ABSTRACT

Water plays an important role in all the sectors like agriculture, industrial and domestic consumptions both in rural and urban area. Due to spatial and temporal non uniformity in the rainfall pattern in tropical regions like Tamil Nadu, conservation of rainwater through tanks, lakes and ponds are age old techniques. These tank systems provide multiple ecosystem services like supplying water for drinking, irrigation, livestock rearing and also help in groundwater recharge, flood control and finally provide habitat for many flora and fauna. Nowadays, most of the urban and rural tank catchments are encroached, surface and groundwater are over exploited and are polluted due to discharge of untreated domestic sewage and industrial effluent. Proper functioning of these tanks, which support rural livelihood is important for the ever-increasing population to achieve the sustainable development goal.

South Indian state of Tamil Nadu is known for textile industry. Due to urbanization and cost-optimization reasons, many of the dyeing industries have shifted from urban centers to nearby rural areas. In rural areas, the safe disposal of untreated effluents from the dyeing units is a challenge and is often let into nearby water bodies. Pallipet tank cascade selected for the present study is one such case. It falls under Nagari watershed in Pallipet block of Thiruvallur district, Tamil Nadu, India. This comprises of four non-system tanks namely Athimanjeri, Konasamudram, Pothatturpettai and Pandravedu. One of the upstream villages of Pandravedu is Pothatturpettai which has about 150 dyeing units. The untreated effluent from these dyeing units is being let into the nearby lake, Thangal through a lined channel. From there effluent water is discharged into Pandravedu tank. The seepage of wastewater from the tank has deteriorated both surface and groundwater of
the Pandravedu village and has affected the entire tank ecosystem. Hence, the present study is taken to understand the eco-hydrological changes in the Pallipet tank cascade, assess the impact of discharging untreated effluent from the dyeing industries and domestic sewage into the Pandravedu tank and suggest better tank management practices from Integrated Water Resources Management (IWRM) perspective.

A walk through survey with the public works department (PWD) officials was conducted to each of the tanks in the cascade to explore various threats. The threats that deteriorate the Pallipet tank cascade are as follows (i) decrease of water inflow to the tank, (ii) poor maintenance of the tank structures, (iii) reduction in tank capacity, (iv) poor institutional mechanisms and governance and (v) discharge of untreated wastewater into the tank. Among the four tanks, Pandravedu is most affected by the discharge of untreated dyeing industry effluent and domestic sewage. To understand the inter and intra tank water quality variations, fifty six water samples were collected during three season viz. pre-monsoon (18), monsoon (18) and post-monsoon (20) during May 2014, Nov 2014 and Jan 2015 respectively. All the samples were collected in clean plastic cans and were analysed in laboratory for physico-chemical parameters using standard procedures recommended by American Public Health Association (APHA, 2005).

The analytical results were compared with drinking water quality standards set by Bureau of Indian Standards (BIS, 2012). Computation of water quality index in the four tanks indicate that 63-75% of samples fall in good class and 25-30% of samples fall in poor class across the three seasons. The samples that fall in poor class are from Pandravedu tank. In depth analysis done in Pandravedu, clearly indicate that the water quality index computed with both the bore wells that supply drinking water to the village falls in poor category across seasons.
Irrigation water quality indices namely, sodium absorption ratio (SAR), percentage sodium (% Na), magnesium absorption ratio (MAR), Kelly’s ratio (KR), residual sodium bi-carbonate (RSBC) and permeability index (PI) are computed with the analytical results got from water quality analysis across the three seasons in all the four tanks. Total hardness indicate that the groundwater quality falls between hard and very hard category. Percentage sodium confirms that, water samples from Pandravedu tank fall in doubtful category (60% - 80%) while the other samples fall in permissible category and KR confirm that samples from Pandravedu tank fall in the excess sodium range, whereas the rest of the samples fall in suitable range. Wilcox diagram illustrate that water samples from wastewater channel and Pandravedu tank fall in C3S2 class which has high salinity and medium sodium hazard.

