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Water Policy Research
HIGHLIGHT

Wastewater Irrigation in Jammu and Kashmir
An exploration

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More than 25-30 per cent of the water in the canals and field channels across Jammu and Srinagar is wastewater from urban areas. Interestingly, while wastewater irrigation has resulted in increased crop yields owing to high nutrient content in Maharashtra and Karnataka, research in J&K found no perceptible difference in crop yields. Could this be due to the degree of mixed wastewater in the canals and field channels? Based on field research in and around Srinagar and Jammu, this Highlight tracks the current status of wastewater generation; extent of its use by downstream farmers; and the perceived health risks associated with wastewater use in agriculture.

Wastewater Irrigation in Jammu and Kashmir*†‡

An exploration

Research highlight based on Shaheen (2016).

1. Urbanisation in Jammu and Kashmir

The sixth largest state in India, the hill state of Jammu and Kashmir (J&K) has always had abundant water resources. As a result of tourism and developmental activities in this fast urbanizing state, increased demand for land, water supply, sewerage, solid waste management, housing and roads is exerting pressure on urban local bodies (ULBs). According to the Comptroller and Auditor General of India (CAG), irrigation canals across J&K were allowed by the government to turn into sewerage drains (Kashmir Times 2015). Clearly, this steady urban population boom has led to increased sewage generation and current sewage treatment facilities are insufficient to meet these needs.

Take the case of our study areas of Srinagar and Jammu. According to Srinagar City Development Plan (SCDP), only 30 per cent area is covered by sufficient sewerage systems while only 12 per cent households have access to sewerage connections (JKERA 2007). Against the total sewage generation of 195 MLD, Srinagar has 4 sewerage treatment plants with total capacity of 32.2 MLD. Likewise, sewerage systems in Jammu city manage to cater to only 8.41 per cent of sewage generated, with a capacity of 11 MLD from two functional sewage treatment plants. All sewage water, treated and untreated, is ultimately disposed-off in rivers, water courses and canals downstream of the two cities.

Most irrigation canals are fed through lift irrigation schemes from the river Jhelum and its tributaries in Srinagar district and from the river Tawi in Jammu district which have a significant composition of wastewater. These irrigation canals also receive more wastewater as smaller drains coming out from hamlets along the path are discharged in these canals and field channels. Farmers in the region therefore use untreated wastewater for irrigation as sewage and effluents from urban areas are discharged untreated into water bodies. This default utilisation of wastewater in agriculture reduces the pollutant load further downstream by removing effluents from polluted streams and applying it to soil.

2. Objectives and methodology

The study was conducted on the wastewater utilisation in agriculture in and around Jammu and Srinagar to:

[a] Calculate the extent of the wastewater irrigation economy.

[b] Understand stakeholder (farmers, traders, consumers) perspectives on the use of wastewater for irrigation.

[c] Undertake a perception-based health risk assessment.

To calculate the wastewater irrigation economy of the twin capital cities, data regarding areas practising agriculture was collected from the Department of Agriculture and Horticulture. These figures were cross checked with data generated by the SKUAST-K (2014). Additional information on irrigation infrastructure and drainage systems was collected from the Irrigation and Flood Control Department; City Mechanical Drainage and Srinagar Municipal Corporation (SMC) and Jammu Municipal Corporation (JMC).

Transect walks were conducted along the path of sewage flow. These walks traced the source of irrigation through the nallah (open drains/canals), canal or field channel that received sewage water either from dewatering sewage units of the City Mechanical Drainage, through natural drainage or directly from the outlets of households along the water course.

GIS mapping was utilised to identify the cropped area and these areas were verified by ground-truthing. Finally, information on crops grown, input use, revenue realised and specifically regarding water use in irrigation, its source, quality and availability for crop production was gathered through focussed group discussions (FGDs) with farmers in the mapped areas.

3. Field studies in Srinagar and Jammu

3.1 Extent of wastewater use in agriculture

We observed that the network of irrigation canals or kuhls (channels utilising gravity to carry water from nearby streams to fields) in the study areas were plagued with garbage. The canals and field channels which used to carry water from the source (usually water from river *Jhelum* through lift irrigation schemes) to fields are now being used as sewer drains and for wastewater, moving in reverse direction to the river. The canals and field channels that are used for irrigation also act as sewer drains in urban areas. Field survey and interactions with farmers and residents of peri-urban areas revealed that

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Picture 1: Brari Nambal Lagoon sewage water in Srinagar

more than 25-30% of the water in canals and field channels is wastewater from urban areas (see Map 1 and Map 2). The percentage concentration of wastewater will be even more during drought years when due to low rainfall, the flow in rivers and major canals is lesser.

