Scientific Journal Impact Factor (SJIF): 1.711

e-ISSN : 2349-9745
p-ISSN : 2393-8161

International Journal of Modern Trends in Engineering and Research

www.ijmter.com

Use of Polluted River Water after the Treatment for Irrigation Purpose Case study: Purandar Lift Irrigation Scheme

Miss. Pranjali Arun Chiwhane[1], Dr. Sameer S. Shastri[2], Dr. D. K. Parbat[3]

[1]*Department of Civil Engineering, Sinhgad college of Engg., Pune -411 041*

[2]*Department of Civil Engineering, Sinhgad college of Engg., Pune -411, 041*

[3]*Department of Civil Engineering, Government Polytechnic College Nagpur-440 001*

Abstract-Water is one of the basic needs having vital importance for the survival of human being. Environment fulfils this need of human being by providing different natural resources like rivers, lakes, streams etc. This need of human being demands for clean water for drinking and recreation purpose but now-a-days, due to the reasons like increased population, urbanization & industrialization are getting polluting these natural resources. As the demand for water increases, making more efficient use of water becomes more important.

River Mutha as it passes through the city of Pune receives domestic waste as well as industrial waste. Untreated or partially treated wastewater, which is a negative externality of urban water use, is widely used for irrigation in water scarce regions like Purandar, Daund, Haweli, and Baramati having undulating ground profile where average rainfall is around 400 to 500 mm. Marginal quality water or water whose quality might pose a threat to sustainable agriculture and/or human health if used for irrigation without taking certain precautions. In order to protect the public both from consuming crops grown on contaminated water and from direct exposure to the applied effluent during ploughing etc. The waste water needs to be treated properly before it is supplied for irrigation. Low cost technology (oxidation pond) is particularly well suited for tropical and subtropical regions because the greater amount of sun and higher temp contribute to a more efficient removal of waste as well as system provide reliable, low cost, and relatively low maintenance treatment for municipal and industrial discharges.

Keywords — wastewater irrigation, oxidation pond, wastewater treatment.

I. INTRODUCTION

River Mutha as it passes through the city of Pune and river Mula from chinchwad receives domestic wastes along with industrial effluents from small-scale industries are getting polluted. Water from Mutha (after confluence with Mula) and before the confluence with river Bhima has been lifted by the Purandar Lift Irrigation Scheme for irrigation purpose. Untreated or partially treated wastewater, which is a negative externality of urban water use, is widely used for irrigation in water scarce regions like Purandar, Daund, Haweli, and Baramati having undulating ground profile where average rainfall is around 400 to 500 mm. So, farmers are forced to use water coming from Purandar Lift Irrigation Scheme for irrigation and they are satisfied by using this water as their crop production has increased. But they are unaware about long term effects of using this polluted water to ground water. Marginal quality water or water whose quality might pose a threat to sustainable agriculture and/or human health if used for irrigation without taking certain precautions so this report suggest that if there is shortage of fresh water, treated wastewater can also serve the purpose of irrigation.

In Purandar Lift Irrigation Scheme river water is lifted from the source up to the height of 370 m in six stages and conveyed through closed pipes to considerable distances and used for irrigation to irrigate around 25,498 hector of land having discharge of 8000 lit/sec. Purandar Lift Irrigation Scheme consists of seven gravity mains of 76182 m length and on gravity main total length of 169.181 km minors.

II.OBJECTIVES

Objectives of the project are

- To understand the existing distribution scenario;
- To analyse various parameters of river water;
- Ways of using polluted river water for irrigation;
- To analyse the current scenario of availability of barren land;
- To make optimum utilisation of barren land;
- To assess the social impact & ways to overcome that.

III.LITERATURE REVIEW

(2006) Wastewater irrigation in the developing world—two case studies from the Kathmandu Valley in Nepal *by* ***Thomas Rutkowski***, ***Liqa Raschid-Sally***, *(International Water Management Institute, Ghana) &* ***Stephanie Buechler*** *(Bureau of Applied Research in Anthropology, University of Arizona, Tucson, AZ, USA.* This paper briefly reviews that at least one-half of the farmers (55% of sample) have personally experienced, or have had a family member experience skin problems as a result of irrigating with wastewater.

