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A Study On Wastewater Irrigation In Salem District Of Tamil Nadu

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ABSTRACT

This paper highlights the use of wastewater for irrigation purposes on groundwater quality and its ultimate effects on human health for the local community in Salem, Tamil Nadu. Field study was conducted in Virapandi village, Salem and quality parameters like pH, EC, SAR, RSC, TDS, heavy metals (Mn, Ni, Cr, Pb, Cu, Co, Fe, Zn) and biological parameters like Total Coliform and Faecal Coliform (E-Coli) were observed in groundwater samples. Results of the study revealed that the untreated wastewater application raises the values of EC, TDS, SAR and RSC compared with the National Environmental Quality Standards (NEQS). These parameters not only degrade the soil structure but also contaminate the groundwater, causing severe health hazards to the local community. As far as heavy metals are concerned, only the concentration Ni, Cr and Pb in the wastewater treated soils found in permissible range. Use of wastewater by mixing with fresh water to keep the environment healthy was suggested, if available.

KEYWORDS: Wastewater, Groundwater, Quality, Environment, Health Impact

1. INTRODUCTION

Wastewater is made up of domestic wastewater, industrial wastewater, storm water etc. and its application in agriculture is a global practice. In many countries with a shortage of water there is also an escalating growth in population, resulting in increasing demand for drinking and agricultural water. Along with the increase in water demand, comes the production of vast amounts of wastewater, both industrial and domestic. With the rapid urbanization the municipalities have no means to manage the wastewater produced, resulting in inadequate or nonexistent treatment. The disposal of wastewater into water bodies imposes a public health risk. The pollution of fresh water sources further contributes to the water shortages. A recent report from the World Health Organization says that nearly 20% of the world's population has no source of safe drinking water (Bartam *et al.*, 2005). International Water Management Institute estimates that by 2025, 1.8 billion people will live in regions with absolute water scarcity (IWMI, 2000).

In water scarce communities wastewater is looked upon as a valuable resource with its high nutrient content and its year around availability. In many developing countries the urbanization will continue and as a result the wastewater flows will increase in the future. The use of untreated wastewater is a growing practice that is difficult to control. There exist many negatives effects of the use, e.g. health hazards due to microbial and chemical contamination, soil Stalinization and contamination of groundwater sources. But many times the economical benefits are much larger and farmers experience larger crop yields without the expenses of fertilizers.

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Rough estimates indicate that at least 20 million hectares in 50 countries are irrigated with raw or partially treated wastewater (Mahmood, 2006). Currently, in developing countries, approximately 80% of urban wastewater is used for irrigation contributing to 70-80% food security and the livelihoods of urban and peri-urban communities (Mara and Cairncross, 1989; Cooper, 1991).

The quality of wastewater effluents is responsible for the degradation of the receiving water bodies, such as lakes, rivers, streams, etc. The potential deleterious effects of polluted wastewater effluents on the quality of receiving water bodies are manifold and depend on volume of the discharge, the chemical and microbiological concentration/ composition of the effluents. It also depends on type of the discharge for example whether it is amount of suspended solids or organic matter or hazardous pollutants like heavy metals and organ chlorines, and the characteristics of the receiving waters (Owuli, 2003).

Wastewater is a complex resource, with both advantages and inconveniences for its use. Wastewater and its nutrient contents can be used for crop production, thus providing significant benefits to the farming communities and society in general. However, wastewater use can also impose negative impacts on communities and on ecosystems. The widespread use of wastewater containing toxic wastes and the lack of adequate finances for treatment is likely to cause an increase in the incidence of wastewater borne diseases as well as more rapid degradation of the environment. Although the harmful effects of using contaminated wastewater effluents could be delayed for several years using intensive and heavy irrigations, it adversely affect groundwater quality when nutrients leach down the soil (Mahmood and Maqbool, 2006).

The widespread use of wastewater containing toxic wastes and the lack of adequate finances for treatment is likely to cause an increase in the incidence of wastewater-borne diseases as well as more rapid degradation of the environment. Along with hazardous concentration of soluble salts and heavy metals, all the sewage waters do contain plant nutrients and organic matter (Ghafoor *et al.*, 1995). Farmers using sewage water for irrigation save a lot of fertilizer expenditure (Ibrahim and Salmon, 1992). Harmful effects of saline and metals contaminated effluent could be delayed for several years using intensive and heavy irrigations. This not only leach down the salts already present in soil but also adversely affect on groundwater quality which is of great concerned in the study area, as most of the community uses groundwater for drinking purposes.

In order to work out the environmental impacts of the untreated wastewater irrigation, a research study was conducted to quantify the extent of ground water contamination using wastewater irrigation and to evaluate their effects on human health of the local community.

