STRATEGIC ANALYSIS OF SPATIAL AND TEMPORAL WATER QUALITY OF RIVER CHENAB AND ITS MANAGEMENT

Submitted by

MUHAMMAD TOUSIF BHATTI
(2005-PhD-CEWRE-07)

FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY IN
WATER RESOURCES ENGINEERING

CENTRE OF EXCELLENCE IN WATER RESOURCES ENGINEERING
University of Engineering and Technology
LAHORE, PAKISTAN

2009

ABSTRACT

Water quality of many rivers in the developing countries is under serious threat of degradation and Pakistan is no exception to this. The river water may be polluted by the effluents stemming from industrial, municipal, agricultural or mining activities. The most affected rivers are those flowing through the urban areas and subjected to anthropogenic activities. The river Chenab, traversing near the industrial cities and municipalities, is largely used for constant disposal of untreated effluents in the Punjab province of Pakistan. Consequently water quality of the river degrades particularly in the low flow months.

This study was conducted to monitor, assess and model the water quality (WQ) of river Chenab over a length of 292 km from its entrance in Pakistan at Marala. The monitoring program was conducted during low flow months (October to March) of years 2006-7 and 2007-8. Water samples were collected from seven locations along the river and all the contributing drains as well. These samples were analyzed for a variety of physical, chemical and biological quality parameters.

The data collected from monitoring as well as from secondary sources were utilized in three phases of analysis. In the first phase water quality indices (WQIs) were calculated using CWQI 1.0 model developed by Canadian Council of Ministers of the Environment (CCME). Three intended uses of river water i.e. drinking, aquatic life and irrigation were incorporated for WQI calculations at selected points along the river. In the second phase, mathematical model (MIKE 11 model developed by Danish Hydraulic Institute (DHI), Denmark) was formulated to simulate a conservative WQ parameter

(salinity of river water). Two non-conservative WQ parameters (dissolved oxygen (DO) and biochemical oxygen demand (BOD)) were modeled in third phase of the analysis using MIKE 11 model.

The results of WQI revealed that the lower river reach (185 to 233 km) was more polluted than the upper 185 km segment. In this river reach, overall WQI ranking were poor for drinking and marginal for both irrigation and aquatic life. The WQIs for all three uses were ranked poor at sampling point located at 233 km below Marala headworks. The calibrated model for salinity simulated the most saline condition in the river during the months with minimum flow (i.e. November and December). The results also depicted high salinity in the downstream river reach receiving polluted effluents from two major drains (Faqirian Sillanwali and Chakbandi drain). Finally the model was calibrated and validated for DO and BOD. The results of simulations indicated DO depletion and high BOD levels in the downstream river reaches particularly from 200 to 270 km.

Different scenarios were also tested to predict the river water salinity by varying discharge of the drains. The salinity of river water was found highly sensitive to the amount of effluents added by the surface drains. The study of management scenarios for BOD suggested that the maximum water quality improvement can be achieved if there is no diversion of flow from the river coupled with 60 percent reduction in BOD of the drain effluents through treatment.