RIVER RAVI POTENTIALS, POLLUTION AND SOLUTIONS: AN OVERVIEW

By

Yasar A., Fawad A., Fateha A., Amna I. and Zainab R.

Sustainable Development Study Centre GC University Lahore

Abstract

River Ravi originating in India and ending in Pakistan irrigates almost one million acres of agricultural land in India and has a power generation potential of 2294MW. Intense pollution contributed by both India and Pakistan is threatening irrigation and ground waters and also terrestrial and aquatic life. About 1307.08 tons of hazardous and untreated waste is going into Ravi on daily basis. The load from district Lahore is 728.75 tons per day. About 1810 cusecs municipals sewage and toxic industrial effluents are being thrown into river by ten sewage drains and pumping stations. Prevention at source level is a solution for industrial effluents providing low interest loans and enforcing fines / taxes. To mitigate the environmental effects of sewage natural system of waste water treatment like oxidation ponds and lagoons can be cost effective solution. For the availability of water about 2000 cusecs of fresh water from Marala Ravi (MR) LINK canal is required to maintain dissolved oxygen level of 4 to 5mg/l. A lake/reservoir can be constructed within the course of the river from Siphon to Thokar Niaz Baig which will have many positive outcomes, flood control, recharging of ground water, development of recreational sites, aquaculture propagation and land reclamation.

Introduction

Water is essential source to sustain life on earth, 70% area of earth is covered with water but only 2.5% is fresh water and 30% of it is in glaciers form. Human beings are typically dependent on fresh water. Available fresh water is only less than 1%.Today this available fresh water is the most threatened natural resource. Rivers are one of such fresh water reservoirs. The region of subcontinent is rich in natural resources along with fresh water. Pakistan is blessed with rivers and all of them flow through Punjab province. The river of Kashmir and Pakistan, Ravi arises in Bara Bangal, a branch of the Dhauladhar range of Himalayas in Chamba district of Himachal Pradesh, a state of India. It starts in the northwestern direction and turns to south-west near Dalhousie (Fig. 1), the boundary of Jammu Kashmir. [1]

Fig1: Ravi turns to south-west.

The river Ravi which contributes the marvelous beauty of Chamba valley (Fig. 2), its basin lies between the Pir Panjal and Dhauladhar. The right bank that is at Kashmir side, tributaries of Ravi are Budhil, Tundahan, Beljedi, Saho, and Sial while its left bank tributary that is at Punjab side is Chirchind. Ravi zig-zags between the north western India and north eastern Pakistan after cutting Dhauladhar; flows to Pakistan border and along it before entering Pakistani Punjab.

Fig. 2: Ravi contributes the marvelous beauty of Chamba Valley

Ultimately Ravi merges Chenab River, but before the emergence of Ravi Chenab, the two rivers are linked to each other via Marala Ravi link canal and Upper Chenab Canal and Qadirabad- Bulloki Link Canal joins both the rivers at Bulloki headwork. Most wastewater discharge reaches to Ravi in the 60km stretch between Bulloki and Lahore. The last link canal is Trimmu Sindhnai ending at Sindhnai Barrage (Fig. 3) on Ravi .[2]

Fig. 3: Sindhnai Barrage on Ravi

Water availability in Pakistan and India

In India, overall water availability has declined from over 5000 cubic per meters in 1950 to 1800 cubic per meters in 2005. In Pakistan per capita availability of water has declined from 5600 cubic meters in 1947 to 1200 cubic meters in 2005, fast approaching the threshold level of 1000 cubic meters in 2007. The decline in water availability could be disastrous for irrigation. Pakistan has world's largest irrigation network, providing 60% of water utilized for irrigation. The inflow of water for irrigation has declined from 140MAF in 1980s to an average of 100MAF in 2005. It is feared that it will decline further as the flows in the three rivers, one of them is Ravi, are reducing at the rate of 6.6% per year. The mean annual inflow into the country through the western rivers (the Indus, including the Kabul tributary, the Jhelum and the Chenab) amounted to 170.27 km^3 in 1995. The mean annual natural inflow into the country through the eastern rivers (the Ravi, the Beas, and the Sutlej) is estimated at 11.1 km^3, but this is reserved for India, according to the 1960 Indus Water Treaty. [3]

Hydropower potential of Ravi in India

The Hydropower potential system of Ravi River on Indian side has been assessed as 2294 MW. The hydropower potential developed since 1980s is through installation of Baira Suil Hydroelectric Power Project of 198 MW capacity, the Chamera-I of 540 MW capacity commissioned in 1994, the Ranjit sagar Multipurpose Project (600 MW) completed in 1999 and the Chamera-II of 300 MW capacity in the upstream of Chamera-I commissioned in 2004 and Thein dam with potential of 600 MW.