Wastewater samples collected from the source and confluence point of the channel exceeded maximum tolerance limits for industrial effluent discharged into inland surface bodies as per IS 2490, part 1 – 1981. Evaluation of tank water for fisheries purposes specify that 90% of the parameters exceeded the desirable range which resulted in reduction of both quantity and quality of fishes. Seasonal correlation of water quality parameters illustrate that change in correlation levels of parameters across three seasons are influenced by fluctuating amounts of wastewater discharged by the two polluting sources into Pandravedu tank.

The community perception on changing ecosystem services in the Pallipet tank cascade was ascertained by conducting a focused group discussion (FGD) in each villages with key-informants and farmers. People’s average rating for the ecosystem services for the four tanks during the year 2000 are 2.5, 3.0, 3.1 and 3.5 respectively. While for the year 2015, the ratings are 1.7, 2.7, 2.8 and 1.5 respectively. The decrease in the average ratings in the first three tanks are insignificant whereas in Pandravedu it is
highly significant. The change in the ecosystem services in the first three tanks are attributed to the poor maintenance and management of the tanks whereas in Pandravedu it is attributed to the discharge of untreated dyeing industry effluent and domestic sewage into the tank.

Interpretation of results from in depth analysis in Pandravedu using participatory rural appraisal (PRA) tools like resource mapping, problem tree analysis and FGD indicate that discharge of wastewater into the tank has affected agriculture, where the rice yield has reduced by 40%, the farmers have shifted the paddy cultivation from fine varieties of rice (ADT 43, ADT 45) to a coarse variety of rice like ADT 37. Stunted paddy growth observed by the farmers is attributed to high salinity and excess sodium which is confirmed through water quality analysis. Women labourers who do intercultural activities like weeding in the field, reported the change in the color of the skin. They also report that livestock fall sick when they drink water from the tank. Farmers expressed that the colour of the fish has changed to dark purple and about 40% of people who consumed these fishes reported vomiting and diarrhoea. Water supplied from bore wells that are nearby Pandravedu tank has become unfit for drinking and domestic use. It causes health issues like vomiting, diarrhea and irritation to the skin. Disappearance of crabs and Ponnaganni plants (dwarf copperleaf) in Pandravedu village indicate that the respective fauna and flora biodiversity needs in depth exploration.

Role of local institutions and stakeholders in tank cascade management and their institutional linkages were assessed using FGD which revealed that there is no water users association in the tank cascade. In Pandravedu, though people are aware of the impact of wastewater discharge, absence of active and strong water user’s association, dominance of institutional linkages like marriage, caste, kith and kin relationship between two villages ended up with no solution.
The present study examined the treatment service of Thangal wetland to Pandravedu tank using a mathematical model SubWet 2.0. Physico-chemical parameters analysed from the wastewater samples collected at the inlet and outlet of the wetland like BOD, nitrate, ammonium and total phosphorus are used to calibrate and run the model. The removal efficiencies of the above mentioned parameters are estimated to be 16.2%, 18%, 31% and 50% respectively. The role played by the vegetation like cattail (Typha angustifolia), duckweed, etc., in the Thangal wetland is confirmed with the current research findings. Scenario 1 analysis across the two seasons namely pre-monsoon and monsoon indicate that, there is reduction in the percentage removal of biological oxygen demand (BOD) if there is increase in BOD load in the wastewater. Scenario 2 shows that increase in temperature across two seasons, improved the removal efficiencies of BOD, nitrate and ammonium. Scenario 3 indicates that decrease in the area of Thangal wetland resulted in reduction of all the removal efficiencies in both the seasons.

The study concludes that the present treatment potential of the Thangal is appreciated as part of pre-treatment system of wastewater for Pandravedu village. The study also suggests that the treatment potential could be improved if the Thangal is maintained by a continuous monitoring setup which would study the primary treatment and the biological activity of wastewater that is taking place in the wetland prior to its entry into the Pandravedu tank. Solutions from IWRM perspective could be of forming IWRM institutions comprising all stakeholders like PWD, Pollution Control Board (PCB), Agriculture Department (AD), Revenue Department (RD), health department, village community and dyeing industry owners and capacitating them about loss of ecosystem services and health issues.