(2009) Impact of irrigation water quality on human health: A case study in India *by* ***Jeena T. Srinivasan***, *(RULNR, Centre for Economic and Social Studies, Nizamiah Observatory Campus, Hyderabad, India) &* ***V. Ratna Reddy,*** *(Livelihoods and Natural Resources Management Institute, Hyderabad, India).* Waste water pose health risks directly to agricultural workers and indirectly to consumers of the wastewater grown produce. This paper briefly reviews the health risks of using wastewater for irrigation and elicits the health problems of those who are directly exposed to wastewater based livelihood activities. It further estimates the morbidity and its determinants and estimates the cost of illness incurred by the households in the vicinity of wastewater irrigated area. Primary data collected from six wastewater and one fresh water irrigated villages have been used for the analysis. The study finds that there exists significantly higher morbidity in the wastewater irrigated villages when compared to fresh water irrigated village and the cost of illness incurred by these households is substantial. The study recommends adequate treatment of wastewater and public health education for adopting precautionary and preventive measures for those directly exposed to wastewater.

(2009) Wastewater Irrigation in Vadodara Gujarat, India: Economic Catalyst for Marginalized communities *by* ***Vaibhav Bhamoriya*** *(IWMI–Tata Water Policy Program, Anand, Gujarat, India).* On the wastewater-irrigated farms fertilizer use has gone down, but pesticide use and labour inputs have increased in the past few years. The farmers recognize the fertilizer-saving benefit of wastewater and also the need for more pesticides because municipal sewage also contains plant pathogens.

(2009) Performance of an oxidation pond -A case study **Ashish Kumar Nayak** (Department Of Civil Engineering National Institute Of Technology, Rourkela) (2006) WHO Guidelines for the safe use of Wastewater, -Volume II Wastewater Use In Agriculture **World Health Organization, France.** Design manual for waste stabilization ponds in India **Duncan Mara.** Design of oxidation pond.

IV.NECESSITY OF THE STUDY

In order to protect the public both from consuming crops grown on contaminated water and from direct exposure to the applied effluent during ploughing etc. The waste water needs to be treated properly before it is supplied for irrigation.

Potential impacts of wastewater use in agriculture .The review covers:

A. Public Health:

In particular, human parasites such as protozoa and helminthes eggs are of special significance in this regard as they prove to be most difficult to remove by treatment processes and have been implicated in a number of infectious gastrointestinal diseases in both developed and developing countries. However, in evaluating health Impacts it must be remembered that it is the Wastewater contains pathogenic microorganisms such as bacteria, viruses, and parasites, which have the potential to cause disease actual risk that make people fall ill that must be quantified and not the presence of pathogens in water. Whilst the potential risk may be quite high, the actual risk depends on many other factors. The reuse of untreated wastewater for irrigation, no doubt, poses a high risk to human health in all age groups. However, the degree of risk may vary among the various age groups. Untreated wastewater irrigation leads to relatively higher prevalence of hookworm (Feenstra et al. 2000),and Ascarias is infections among children (Cifuentes et al. 2000; and Habbari et al. 2000).Heavy metals in wastewater pose a health risk if they are ingested in sufficient concentrations ,and can be dangerous.

In principle, uptake of heavy metals by crops and the risk posed to consumers may not be an issue as plants cannot resist high concentrations of these pollutants and die off before they become a threat to humans. Shuval et al. (1986), made an extensive study of health effects of pathogens but there is no comprehensive study which assess the impact of heavy metals and the real risks posed to human health .These findings have important implications for the valuation of public health risks associated with wastewater irrigation. First, they indicate that valuation of public health risk is an important decision variable in wastewater irrigation and both adult population as well as children should be considered as potential exposure group. Second, the entire population, living within and outside the wastewater irrigation zone, should be considered as the potential exposure groups for economic valuation purposes.