Sutlej and Ravi basins contribute more than 72 % potential capacity out of 25000 MW assessed potential capacity of hydroelectric power. The catchments area of Ravi basin is experiencing drastic climatic changes, because of 100 kilometers reservoirs of Shahpur Kandi (125 MW), Thein Dam (600 MW, with Catchment area of 6086sq km and reservoir of 87 sq. Km), Chamera-1 and Chamera-II [4]

Table 1: Showing the Power Projects on Ravi basin [4]:

Sr. No.	Name of Power Project	Name of River/ nallah	Classifica-tion	Installation Capacity (in MW)
1.	Chamera-I	Ravi	Large	540.00
2.	Chamera-II	Ravi	Large	300.00
3.	Chamera-III	Ravi	Large	231.00
4.	Baira Suil	Baira Suil	Large	198.00
5.	Bhuri Singh	Saal Nala	Micro	000.45
6.	Tundah-I	Tundah nallah	Small	015.00
7.	Tundah-II	Tundah nallah	Small	030.00
8.	Bharmour	Budhil	Micro	000.02
9.	Garola	Garola nallah	Micro	000.05
10.	Holi	Holi nallah	Small	003.00
11.	Sal Stage –I	Saal nallah	Small	008.25
12.	Sal Stage –II	Saal nallah	Small	002.25
13.	Budhil	Budhil nallah	Medium	081.00

Sr. No.	Name of Power Project	Name of River/ nallah	Classifica-tion	Installation Capacity (in MW)
14.	Bharmour	Budhil nallah	Medium	045.00
15.	Harsar	Budhil nallah	Medium	060.00
16.	Kugti	Budhil nallah	Medium	045.00
17.	Sindi	Ravi	Medium	120.00
18.	Bara Bangal	Ravi	Medium	160.00
19.	Thein Dam	Ravi Sewa	Large	600

Pollution Threats

The main sources of pollution in the River Ravi from Lahore Siphon to Baloki head works are urban, agricultural and industrial waste waters discharged from various industries. Substantial deterioration of river water and bed sediments is done by Mehmood Booti, Shad bagh, Farrukhabad Munshi Hospital, Taj company, Bukkar Mandi and Hadiara drains .The mean metal level in sediments(Cu, Mn, Zn, Cr, Ni and Pb)are generally higher than the mean levels in water. (fig. 4)

Fig. 4: Shadman drain carrying sewage and solid waste in to the Ravi

The metal concentrations in the sediments ranged from 0.99 to 3.17 for Cd.4.60 to 57.40 for Cr.2.22 to 18.53 for Co and 3.38 to 159.75micro gram for Cu on dry matter basis. Copper is extremely toxic for aquatic animals as its concentration increases in water. Planktons show a great tendency to accumulate metals in their bodies from water and sediments in aquatic ecosystem [5]. Phytoplankton's acts as bioindicators of metals in aquatic ecosystem because they eliminate metals from the environment, accumulate and store them for a longer period of time [6-7]. Trace elements like Cd, Cu, Pb etc can be toxic to aquatic biota as planktons have the ability to concentrate heavy metals from their aquatic environment [8-9]. River Ravi is now a menace for the Lahore city as it has turned into a sludge. More than 1500 cusecs of waste water is being disposed off into it without treatment. Low flows in the river have increased the pollutant concentrations to a dangerous level difficult to sustain aquatic life. To mitigate the environmental effects of waste water in river ravi, either we have to treat waste water before disposal or we have to dilute the waste water concentrations by releasing more fresh water into the river. About 2000 cusecs of fresh water from Marala Ravi Link Canal is required to maintain dissolved oxygen level of 4 to 5mg/l. under the existing river flow and waste water load. About 1307.08 tons of hazardous and untreated waste is going into Ravi on daily basis. (Fig. 5) The load from waste water of district Lahore is 728.75 tons per day. About 1810 cusecs municipals sewage and toxic industrial effluents are being thrown into river by ten sewage drains and pumping stations.

