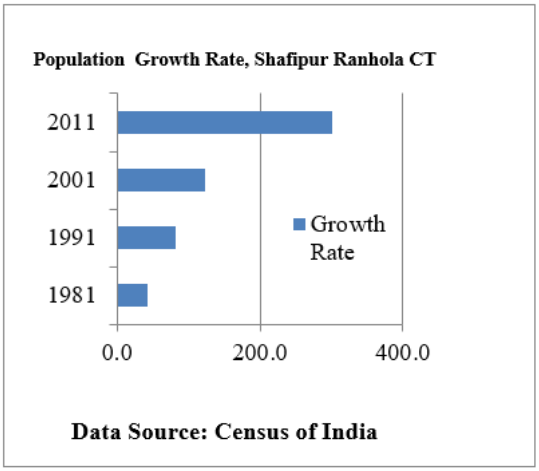
Poor quality of infrastructure for sewage management (Table-2) is pervasive in Delhi. There is a huge gap among three; sewage generated, treatment capacity and actual treatment. Treatment capacity provided by Delhi Jal Board (DJB) is already lower than the needed i.e. only about 80% of the total sewage generated and even that treatment capacity is underutilized which is only

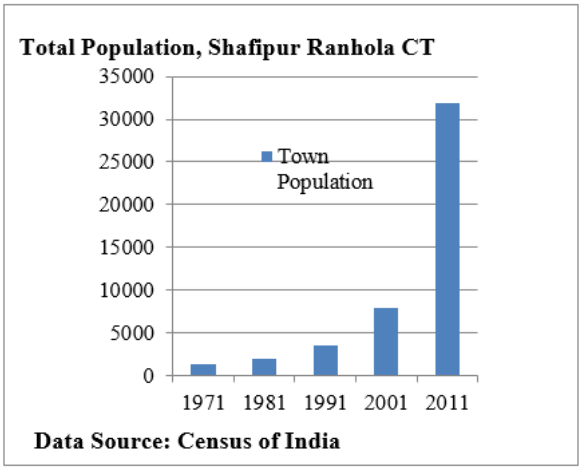
about 68% of the treatment capacity. However only about 54% of the total sewage generated is getting treatment though it is not clear whether it is properly or partially treated.

c) Entrepreneurial moves considering wastewater: Case study of Shafipur Ranhola Census Town:

Study Area: Delhi is a place where one side is full with urban amenities and the other side will give the glimpse of rural area, *Shafipur Ranhola* is such example providing the feature of rural characteristics within urban core. Within an urban area there are number of census town, Ranhola CT is one of such. In west Delhi district, there are three tehsils named *Patel Nagar, Rajauri Garden* and *Punjabi Bagh, Shafipur Ranhola* CT situated in *Punjanbi Bagh tehsil*. District headquarter of this census town is *Rampura* at a road distance of 10km. It is expanded in area of 4.3 sq. km. inhabiting 6211 household (Census of India 2011). It was a village till 1991 in 2001 census it got the place of census town because of the exponential population growth. According to the data of Census of India 2011, population of *Shafipur Ranhola* reached 31944 from 7953 (Census of India 2001) with 301.7% of tremendous growth rate. Population composition of this place is on the similar line with Delhi, maximum inhabitants of this place is from "*Jaat community"* of Haryana but all the farm workers residing here is from Uttar Pradesh, some of them are from Uttarakhand and Bihar though those who are from U.P. and Uttarakhand are from areas not far from Delhi. Since this place is getting occupied for residential purpose, open spaces are shrinking and it has become a major concern for the people who are engaged in activities which is directly related to land such as all the vegetable cultivators. Response of respondents were like; they are growing these greens for their livelihood if this spaces would come under the built form they would have to back to their home town or would be ready to work on any menial as they have no other skill to start upon afresh. They are utilizing it as long as it does not get used for the residential or other urban related purpose.