B.Crops:

Generally speaking, wastewater (treated and untreated) is extensively used in agriculture because it is a rich source of nutrients and provides all the moisture necessary for crop growth. Most crops give higher than potential yields with wastewater irrigation; reduce the need for chemical fertilizers, resulting in net cost savings to farmers. If the total nitrogen delivered to the crop via waste water irrigation exceeds the recommended nitrogen dose for optimal yields, it may stimulate vegetative growth, but delay ripening and maturity, and in extreme circumstances, cause yield losses. Crop scientists have attempted to quantify the effects of treated and untreated wastewater on a number of qualities and yield parameters under various agronomic scenarios (reference bibliography, and annex 3 on “Empirical Evidence of Impacts of Wastewater Irrigation on Crops”). An overview of these studies suggests that treated wastewater can be used for producing better quality crops with higher yields than what would otherwise be possible.

The use of untreated municipal wastewater, as is the practice in many countries, pose a whole set of different problems. Nevertheless, the high concentration of plant food nutrients becomes an incentive for the farmers to use untreated wastewater as it reduces fertilizer costs, even when the higher nutrient concentrations may not necessarily improve crop yields. Most crops, including those grown in peri-urban agriculture, need specific amounts of NPK for maximum yield. Once the recommended level of NPK is exceeded, crop growth and yield may negatively be affected. For example, urea plant effluents are a rich source of liquid fertilizer but in concentrated forms they have adverse effects on rice and corn yields (Singh and Mishra 1987).The composition of municipal wastewater also has to be taken into account. Predominance of domestic wastewater may result in high salinity levels that may affect the yield of salt sensitive crops. Above discussion shows that the economic impacts of wastewater on crops may differ widely depending upon the degree of treatment and nature of the crops. From an economic viewpoint, wastewater irrigation of crops under proper agronomic and water management practice may provide the following benefits:

A. Higher yields,
B. Additional water for irrigation &
C. Value of fertilizer saved.

Alternatively, if plant food nutrients delivered through waste water irrigation result in nutrient over supply, yields may negatively be affected.

C. Soil Resources:

Impact from wastewater on agricultural soil, is mainly due to the presence of high nutrient contents (Nitrogen and Phosphorus), high total dissolved solids and other constituents such as heavy metals, which are added to the soil over time. Wastewater can also contain salts that may accumulate in the root zone with possible harmful impacts on soil health and crop yields. The leaching of these salts below the root zone may cause soil and groundwater pollution (Bond 1999). Prolonged use of saline and sodium rich wastewater is a potential hazard for soil as it may erode the soil structure and effect productivity. This may result in the land use becoming none sustainably the long run. The problem of soil salinity and sodality can be resolved by the application of natural or artificial soil amendments. However, soil reclamation measures are costly, adding to economic constraints resulting in losses to crop productivity. Moreover, it may not be possible to restore the soil to the original productivity level, by using these soil amendments. Hence, wastewater irrigation may have long-term economic impacts on the soil, which in turn may affect market prices and land values of saline and waterlogged soils. Wastewater induced salinity may reduce crop productivity due to general growth suppression, at pre-early seedling stage, due to nutritional imbalance, and growth suppression due to toxic ions(Kijne et al. 1998).

The net effect on growth may be a reduction in crop yields and potential loss of income to farmers. Wastewater irrigation may lead to transport of heavy metals to soils and may cause crop contamination affecting soil flora and fauna. Some of these heavy metals may bio-accumulate in the soil while others, e.g., Cd and Cu, may be redistributed by soil fauna such as earthworms (Kruse and Barrett 1985). Studies conducted in Mexico (Assad in et al. 1998), where wastewater mixed with river water has been used for crop irrigation for decades, indicate that polluted water irrigation may account for up to 31percent of soil surface metal accumulation and lead to heavy metal uptake by alfalfa. However, heavy metal concentrations in alfalfa pose no risk to animal or human health. In a critical assessment of USEPA heavy metal guidelines, McBride (1995, argues that heavy metals applied through sewage use can harm sensitive plants with possible loss of soil productivity12in the long run, if available in sufficient quantities. In general, heavy metal accumulation and translocation is more a concern in sewage sludge application than wastewater irrigation, because sludge formed during the treatment process consists of concentrations of most heavy metals.