In Srinagar, wastewater irrigation estimation was conducted for summer season crops because irrigation is required only during this season. During the rabi (winter) season sufficient in-situ moisture is available in the fields due to snowfall or rainfall combined with negligible evapo-transpiration losses. It was observed that the water used by farmers in their fields is neither freshwater nor purely wastewater. In Srinagar, it is a combination of freshwater and wastewater in varying proportions, varying not only by season but also by location reflecting the city drainage systems and disposal of municipal sewage. The study found that majorly 3 crops are irrigated using wastewater in Srinagar. A total of 4,227 hectare is irrigated with wastewater in Srinagar district where gross receipts realised from the produce is ₹90.50 crores (Table 1). However, only 20 per cent of the revenue (₹18.10 crores in Table 1) may be attributed to wastewater use as per its composition in the canals and water courses.

In Jammu, the size of the wastewater irrigation economy was estimated for summer as well as winter season crops. Here too, it was observed that the water used by farmers in their fields is neither freshwater nor purely wastewater but a combination of the two in various proportions, varying by season and location. Major crops grown with wastewater are paddy, vegetables, mustard, wheat and barseem/fodder crops. A total of 1,817 hectare is irrigated using wastewater in Jammu. This figure may double if the border areas of Samba district (part of Jammu district till 2007) are included as the tail end of the wastewater irrigation network. The gross receipts realised from wastewater irrigated produce amounted to ₹50.90 crores (Table 1). Only 25 per cent of the revenue (₹12.73 crores in Table 1) may be attributed to wastewater-use as per its composition in the canals and water courses.

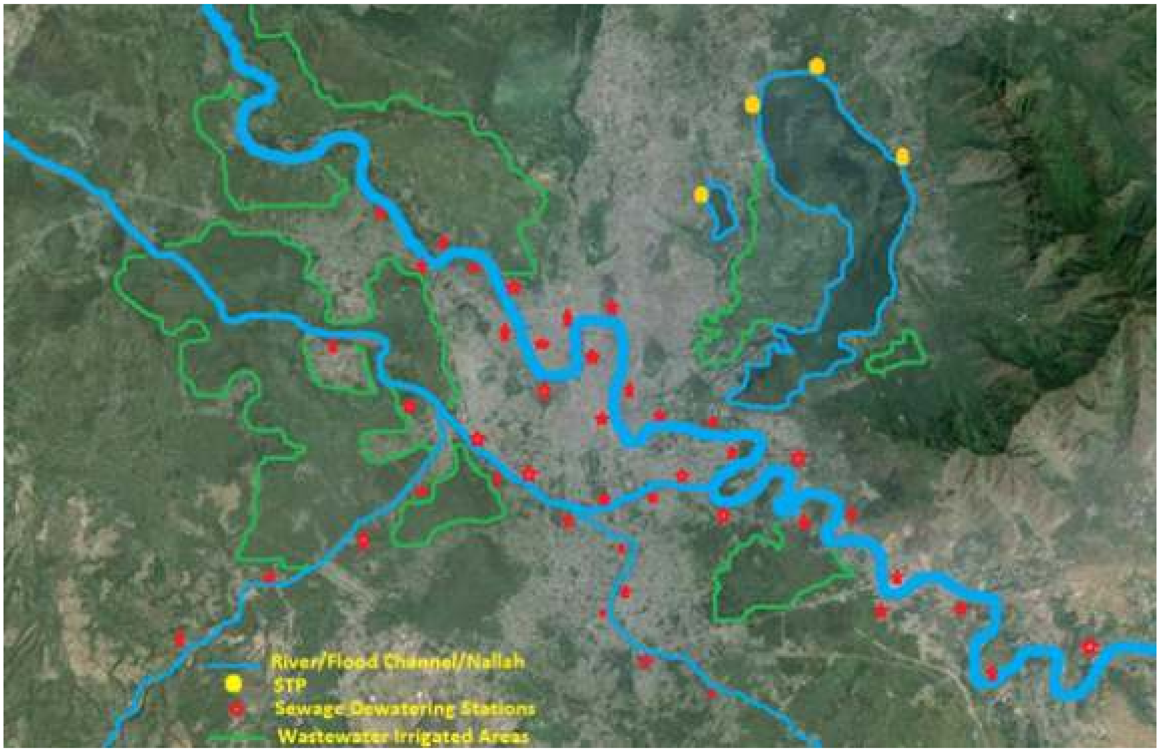
Picture 2: Sewage water drained through city nallah down to river Tawi in Jammu