Building up understanding on population dynamics of Shafipur Ranhola Census Town





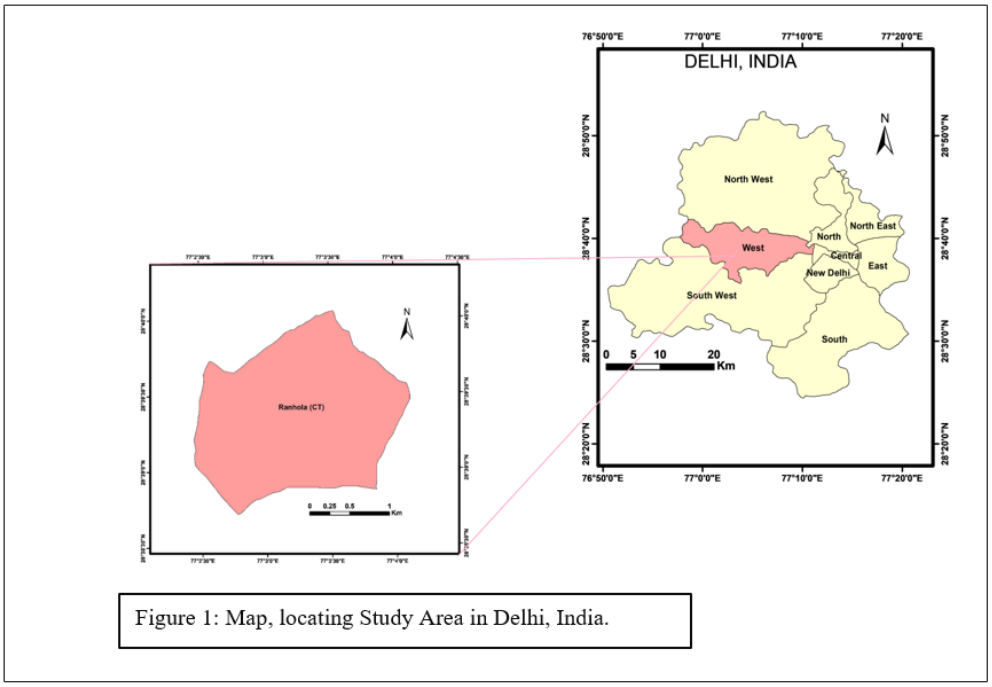


Figure 1: Map, locating Study Area in Delhi, India.

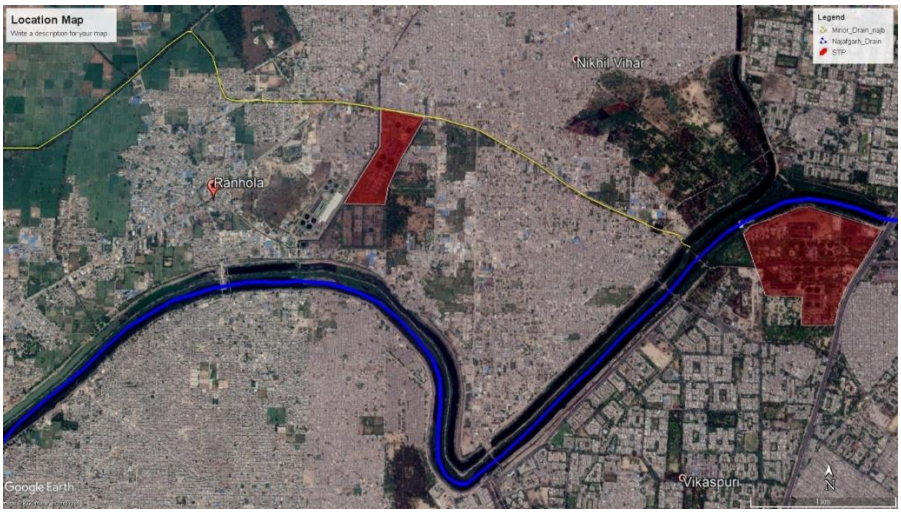


Figure 2: Satellite image of the study area, incorporating important features

Considering the irrigation dynamics of this census town can be explained through, its proximity to all the sites which play major role in agricultural production of this place; *Shafipur Ranhola* CT is surrounded by *Najafgarh* drain (earlier known as *Sahibi* river), and one of its minor channel (open minor drainage) which is the backbone of irrigational facility of this place. Some of the very significant ones are *Keshopur* Sewage Treatment Plant and *Nilothi* Sewage Treatment Plant, these two STPs discharge partially treated water in Najafgarh drain as well as in the minor open drain which contain raw sewage water (Figure-2).

Figures from field visit:

1. Fields of greens, *Shafipur Ranhola* CT
2. Picture of minor open drainage, which is branch of *Najafgarh* drain and the significant source of irrigation.
3. Field of spinach leaves
4. Field of vegetables, a person working in.