The impact of wastewater irrigation on soil may depend on a number of factors such as soil properties, plant characteristics and sources of wastewater. The impact of wastewater from industrial, commercial, domestic, and dairy farm sources are likely to differ widely. The use of dairy factory effluents for 22 years in New Zealand shows that nearly all applied P is stored in the soil while nitrogen storage is minimal, implying nitrogen leaching and consequent nitrate pollution of the groundwater (Degums et al. 2000).

D. Groundwater Resources:

Wastewater application has the potential to affect the quality of groundwater resources in the long run through excess nutrients and salts found in wastewater leaching below the plant root zone. However, the actual impact depends on a host of factors including depth of water table, quality of groundwater, soil drainage, and scale of wastewater irrigation. For instance the quality of groundwater would determine the magnitude of the impact from leaching of nitrates. If the groundwater is brackish the leaching of nitrates would be of little concern as the water has non valuable use attached to it.

The proximity of wastewater irrigation to sources of potable water supplies such as wells or tube wells will influence how we evaluate the severity of ground water pollution effects. Groundwater constitutes a major source of potable water for many developing country communities. Hence the potential of groundwater contamination needs to be evaluated before embarking on a major wastewater irrigation program. In addition to the accretion of salts and nitrates, under certain conditions, wastewater irrigation has the potential to translocation pathogenic bacteria and viruses to groundwater (NRC report 1996). Farid et al. (1993), report that in Gabal el As far farm in the Greater Cairo region, where untreated or primary treated wastewater has been used for irrigation since 1915, the long-term use of wastewater for crop irrigation has interestingly led to an improvement in the salinity of the groundwater. This was offset by evidence of coli form contamination of groundwater which was also observed in Mexico (Downs et al. 1999, Gallegos et al. 1999).

A companion study (Rawhide al. 1995), reveals that in the wastewater irrigated Gabar el Asfar region, concentrations of chloride, sulfate, TDS, and dissolved oxygen in groundwater is much higher than average concentrations in sewage effluents. The leaching and drainage of wastewater, applied for crop irrigation, to groundwater aquifer may serve as a source of groundwater recharge. In some regions,50-70 percent of irrigation water may percolate to groundwater aquifer (Rashed et al. 1995). The influence of percolated wastewater on groundwater quality and its recharge is thus likely to be substantial. Despite fields indicates that cadmium concentration decreases as water passes through the fields. This may have an impact with respect to concentrations of heavy metals in drainage water. The effects of these concentrations on the ecosystem may thus be reduced.

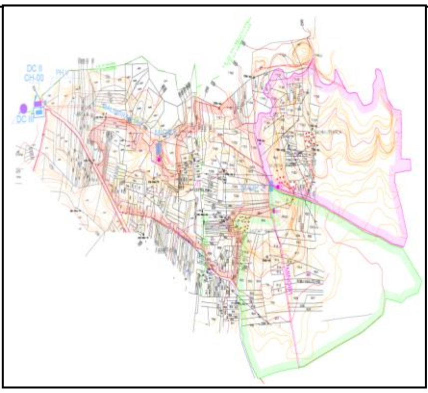
V.METHODOLOGY

A. Data collection from minor irrigation department Swargate Pune.
B. Study of contour maps of Purandar Lift Irrigation Scheme in order to understand existing distribution Scenario.
C. Study of water quality requirement for irrigation.
D. To Analyze various parameters of river water to determine suitability for Irrigation : As this river water is used for irrigation, the parameters required to be analyze are BOD,COD, Hardness, Heavy Metals like total chromium, Lead, Mercury etc.
E. Identification of barren land suitable for installation of treatment facility & to check its feasibility for the treatment unit in order to avoid pumping so that water will flow through gravity.
F. Design oxidation ponds as most viable techno-economical solution.
G. Recommendations for alternate source of income

VI. ANALYSIS

A. Visit to Purandar Lift Irrigation Scheme site
B. Carried out regular meeting and discussion with Deputy Engineering Purandar Lift Irrigation scheme.