Since large amounts of wastewater effluents are passed through sewage treatment systems on a daily basis, there is a need to remedy and diminish the overall impacts of these effluents in receiving water bodies. In order to comply with wastewater legislations and guidelines, wastewater must be treated before discharge. This can be achieved through the application of appropriate treatment processes, which will help to minimize the risks to public health and the environment. To achieve unpolluted wastewater discharge into receiving water bodies, there is the need for careful planning, adequate and suitable treatment, regular monitoring and appropriate legislation. This is will enhance science-based decisions and ensure the sustainability of the environment and the health of plants and animals. There is also a need to ensure that effluents standards and limitations, as set by regulatory bodies are not compromised.

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2. THEORY

The theory of Negative Externality is the foundation of environmental economics. We review briefly three seminal contributions to the theory by Pigou (1920), Coase (1960) and Baumol and Oates (1988).

Pigou deals with the problem of smoke emission by a factory damaging nearby business/residents. His solution for correcting the negative externality is to impose a per unit tax on output of the firm generating the negative externality. The per unit tax should be equal to the difference between the social marginal cost and the private marginal cost corresponding to the social optimal output, the output satisfying the condition the price equals the social marginal cost. Imposition of such a tax will raise the output price and reduce the demand and thereby helps in internalizing the environmental costs to some extent in the decisions of producers and consumers of the product. Pigou recognizes that 'sometimes, when the interrelations of the various private persons affected are highly complex, the government may find it necessary to exercise some means of authoritative control.

Coase considers the pollution problem of reciprocal nature. He says it is necessary to know whether the damaging business is liable or not for the damage caused since without the establishment of this initial delimitation of rights there can be no market transactions to transfer and recombine them. But the ultimate result (which maximizes the value of production) is independent of the legal position if the pricing system is assumed to work without cost. This proposition is known as the Coase theorem. He argues that the problem which we face in dealing with actions which have harmful effects is not simply one of restraining those responsible for them. What has to be decided is whether the gain from preventing the harm is greater than the loss which would be suffered elsewhere as a result of stopping the action which produces the harm. He rules out government intervention in the form of specifying standards or levying a tax to correct the externality, but advocates a role for government in defining and enforcing property rights for environmental resources and mitigating transaction costs.

Baumol and Oates highlight the information problems (knowledge of marginal damage and marginal social cost functions, determination of social optimal output and its uniqueness) in implementing the Pigouvian tax. To solve this problem he suggests a two-stage approach:

First, decide the ambient standards based on available scientific knowledge or/and social preferences, and second, pursue one of the following two options, namely, standards and charges approach or standards and permits approach.

Given the standards, the charges can be decided based on knowledge of the marginal abatement cost functions. Alternatively, giventhe standards and information about the baseline pollution levels, tradable permits/quotas can be distributed and prices of the permits be determined by the market forces.

In the absence of wastewater, the households in these villages have to mostly engage in distress migration or remain unemployed. The possibility of carrying out agricultural activities itself is a positive externality. Irrigation with untreated or partially wastewater is a negative externality because the households in the peri-urban areas are exposed to the hazards associated with it. The sewage flow is likely to contaminate the ground water even risking the quality of drinking water. The major health hazard of using wastewater is for the persons who are in contact with wastewater.

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3. MATERIAL AND METHODS

AREA OF THE STUDY

Salem pronunciation is a city and a corporation in Salem district in the Indian state of Tamil Nadu. Located in the north central part of the southernmost state of India, it is the fourth largest city of Tamil Nadu, after Chennai, Coimbatore and Madurai. Almost completely surrounded by hills, it is also a part of the Kongu Nadu (Tirupur and Coimbatore) region. The estimated sewage generations 325.75 MLD among corporation and municipalities and 55.75 MLD and town Panchayats. In Salem Corporation, water treatment facilities have not been established and hence there is no organized disposal of sewage water. Nature of Disposal and quantity through river water is 124.75 MLD in Municipalities and 29.47 MLD in Town Panchayats. The district also lacks underground drainage system except Salem Corporation.

There are 9 Taluks, 20 blocks and 646 villages in Salem District. The study site lies between North Latitudes 10°58′ and 11°48′ East Longitudes 77°53′ and 78°21′ with a total drainage of 2,438 km2. In this study, researcher selected six wastewater irrigated villages for in-depth study. The villages were purposively selected based on quality of the wastewater used for irrigation. These villages belonging to Veerapandi Taluk in Salem district. In each of the six villages in the first stage a survey was conducted to collect baseline information and to list all the households. In the second stage sample households were selected based on stratified random sampling procedure. Here ownership of land has been the stratum used. About 5 percent of the households from each stratum have been selected for detailed household survey using structured interview schedules. The surveys have been conduct during 2016-2017. The following table gives the details of sampling.