Case study: Waste water use, Livelihood analysis:

Spatially juxtaposed with other urban activities, and competing for land, labour, and resources, Ranhola CT shows the feature of livelihood activities based on innovative idea though they necessity driven. American Economist M.J. Baumol suggests that as world is very conscious about growth, providing motivation to the entrepreneurs would energize the growth. (Rasool & Naseer, 2012) write that there are various factors or causes which generate and also promote entrepreneurship at its different stages such

as; economic, institutional, geographical, structural etc. Types of entrepreneurs on these bases are; Necessity driven (kind of a negative approach because individual choses to become an entrepreneur when there is no alternative available.), opportunity driven and growth oriented entrepreneurs. All the land holders are not engaged in agricultural activities. Ones who is involved in this work are basically tenant cultivators immigrated here majorly from Uttar Pradesh, and Uttarakhand and Bihar. 80% of the surveyed cultivators are from Uttar Pradesh, that too from western part of it; such as *Shahjahajnpur, Unnao, Sitapur, Hardoi and Lakhimpur*. 15% of them are from Uttarakhand, all three of these cultivators are from Pauri Garhwal region. More than 70% of the surveyed population living in rented houses which indicate that these fields provide them livelihood opportunity. Those who have houses there are not included in agriculture. Immigrants are included in census town population but they are included in agriculture. All the sample populations here are tenant cultivators. 75% of the cultivators pay for the field in fixed rent though the value of rent is variable for individual field for the different landlord. Reluctances would be observed in replying for the rent they pay to the field owner. They provided a rough estimate for this; 1 lakh per *Killa* (per *killa* has about 5 *bihga)* per year and 25% cultivators pay through giving share in income from the selling they called it "*addha"*. As it is established logic and also sensible thing to grow more perishable produce like vegetables etc. close to urban markets. Their produce for summer and winter as they told; spinach, fenugreek greens, coriander, okra are their major produce for winter season while brinjal, okra, pumpkin for summer season. They sell their produce in "*Nasirpur Mandi"* in wholesale as it becomes easy for them to get meaningful value of their produce. Maximum leased in land are 3 *killa* while average land leased in for production purpose in 1.925 *killa* which is currently providing them their livelihood base. As it was observed that all the cultivators irrigate their field by themselves and that too without taking any precaution as they perceive that this water is not harmful till now they have not faced any negative health impact.

As indirect use of untreated effluent is common throughout Delhi, their perception towards using wastewater is not very surprising given the scenario where it is difficult to get even drinking water daily basis. Their response was; this channel is their backbone of livelihood and they have no problem in using this water for irrigational purpose as it has nutritional value more than the fresh water though they are not aware about the pollution level of this form of water. Since there is no restriction in using this water (they do not have to buy it) cultivators are content with using it. Though they are not aware of the negative impact of using this form of water they are to some extent in line with the researched data of various sources; "*There can however be a mismatch between its rate of production (which may be relatively constant) and the demand by agriculture which varies with the irrigated area and the time of year. Agricultural production close to cities is the most cost effective use."* (FAO)

Limiting factors: Given the time constrain, water of the minor drain could not be tested to reach to any conclusion about the quality of the water getting used for agricultural purpose.

Conclusion

Use of wastewater is not a new phenomenon it has a long history, though it has not always been properly managed or thought of in this way. Awareness about the wastewater use has evolved with the history of mankind. With increasing population growth, urbanization and consequently increasing burden on available water resources, it became necessity to think about alternative sources of water where this displaced resource make a significant foothold. The primary users of wastewater are small landholding farmers residing in cities or in peri-urban areas. They find the water available in the small channels carrying residual water with different degrees of pollution passing through the city easy way to earn livelihood. In several situations, this form of water is the only reliable water source, especially in the current scenario of exponentially growing urban population (Buechler & Mekala, 2005). Since use of wastewater is still being covered in informal economy, the use of wastewater is not documented properly; there is no information available for the farmers dependent on wastewater. Probably more livelihoods are sustained through informal than the wastewater related activities which are formal (Raschid-Sally, L.; Jayakody, P.;, 2008). By going the benefits of using this non-conventional source of water with some precautionary measure, it would better to recognize wastewater as a displaced resource. Sustainability of this model would be very high if wastes are treated properly. This use of waste water in the field of agriculture is necessity driven.

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