Figure 1 Contour map of location Malshiras



C. Collected contour maps of the site which includes around 250 different contour maps. Based on the regular visits to Purandar Lift Irrigation Scheme site and contour maps studied I have selected three locations on major lines of Purandar Lift Irrigation Scheme that are Malshiras, Dive & Baramati. Malshiras line consists of total 18 minors having length of 6250 m and 69 of chucks (area surrounded by the outlet) where I am getting 133.66 hectors. 2 on Dive line in Minor 2 on outlet no. 3 I am getting 22 hector having chuck 2190. Out of baramati malshiras and dive lines, baramati line is not executed yet but I have identified location before excution on Dive line on Minor 2 and otlet no1i am getting 3.86 hector of gut no 203.89 hector where command area is203.89 hec. On Baramati line i have selected alternate location on Minor 1 on outlet no 1where I am getting 3.76 hector of gut no 109 and command area 200.49 hector.

D. Carried out sampling and analysis of the river water starting from the month of October.

Table 1: Analysis Data

PARAMETERS	UNITS	RANGE	DATE									
			30-Oct-13	15-Nov-13	06-Dec-13	19-Dec-13	24-Jan-14	07-Feb-14	24-Feb-14	07-Mar-14	24-Mar-14	28-Mar-14
BOD	mg/l	46-155	46	52	68	84	96	108	116	128	135	155
COD	mg/l	108- 248	108	118	132	148	168	172	196	212	236	248
Total Chromium	mg/l	<0.5	<0.5	-	-	-	-	-	-	-	-	-
Hardness	mg/l	210-212	210	132	148	220	180	216	228	204	208	212
Mercury (Hg)	mg/l	<0.05	<0.05	-	-	-	-	-	-	-	-	-
Lead (Pb)	mg/l	<0.2	<0.2	-	-	-	-	-	-	-	-	-
pH	-	7.66-6.89	7.66	7.65	7.8	7.66	7.78	6.9	7.46	6.89	6.66	6.89
E coli	CFU /100 ml	400	400	-	-	-	-	-	-	-	-	-

From the analysis of above data it can be established that the various parameters used for determining the water quality are above acceptable limits set for irrigation usage. This establishes the necessity of treatment of this river water which is currently being used for irrigation by farmers.

VII. RESULTS

Based on the data received from minor irrigation department of GOM the discharge of influent river water is found to be 30 lit/sec and the latitude of project site is 18. From analysis of samples collected from study area, the influent BOD was considered to be 250 mg/l. As per the recommended standards for irrigation the effluent BOD is taken as 30mg/l following design is done. As for the design of oxidation pond the elevation is also required which was found to be 550m using the Google Earth software after providing it with project location.

The estimation was performed for each pond as per the design. In order to reduce the cost of construction of pond, the excavated material is utilised for the construction of embankment by keeping the volume of excavation & filling equal. From the design the surface area of each pond is 2.59 Ha.

Table 2: Cost of Oxidation Pond

Cost of Oxidation Pond	
TOTAL (One Pond)	₹69,19,397.00
TOTAL (Five Ponds)	₹3,45,96,985.00

Considering Lump-sum cost for Administrative buildings, connecting roads & other miscellaneous expenses, the total cost of all ponds can be taken as **₹3,75,00,000/-.**

Following cost is based on alternate design which is based on actual field data from project site. From the analysis of sample collected from the study area, the influent BOD is found to be 150 mg/l. As per the recommended standards for irrigation, the effluent BOD is taken as 100 mg/l for the purpose of design.