Fig. 5: Dumping of solid and hazardous waste in to the Ravi at Lahore

Toxic waste from ten drains, five major industrial sewage carrying drains are all contributing towards the extinction of many native fish species besides posing a serious threat to the remaining aquatic life and underground water level.

Effect on food chain

The problem of environmental pollution due to toxic metals has begun to cause concern now in most areas where water for irrigation is becoming scarce and people are using the drain water for irrigation. The toxic heavy metals entering the ecosystem may lead to geo accumulation, bioaccumulation and biomagnifications. Heavy metals like Fe, Cu, Zn, Ni and other trace elements are important for proper functioning of biological systems and their deficiency or excess could lead to a number of disorders. Food chain contamination by heavy metals has become a burning issue in recent years because of their potential accumulation in bio stems through contaminated water, soil and air.

Ground water contamination

The use of polluted water increases the value of conductivity, total dissolved solids, sodium absorption ratio and residual sodium carbonate in ground water and exceeds the acceptable limits of National Environment Quality Standards. The main reason for the use of this polluted water is the non availability of enough funding to treat polluted water before using for irrigation purposes. As a result it degrades the environment as well as a cause of water borne diseases. All polluted water contains plant nutrients and also organic matter other than high concentration of soluble salts and heavy metals. Harmful effects can last for several years due to extensive irrigation of polluted water so it can not only leach down the soil but also has a negative effect on ground water quality. In Pakistan more than eighty percent of the population uses ground water for drinking purpose.

The area under waste water irrigation has increased significantly with about 20 million hectares producing nearly 40% of the food produced worldwide [10]. In Pakistan, about 32,500 ha are presently irrigated using waste water. Farming communities in water-scarce regions increasingly practice the use of waste water in agriculture. Untreated waste water is generally considered unacceptable for direct use because of potential health risks. Among the greatest threats to human health by the use of this waste water is the presence of high levels of heavy metals in waste water [11].

Solutions to pollution

Major part of Ravi pollution is coming from the industries both from Pakistan and India. The most important solution is prevention at source level. Industries should install the waste water treatment plants and treat water before discharging this can be encouraged by providing low interest loans. Moreover

fines and taxes should be enforced on throwing highly contaminated water to river as well as law and legislation should be imposed on direct waste throwing as well as on illegal dumping. Some cost effective integrated physical/ natural systems can be applied both for the treatment of sewage and industrial effluents.

Screening is the first treatment step for surface water treatment. It is basically the removal of larger objects from water; its purpose is to minimize the hurdles which can hinder the further purification process. River Ravi contains a huge amount of large solid waste, carried to it through drains so screening can be more effective if it is applied at the pollutant carrying drains [12].

Sedimentation is a physical process, but promoted sedimentation is physiochemical process. In this method, chemical is added to make heavy mass called sludge and this sludge can be removed from the water. The rate of sedimentation is enhanced by adding alum, iron salts, colloidal silicate, etc., which produce flocculent precipitates. Microorganisms and suspended particles are entrapped and settle rapidly. Sedimentation is more effective at slow speed flow so by creating physical hurdles speed of flowing water of river can be reduced to make sedimentation effective.[13]

Lagoon systems only require land , many ponds can be formed in which algae growth can be promoted. Algae grow up in upper aerobic surface, increases the DO level, absorbs excess nutrients as food and decomposes the organic waste. [14]