3.2 Key Findings

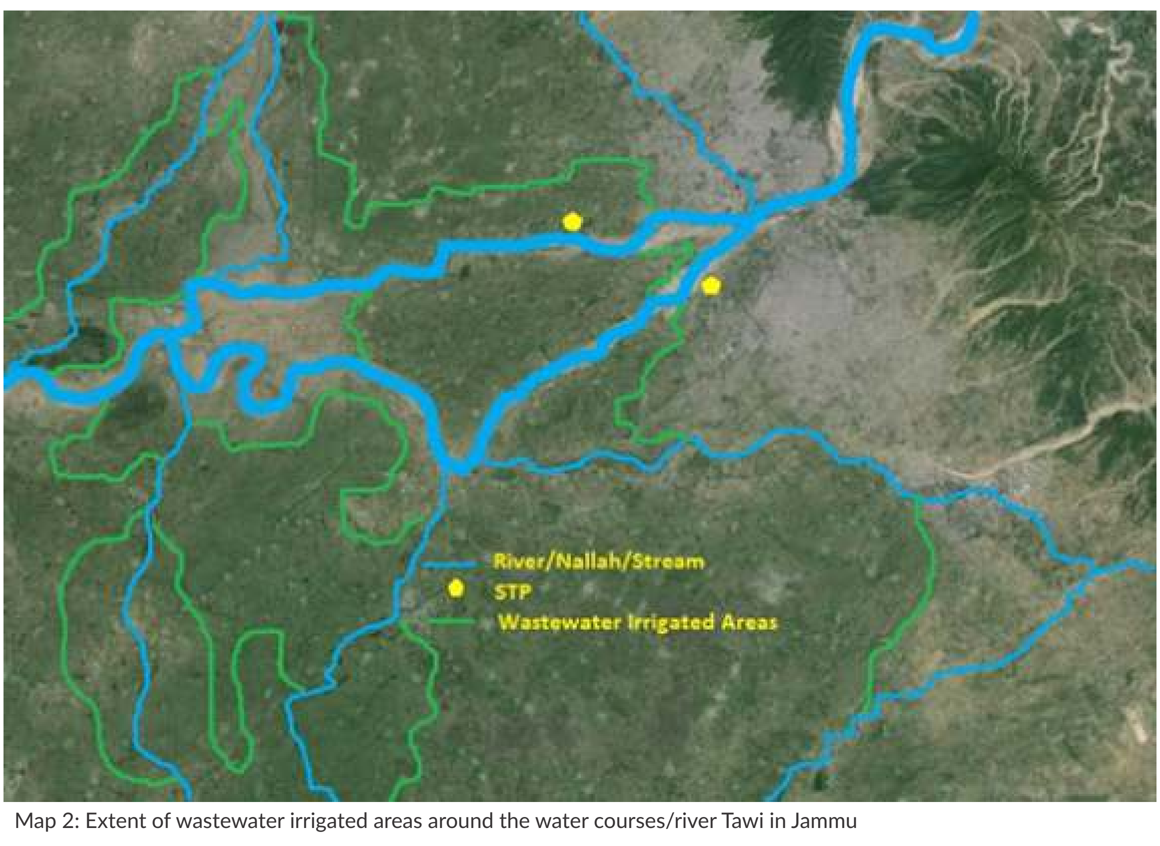
1. The study found that water used for irrigation is a mixture of wastewater (black or grey in colour) and fresh water (blue in colour) in Srinagar and Jammu. In fact, farmers using wastewater by default were often unaware of their utilisation as it is mixed with water sourced via lift irrigation from the rivers, flood-spell channels or nallahs. Farmers cultivating vegetables on the banks of rivers draw water from watercourses and other stagnant water bodies which contain a significant portion of sewage water.
2. Wastewater irrigation in Srinagar city is only during the summer season unlike in Jammu city where irrigation is required throughout the year due to its sub-tropical climate.