More than 2000 hectares are irrigated by untreated wastewater. In the present study Virapandi Taluk, where only mean of irrigation is wastewater, was selected.

Table 1

SERIAL NUMBER	VILLAGES	TOTAL NUMBER OF HOUSEHOLDS	SAMPLE HOUSEHOLDS
1	AKKARAPALAYAM	723	72
2	VEERAPANDI	1369	137
3	MURANGAPATI	674	67
4	PAPARAPATI	938	93
5	RAKKIPATI	498	50
6	RAJAPALAYAM	427	42
	TOTAL VILLAGES	**4629**	**461**

Source: Primary Data

Analysis of samples was done in the Laboratory according to the standard methods for the parameters like pH, SAR (Sodium Adsorption Ratio), RSC (Residual Sodium Carbonate), TDS (Total Dissolved Solids), EC (Electric Conductivity) and E-Coli. Heavy metal (Mn, Ni, Cr, Pb, Cu, Co, Fe, and Zn) concentrations in the ground- water were also examined in the laboratory. An epidemic survey was made using a questionnaire developed to assess the health effects of wastewater irrigation by interviewing local community.

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3. RESULTS AND DISCUSSIONS

Field experimental results are outlined to quantify and evaluate the impact of untreated wastewater reuse on groundwater and human health of local community in Salem.

4. GROUNDWATER QUALITY DETERIORATION

The results obtained from the analyses of groundwater for the selected plots (Table 2) indicates average values of EC found to be 4.7 dS/m, TDS 2549 mg/L, SAR 53.90 mmol/L$^{0.5}$ and RSC 9.4 meq/L. These parameters indicate that the water is hazardous for irrigation according to the National Environmental Quality.

Table 2: Comparison of Varying Quality Groundwater with and NEQS

Parameters	pH	EC (dS/m)	TDS (mg/L)	SAR (mmol/L$^{0.5}$)	RSC (meq/L)
Field Observed	7.8	4.7	2549	53.90	9.4
NEQS	7-10	1.6	1000	10.10	2.4

Source: Primary Data

Table 3: Water Quality Criteria for Irrigation

Class	Quality	EC (dS/m)	TDS (mg/L)	SAR (mmol/L$^{0.5}$)	RSC (meq/L)
1	Suitable	<1.5	<1000	<7.5	<2.0
2	Marginal	1.5-2.7	1000-1800	7.5-15	2.0-4.0
3	Unsuitable	>2.7	>1800	>15	>4.0

Source: Primary Data

Table 3 presents the water quality criteria for irrigation developed by the US Salinity Laboratory Staff in term of suitable, marginal and unsuitable. On comparing the observed values (Table 2) for EC, TDS, SAR and RSC, it was again found that water is unsuitable for irrigation as exceeding the permissible values as explained in Table 3. These results are similar as reported by many researchers (Downs, *et al.*, 1999; Rashed, *et al.*,1995).

On the average, groundwater in the entire study area was moderately saline. The salinity of irrigation water is an important water quality parameter affecting plant growth. Continuous use of wastewater irrigation caused the problem of salinity. It is a matter of common observation that the wastewater carries undesirable contaminates which travel into plant tissues and ultimately end up in human veins. This is extremely dangerous as the humans are drinking groundwater without any treatment and quality of water being used for irrigation is totally unfit for drinking purpose.

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5. HEAVY METALS STATUS IN GROUNDWATER

Table 4: Comparison of Varying Quality Groundwater Heavy Metal Concentrations (mg/L) with NEQS

Heavy Metal	Mn	Ni	Cr	Pb	Cu	Co	Fe	Zn
Field Observed	1.7	0.114	0.03	0.14	0.29	0.13	3.90	1.88
NEQS	0.12	0.20	1.00	0.50	1.00	0.05	5.00	0.77

Source: Primary Data

Among metals (Table 4), Fe present in maximum quantity with 45% of the total metal concentration whereas, Cr was minimum. Table further indicates clearly that heavy metals concentration of Mn, Cu, Co and Zn accumulation in wastewater irrigation treatment found higher than the values presented by NEQS, however, Ni, Cr and Pb concentration was minimum. the effects of wastewater irrigation on health related diseases in the study area. It is evident that the overall ratio of sufferings from all the diseases is higher in Virapandi village where wastewater irrigation is the only mean for irrigating field crops. It is also important to note that maximum number of household and their inhabitants are affected by different diseases related to stomach and digestory system (Diarrhea, Dysentery and Diarrhea with fever) which are the direct effect of the use of polluted water for drinking as well as the direct exposure to the wastewater. It is also inferred during survey that number of people suffered among one house hold and the frequency of getting ill in a year is also higher in this village. An immediate action plan is suggested to minimize the hazardous effect of wastewater irrigation to save our community as well as our future on this globe.

