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# Wastewater Irrigation, Heavy Metals and the Profitability of Rice Cultivation – Investigating the East Calcutta Wetlands in India

**In India, as in many developing countries, wastewater is often used to irrigate crops. This undoubtedly helps to recycle useful nutrients through the food chain, but, as there can be toxic chemicals in the wastewater, it also poses risks to human health and may reduce the profitability of cultivated crops. The East Calcutta Wetlands have been a repository for untreated sewage water from the city of Kolkata for decades. They also sustain local agriculture and fisheries activities. But how good is untreated water for agriculture and does wastewater affect the profitability of rice cultivation?**

This Brief, based on a study by Vivekananda Mukherjee and Gautam Gupta from Jadavpur University, Kolkata, investigates the role of the East Calcutta Wetlands in irrigating agriculture. An examination of the East Calcutta Wetlands indicates that waste water is a highly effective input into rice production. Agricultural plots using wastewater containing organic nutrients earn higher profits than those using groundwater. However, the profitability of rice production is negatively affected by the presence of heavy metals such as Chromium, Lead and Mercury that are found in the water and soil. Of the two opposing effects of wastewater irrigation, the positive effects of organic nutrients outweigh the negative effects of heavy metal toxicity. Thus, the overall effect of using sewage water is to increase profits relative to ground water. However, there is reason for concern because profitability seems to be on the decline because of the increasing presence of heavy metals.

This study highlights the need to control the use and discharge of such chemicals, and propose some ways in which this might be done. The study also adds new insights to the ongoing policy debate about how best to preserve the East Calcutta Wetlands and safeguard their ecological and social benefits.

## The East Calcutta Wetlands

The East Calcutta Wetlands are located on the south-eastern fringe of the city of Kolkata and are spread across an area of approximately 7,500 hectares. Since British colonial times, the area has been used for the disposal of sewage water from the city. From 1930 onwards, people living in the area have used this untreated sewage water for fisheries and agriculture (see side bar).

The quality of the untreated sewage water used by farmers in the wetlands has changed over time with changes in the population and industrial profile of the city of Kolkata. On the one hand, population and industrial growth have led to an increase in the toxicity of sewage. On the other hand, concerns over environmental pollution have led to the relocation of some polluting industries (such as tanneries) outside the city limits. These environmental concerns have also led to the adoption of effluent treatment practices by some industries. Moreover, the relocation of cowsheds outside the city has contributed to a drop in the biodegradable content of wastewater.

## Collecting Data on Rice Cultivation and Water Toxicity

Rice is the major crop in the East Calcutta Wetlands even though vegetables, jute and oilseeds are also produced. Rice, however, occupies a

This policy brief is based on SANDEE working paper No. 62-11, 'Toxicity and Profitability of Rice Cultivation under Waste-Water Irrigation: The Case of the East Calcutta Wetlands' by Vivekananda Mukherjee, and Gautam Gupta, Department of Economics, Jadavpur University, Kolkata, India. The full report is available at: www.sandeeonline.org

## The East Calcutta Wetlands Wastewater Project

The East Calcutta Wetlands wastewater project was initiated in 1930 when sewage from the city was diverted to the wetlands through a chain of canals. Since then, the sewage water has provided the farmers with not only a cheap irrigation option in the dry season of the year but also an inexpensive substitute for costly fertilizers (because the water is full of nutrients).

The project has enabled the East Calcutta Wetlands, which spreads over an area of approximately 7500 hectares towards the south eastern fringe of the Kolkata metropolis, to provide important eco-system services to the city as well as livelihood support to a large number of people living in the region. The area is home to the largest wastewater-based non-saline fishery in the world.

Wetlands are very effective at cleaning the wastewater. The city of Kolkata relies on the East Calcutta Wetlands for wastewater disposal and has not constructed a treatment plant for sewage. This is remarkable given the manifold expansion of the city over the decades and the corresponding increase in the bio-degradable and non-bio-degradable content of its sewage water. Not only does the East Calcutta Wetlands save the city the cost of constructing a sewage treatment plant, it also contributes to flood control and helps with carbon sequestration.

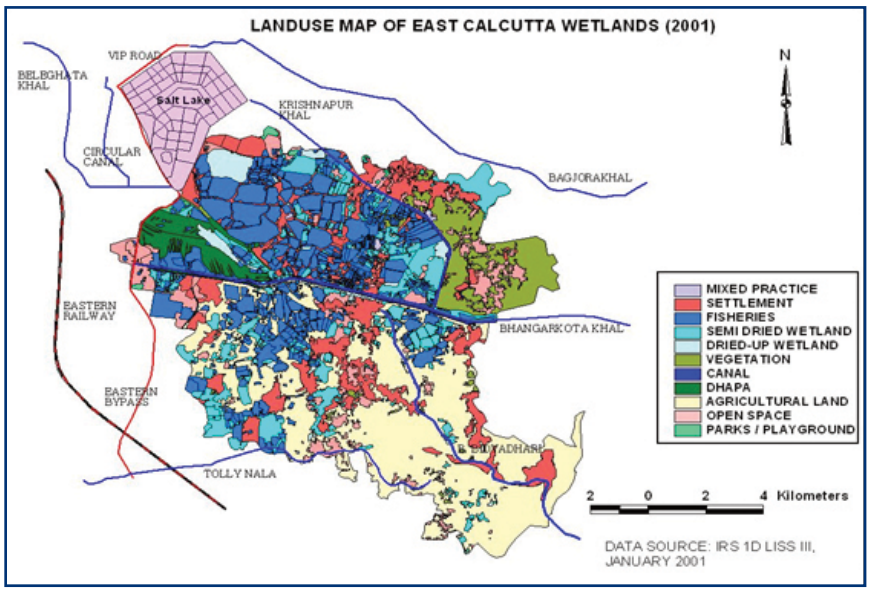
From an ecological point of view, the wetland area supports a wide variety of flora and fauna and is a storehouse of biodiversity. In 2002, the Wetlands were added to the list of Ramsar sites.