In the oxidation ponds, the purification processes are principally aerobic and the oxygen is provided by photosynthetic activity of algae, which grow in them and by the exchange between the pond surface and the ambient air. In ponds the processes are aerobic on the surface, where the sunlight can penetrate allowing the photosynthetic activity of algae. The processes are anaerobic on the bottom, due to the lack of oxygen. The exchanging processes between the anaerobic bottom layer and the aerobic top layer are very similar to the ones that develop in optional ponds. On the free surface of tanks when exposed to sunlight, algae grow. They can produce oxygen and increase dissolve oxygen (DO) level up to 11. Some predators contained in the pond swallow these algae and bacteria producing CO_2. The sun radiation cannot reach the bottom of the pond and algae cannot grow, so from the intermediate level of the tanks the conditions are anaerobic, with the consequent growth of anaerobic bacteria. If anaerobic microorganisms float from the bottom to the surface of the tank, algae oxidize them. During the winter a lot of organic matter accumulates at the bottom of storage tanks. In spring some anaerobic reactions develop due to the rise of temperature. These reactions go on until green algae grow. The tank is not homogeneous anymore, but an aerobic and an anaerobic layer can be located. This thermal stratification causes an increasing aerobic activity on the

surface and anaerobic at the bottom, because of the algae growth, which block the penetration of solar radiation. The main factors, which influence microorganisms' removal, are the solar radiation intensity and the algae activity. [15]

Water table in the surroundings of Lahore is falling at the rate of 4ft/year, to recharge the depleting ground water aquifer a lake within the course of the river from Siphon to Thokar Niaz Baig can be formed by the flood/rainy water or by feeding through Marala Ravi or BRBD link canals. In addition to the recharging of ground water it will have many other positive outcomes, recreational sites, development of aquaculture and land reclamation.

Recommendations

- Industrial effluents are the major contributors of pollution. Prevention at source level is a solution for industrial effluents. This can be achieved by providing them low interest loans for the installation of treatment plants and at the same time enforcing NEQS and imposing fines.
- The best way to mitigate the environmental effects of domestic waste water is to treat sewage before disposal. Natural system of waste water treatment like gravity settling, oxidation ponds and lagoons can be cost effective solutions. This will not only improve the water quality but also treated water can be reused for irrigation without impacting the – health conditions.
- To increase the water availability about 2000 cusecs of fresh water from Marala Ravi (MR) LINK canal could be released into the river without impacting the water level at Baloki head works. This will maintain dissolved oxygen level of 4 to 5mg/l which is required for the aquaculture survival.
- A lake/reservoir can be constructed within the course of the river from Siphon to Thokar Niaz Baig which will have many positive outcomes, flood control, recharging of ground water, development of recreational sites, aquaculture propagation and land reclamation.

References

1. www.indiannetzone.com/14/ravi_river.htm
2. Pervaiz, M. A., Rivers and link canals of punjab ,science and technology
3. www.srategicoforenite.com
4. Salariya, M., 2007. "A study of impacts of hydroelectric power projects on ecology an society in Chamba district of Himachal Pardesh." PhD. thesis submitted to MJP Rohilkhand university, Bareilly, Uttar Pardesh, India.

5. Khan Javed, M. and S. Hayat, 1999. Heavy metal toxicity of river Ravi aquatic ecosystem. *Pakistan J. Agric. Sci.*, 36: 81–9

6. Eisler, R., 1985. Selenium hazards to fish, wildlife and invertebrates; A synoptic review. *US Fish and Wildlife Service Biological Report*, 85: 157

7. Eisler, R., 1988. Lead hazards to fish, wildlife and invertebrates; A synoptic review. *US Fish and Wildlife Service Biological Report*, 85: 134

8. J. Harding P.C. and B.A. Whitton, 1981. Accumulation of zinc, cadmium and lead by field population of Lamanea. *Water Res*., 15: 301–19

9. Javed, M. and S. Hayat., 1996. Planktonic productivity of river water as a bio-indicator of freshwater contamination by metals. Proc. Pakistan Congr. Zool. 16:383-398.

10. International Symposium: Water for the 21st Century, WHO-UNESCO; pp. 245-255

11. Saleem, M., 2005. Irrigated area under waste water. *The DAWN*. October 3, 2005

12. www.lenntech.com/library/clarification/phsychem.htm

13. www.microbiologyprocedure.com/water_microbiology/sedimentation

14. www.lenntech.com/lagooning.htm

15. www.lenntech.com/storage_intank.htm