6. CONCLUSIONS

The EC, TDS, SAR and RSC of the groundwater are higher than NEQS in the wastewater irrigated fields causing deterioration of groundwater quality, making it unfit for irrigation use. As far as the presence of heavy metals are concerned, all the parameters in groundwater were found higher than the permissible range except Ni, Cr and Pb in the wastewater treated soils. The epidemic survey results revealed the prevalence of higher suffering rate of local community from waterborne diseases like Diarrhea, Typhoid, and Dysentery in study area.

7. REFERENCES

1. Bartam J., Lewis K., Lenton R., Wright A., 2005. Focusing on improved water and sanitation for health. The Lancet Vol 365, pp 810-812
2. Baumol, W. and W.E. Oates (1988), Theory of Environmental Policy, Cambridge University Press.
3. Coase, R (1960), The Problem of Social Cost, Journal of Law and Economics, 3, 1-44.
4. Cooper, R.C. (1991). Public health concerns in wastewater reuse.Water Science and Technology, 24(9), 55-65
5. Downs, T.J., Cifuentes-Garcia, E. and Suffet, I.M. (1999). Risk screening for exposure to groundwater pollution in a wastewater irrigation district of the Mexico City region. Environmental Health Perspectives, 107(7), 553- 561.
6. Ghafoor, A., Rauf., A. , Arif, M. and Muzaffar, W. (1994). Chemical composition of effluents from different industries of the Faisalabad. Pakistan Journal of Agriculture Sciences, 33, 73-74.

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7. Government of India (Ministry of Environment and Forests) (2004), Policy Statement for Abatement of Pollution.
8. Government of India (Ministry of Finance) (1999), Economic Survey 1998-99.
9. Ibrahim, M. and Salmon, S. (1992). Chemical compositionof Faisalabad city sewage effluent. I. Nitrogen, phosphorus and potassium contents. Pakistan Journal of Agriculture Sciences, 30, 381-390.
10. International Water Management Institute, 2000. Projected Water Scarcity in 2025. www.iwmi.cgiar.org/home/wsmap.htm#A1 (accessed March 6 2005)
11. Mahmood, S. (2006). Wastewater Irrigation: Issues and Constraints for Sustainable Irrigated Agriculture. Journal of Italian Agronomy. (Communicated).
12. Maqbool, M.A. (2007). Environmental consequences of wastewater irrigation. MS thesis, Centre of Excellence in Water Resources Engineering, Lahore, Pakistan.
13. Mara, D. and Cairn cross, S., (1989). Guidelines for safe use of wastewater and excreta in agriculture and aquaculture: measures for public health protection. World Health Organization, Geneva, 187p.
14. Owuli MA (2003). Assessment of impact of sewage effluents on coastal water quality in Hafnarfjordur, Iceland. The United Nations Fishery Training Program, Final Report.
15. Pigou, A.C. (1920), The Economics of Welfare, Macmillan.
16. Rashed M., Awad., S.R., Salam, M.A. and Smidt, E. (1995). Monitoring of groundwater in Gabal el Asfar wastewater irrigated area (Greater Cairo). Water Science and Technology, 32(11), 163-169.
17. Sankar, U. (2000), Environmental Economics, Reader in Economics, Oxford University Press, Oxford India Paperback 4th impression 2004.
18. Van der Hoek W., Hassan M.U., Ensink J.H.J., Feenstra S., Raschid-Sally L., Munir S., Aslam R., Ali N., Hussain R., Matsuno Y., 2002. Urban Wastewater: A Valuable Resource for Agriculture – A Case Study from Haroonabad, Pakistan. Research Report 63. Colombo, Sri Lanka: International Water Management Institute.
19. van der Hoek, W., 2004, A Framework for a Global Assessment of the Extent of Wastewater Irrigation: The Need for a Common Wastewater Typology, in: Scott, C. A., Farunqui, N. I., Raschid-Sally, L., Wastewater Use in Irrigated Agriculture, Confronting the Livelihood and Environmental Realities, 11-24, CAB International, International Water Management Institute, International Development Research Centre, Trowbridge.
20. WHO (2006), Guidelines for the safe use of wastewater, excreta and grey water.Vol.2 Wastewater use in agriculture. World Health Origination, Geneva.