**Agriculture in ECW**

majority of cultivated land during the winter/summer crop when wastewater is used for irrigation. Rice also uses substantial amounts of water at different stages of production. Thus, it is more likely to be vulnerable to wastewater toxicity.

The East Calcutta Wetlands is a complex ecosystem with many different canals feeding into it. Thus, rice cultivation is based on wastewater from more than one canal. To account for differences in the toxicity of water, data samples for this study were gathered from nine different locations, which varied in terms of pollution sources (tanneries, canal intersections, etc.) and irrigation canals. The study also took into account the different ways in which farmers use wastewater for irrigation.

Canal water and soil samples were collected and tested chemically for heavy metal toxicity. Toxic chemicals are deposited in soils over years and can be taken up by crops as they grow. Two soil samples were collected from each sampling area and tested for contamination by lead, mercury and chromium. Samples were gathered in March-April, 2010, during the summer crop.



**Pisciculture in ECW**

Profitability data and other farm information were collected through a survey of 360 households. These households provided profitability and other relevant information for 565 plots of land.

## Sewage Water and Profitability

The study sought to identify the different factors that have an impact on the profitability of paddy cultivation. For this, the authors estimated the realized value of profit as a function of output and input prices and a few other key variables. The authors assessed how the use of canal water and the levels of chromium, lead and mercury in canal water and paddy field soils affect profits.

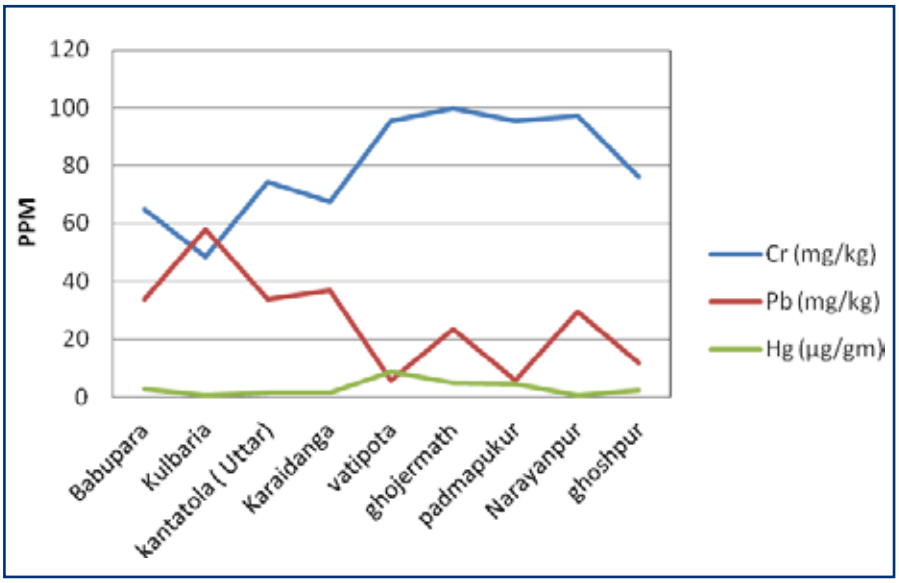
The results indicate that rice cultivation is more profitable in plots of land that use untreated-sewage water for irrigation compared to land that has never been under such irrigation and/or uses only ground water. The average profit per unit of output (Rs/Kg) from all sample plots using urban sewage water was 3.09; while it was only 0.40 for all plots that were irrigated with ground water. Thus, sewage water is clearly quite good because of the nutrients it supplies.

## Chromium and Mercury Reduce Profitability

While sewage water is, overall, a good thing for farmers, the heavy metals in the water are not. Toxic metals like chromium and mercury in the soil have a hand in reducing the profitability of rice cultivation. The analytical results indicate that profits fall (at a rising rate) with increased concentration of chromium and mercury in the soil. This is not surprising since mercury, the lightest heavy metal, has a tendency to climb up a plant to the grain with negative effects on grain quality.

## Presence of Heavy Metals in Soil

Local farmers were of the opinion that the profitability of rice cultivation had been decreasing due to the toxicity of the irrigation water and soil. It is entirely possible that the profitability has been falling over the years due to the rising presence of heavy metals. Furthermore, since the marginal rate of impact for these metals is increasing, it can be concluded that at some point in the future rice cultivation in the study region may become unprofitable altogether. It is interesting to note that the toxic metals have an impact even though the levels of chromium and mercury in the canal water and soil of the study region still hover around legally permissible levels.



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**Vegetables in Full Flush in ECW**

## What should be Done?

The analyses of rice production in the East Calcutta Wetlands highlight the negative impact of industries located in and around the city that manufacture products such as leather, batteries, paint and glass. There are also negative impacts from private households that use products with a high lead content, such as enamel paints.

There is clearly a need to control the discharge of chromium, lead and mercury in the wetlands. Regulations would be one way to do this. An alternative strategy would be to construct an effluent treatment plant that would remove these metals from sewage before it is discharged into outflow canals. The environmental benefits provided by the East Calcutta Wetlands hinge on, amongst other things, controlling the release of toxic metals into the wetlands. Proper treatment of water would enable the long-established practice of using sewage water in rice cultivation to continue.

A number of issues remain for further analyses. It would be useful, for example, to understand how toxicity affects the various varieties of rice produced in the region. Moreover, since the rice is for human consumption, it would also be important to investigate the health impacts of rice produced using wastewater. Such studies would strengthen our understanding how to continue to conserve and benefit from the East Calcutta Wetlands.


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