Table 1: Wastewater irrigation economy in Srinagar and Jammu

Area	Crops Grown	Wastewater Irrigated Area (WWIA) (ha)	Farm Receipts (₹crores)	Percentage Contribution to WW (₹crores)
Srinagar	Paddy, Vegetables, Apple	4,227	90.50	18.10*
Jammu	Paddy, Vegetables, Fodder, Oilseeds, Wheat	1,817	50.92	12.73*
Total		**6,044**	**141.42**	**30.83**



Map 1: Extent of wastewater irrigated areas along the river Jehlum in Srinagar



Map 2: Extent of wastewater irrigated areas around the water courses/river Tawi in Jammu

3. The study found no significant difference between the yield levels of farms irrigated with wastewater and freshwater.
4. Discussions with stakeholders revealed that farmers, traders and consumers uniformly did not have any specific concerns about working with wastewater. As the state has a history of using night soil in the fields, farmers did not face any difficulty in getting labourers to work in their field or in selling wastewater irrigated produce.
5. Farmers using wastewater were not aware of health risks associated with it and did not report any related health impact. However, discussions with medical professionals revealed that a sizeable number of cases reported were due to polluted water-borne problems.
6. The wastewater irrigation scenario in other major towns in the state is similar. Lack of proper sewage treatment and scientific disposal is ubiquitous across the state. The study found that in most of urban areas, sewage outlets from households fall directly into canals or water courses.
7. In rural areas where water availability is scarce or where there is insufficient surface water, kitchen garden vegetable farming is mostly done by the sewage water from the household. Night soil is also still being used in rural areas, particularly for vegetable cultivation, where dry latrines are prevalent. There is evidence from across the state, especially Karewa areas (rain-fed uplands) about the use of household wastewater for irrigation.

3.3 Wastewater quality and the economics of wastewater irrigation

The agricultural sector remains the largest user of water in India. Irrigation with reclaimed sewage water offers the most readily available and most economically feasible way to supplement fresh water.

Rehman (2011) suggests that the use of domestic effluent for vegetable farming is beneficial for farmers as wastewater is a valuable source of nutrients, organic matters and is less expensive than irrigation water. This is relevant in Srinagar, where the water quality of the river Jhelum was found altered in the catchment area of the city owing to the sewage from houses, houseboats, sludge, animal droppings and human excretions that find their way directly into the river. This water is then utilised by farmers for irrigation. Rehman (2011) also studied the metal concentration in normal and sewage water along with soil testing of fields irrigated by these two sets of water, as well as the vegetables produced through sewage water. High levels of nutrients such as Columbite (Fe) and Manganese (Mn) were noticed in the sewage effluents, whereas irrigation water showed recommended norms. The study found that Knoll kohl (German turnip) grown on sewage-irrigated soil accumulated sufficiently good amounts of trace metals along with the organic carbon accumulation in the soil.

In the Kandi region of Jammu, characterised by extremely low and irregular rainfall, Sharma and Sharma (2015) studied trace element pollution in agricultural fields irrigated by wastewater. They found that black water is highly nutritive, when compared to grey water, and when black water was used for irrigation, it enhanced crop productivity tremendously.

Both these studies point to a positive correlation between increased yields and the use of reclaimed sewage water for irrigation. However, our field studies in Jammu and Srinagar did not find any significant difference in the crop yields. This could possibly be due to the low concentration of wastewater/black water in the water used for irrigation in Jammu and Srinagar.

3.4 Perception-based health risk assessment

A major stumbling block to wastewater use in agriculture is the potential health impact of using untreated wastewater and the associated risk-mitigation practices. Addressing this would strengthen wastewater irrigated agriculture and prevent the degradation of land and water resources attributable to disposal of untreated wastewater (Ramola 2016; Sakhare et al. 2016).

With this in mind, a perception-based health risk assessment was undertaken by adapting the framework proposed by WHO's Sanitation Safety Planning (SSP) manual (WHO 2015). The parameters were decided based on the perceptions of farmers and consumers and not based on the research team's understanding of health risks, as suggested by SSP.

We define two exposure groups:

(I) F1 = Farmers directly handling wastewater but not consuming wastewater irrigated produce; and

(ii) F2 = Farmers directly handling wastewater and are also consumers of wastewater produce.

In Srinagar, the farmers surveyed were also consumers of their produce such as rice, vegetables or apples. No serious health impact due to wastewater use was reported by the farmers. However, high use of pesticides in apple production was observed as a major concern among both farmers as well as labourers involved in the application process of these chemicals. Low levels of skin irritation and scaling problems were identified by certain farmers. The problem of coliform is a general problem for residents of the valley which may be due to various factors besides wastewater irrigation. F2 farmers reported a medium risk score (R= 8) as they are exposed to both skin and food-borne infection.