Table 3: Cost of Oxidation Pond (Alternate Design)

Cost of Oxidation Pond	
TOTAL (One Pond)	₹42,36,079.00
TOTAL (Five Ponds)	₹2,11,80,395.00

Considering Lump-sum cost for Administrative buildings, connecting roads & other miscellaneous expenses, the total cost of all ponds can be taken as **₹2,50,00,000/-.**

ALTERNATE SOURCE OF INCOME FROM OXIDATION POND

Composite Pisciculture is a scientific technology for getting maximum fish production from a pond or a tank through utilisation of available food organisms supplemented by artificial feeding. Fish grows naturally in rivers and ponds but can also be produced under artificial conditions. Small entrepreneurs (farmers) can easily take up pisciculture in ponds and take it up as a source of livelihood or to supplement the family income. It also provides employment to skilled and unskilled youth.

VIII. CONCLUSION

The following conclusions can be drawn from this study,

1. In the current scenario, the use of wastewater for irrigation purposes is a viable option due to scarcity of freshwater as well as availability of wastewater.
2. Currently, untreated or partially treated wastewater is discharged into river streams & that is being used for irrigation purposes. This unrestricted use of wastewater poses a serious threat to health of both consumers & farmers. This adverse impact propagates from crops & ultimately affects the complete food chain.
3. For tropical countries like India, oxidation ponds present a practical & low cost solution for usage of wastewater for irrigation.
4. Oxidation ponds are low cost, low energy, low maintenance & above all sustainable method of wastewater treatment as compared to tertiary treatment.
5. Effective treatment in low-cost oxidation pond is thus a good way to improve the environment.

6. The study also highlights the importance of the topography of the region where oxidation ponds are being constructed. In this study, the oxidation ponds are located in such a manner that pumping is avoided to the maximum extent the complete flow may take place under gravity.

IX.RECOMMENDATIONS

1. The government should provide monetary compensation to the farmers on whose land the oxidation pond is being constructed as well as provide alternate land for farming.
2. The government should also create awareness through mass media as well as by conducting awareness programs regarding hazards of use of untreated/partially treated wastewater & benefits of using wastewater after treatment.
3. The government should also encourage generation of income from the project by utilisation of maturation ponds for pisciculture (Fish Farming). In this way, farmers will derive monetary benefits from the land used for construction of oxidation & will be motivated to provide their land for the project.
4. The municipal corporations should also assume responsibility of untreated wastewater released by them & should give financial assistance to projects for treatment of wastewater.

ACKNOWLEDGMENT

We would like to express my heartfelt gratitude to all my Professors and staff of the Civil Engineering Department, Sinhgad college of Engineering, Pune, for giving us their guidance and cooperation. We are also thankful to Mr. Nanaware, Executive Engineer, Minor Irrigation Division no.1, Swargate Pune 37, GOM Department and Ms. Mugdha Pujari Assistant Engineer Minor Irrigation, survey Sub Division Pune GOM Department, for providing required data of Purandar Lift Irrigation Scheme and providing access to the project site and regular sampling of river water.

REFERENCES

[1] Metcalf and Eddy "Waste water engineering treatment and reuse page no. 744-854".
[2] Soli Arceivala "Wastewater treatment for pollution control and reuse: page no. 201-425".
[3] Thomas Ruthowski, Liqua Rashid sally, Stephanin Buechler "Agricultural water management 88 (2007) 83-91".
[4] R.k. Trivedi "Journal of industrial pollution control 23(2)(2007) pp 403-411 Enviromedia"
[5] M.B. Pescod "Waste water treatment and use in agriculture- FAO irrigation and drainage paper 47".
[6] Dr. Birguy Lamizana "Environmental effects of waste water use in agriculture" GPA/FMEB UNEP Johannesburg 26-27 Sep 2012
[7] Thomas Ruthowski, Liqua Raschid sally, Stephanin Buechler "Waste water irrigation in the developing world-two case studies from the Kathmandu valley in Nepal".
[8] Jeena T. Srinivasan, V. and Ratna Reddy "Impact of irrigation water quality on human health: A case study in India"
[9] Details of Purandar Lift Irrigation Scheme from Mr. M. R. Nanawre (executive engg. Minor irrigation Dept Swargate Pune), Miss. Mugdha Pujari (subdivision minor irrigation Dept Golibar Maidan, Swargate, Pune).