In Jammu, no serious health impacts were reported by farmers (both F1 and F2) attributable to wastewater use except low levels of skin irritation. Some farmers were apprehensive about the possibility of skin-related problems getting aggravated by increased pollution due to sewerage and untreated water. Here, F1 farmers reported a medium risk score (R=8), while F2 farmers reported a higher risk score (R = 18). F2 farmers were categorised under High Risk based on the health risk assessment matrix (see Table 2).

Table 2: Health risk assessment based on perception of farmers in Srinagar and Jammu

Location	Exposure Group	Exposure route	Hazardous event	Farmers and Consumers Perception of Health Risk			Score (A x B)	Risk	Total Score of Risk (R)
				Health issues perceived	Occurrence of disease (A)	Level of treatment required (B)			
Srinagar	F2 (WW irrigators and consumers of WW-irrigated produce)	Skin Penetration	Exposure to sewage during farming activities	Dermatitis in some cases was observed by farmers	Farmers apprehensive that skin problem may likely happen in future	Minor health effects (described as temporary symptoms like irritation, nausea that require little medicines)	3 x 2 = 6	Low	R = 6 + 2 = 8 [MEDIUM RISK]
		Ingestion	Consumption of wastewater irrigated produce	No serious health impact observed	HHs reported that it has not happened in the past and is unlikely to happen in the future	Insignificant (No/negligible health impact)	2 x 1 = 2	Low	
Jammu	F1 (WW irrigators who do not consume WW-irrigated produce)	Skin Penetration	Exposure to sewage during farming activities	No major disease except minor dermatitis observed and reported by some farmers	Farmers perceive that skin infection and other health issues may likely happen in the future	Mild treatment needed in terms of antiseptics and other medicines	4 x 2 = 8	Medium	R = 8 [MEDIUM RISK]
Jammu	F2 (WW irrigators and consumers of WW-irrigated produce)	Skin Penetration	Exposure to sewage during farming activities	No major disease except minor dermatitis observed and reported by some farmers	Farmers perceive that such skin problems would almost certainly happen again in the future	Moderate treatment (described as short-term ailment that required treatment and medicines)	4 x 2 = 8	Medium	R = 8 + 8 = 16 [HIGH RISK]
		Ingestion	Consumption of wastewater irrigated produce	Some farmers reported health problems associated with consumption of raw vegetables	HHs reported that it has rarely happened in the past and is unlikely to happen in the future	Minor level of medication required in certain cases	4 x 2 = 8	Medium	

Data Source: Field Study 2016

4. Conclusion

A steady increase in urban population and insufficient sewage treatment facilities have resulted in the direct disposal of untreated or partially treated municipal wastewater into water channels downstream from cities. This study found that more than 25-30% of the water in canals and field channels is municipal wastewater. An analysis of the extent and size of the wastewater irrigation economy revealed that 6,044 hectare is irrigated using wastewater in peri-urban Jammu and Srinagar. A gross value of ₹30.83 crores may be attributed to wastewater, estimated based on the proportion of wastewater in canals and water courses. Similar studies in Karnataka (Gupta et al. 2016) and Maharashtra (Palrecha et al. 2016) have attributed increased yields to the high nutrient content of wastewater. However, our exploration in Jammu and Kashmir found no significant difference between the yield of farms irrigated with wastewater and freshwater. We suggest that this could be due to the mixing of wastewater and freshwater in canals and other water channels in Jammu and Kashmir.

Our explorations on the potential health impacts of using wastewater for irrigation revealed that stakeholders – farmers, traders and consumers – do not have any concerns about working with wastewater and wastewater-irrigated produce. The health risk assessment found medium levels of risk perception among both categories of farmers (F1 in Jammu and F2 in Srinagar). However, the assessment revealed higher levels of health risk perception among the F2 farmers who consume wastewater irrigated produce in Jammu. Addressing the health concerns would strengthen wastewater irrigated agriculture and, at the same time, prevent significant degradation of land and water resources.

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About the IWMI-Tata Program and Water Policy Highlights

The IWMI-Tata Water Policy Program (ITP) was launched in 2000 as a co-equal partnership between the International Water Management Institute (IWMI), Colombo and Sir Ratan Tata Trust (SRTT), Mumbai. The program presents new perspectives and practical solutions derived from the wealth of research done in India on water resource management. Its objective is to help policy makers at the central, state and local levels address their water challenges – in areas such as sustainable groundwater management, water scarcity, and rural poverty – by translating research findings into practical policy recommendations. Through this program, IWMI collaborates with a range of partners across India to identify, analyze and document relevant water management approaches and current practices. These practices are assessed and synthesized for maximum policy impact in the series on Water Policy Highlights and IWMI-Tata Comments.

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