DHI CASE STORY

RESTORING THE YAMUNA RIVER BASIN

Using Integrated Water Resources Management and water quality modelling

Millions of people in India depend on the Yamuna River for domestic, industrial and agricultural uses. During the non-monsoon (dry) season, however, stretches of the river become highly polluted and the water quality drops. To help the Government of India (GoI) improve the water quality during the dry season, we conducted an Integrated Water Resources Management (IWRM) and water quality modelling study. As part of the study, we also created a Decision Support System (DSS) that will enable authorities to restore the water quality of the river based on sound information.

PROTECTING A SACRED RIVER

The 1,376 km long Yamuna River – the largest tributary of the Ganga River – is one of the most important and sacred rivers in India. The Ganga's 360,220 km^2 basin area spreads across seven states: Uttarakhand, Himachal Pradesh, Uttar Pradesh, Haryana, Delhi, Rajasthan and Madhya Pradesh. Approximately 12.4% India's population depends on the Yamuna River basin.

Canal off-taking from Hathnikund Barrage on the Yamuna River

SUMMARY

CLIENT

- National River Conservation Directorate (NRCD)
- Ministry of Environment and Forests (MoEF)
- Government of India (GoI)

CHALLENGE

- Controlling pollution in a 1,298 km stretch of the Yamuna River (from the Hathnikund Barrage to its confluence with the Ganga River)

SOLUTION

An Integrated Water Resources Management (IWRM) and water quality modelling study, leading to the development of a Decision Support System (DSS) to aid in:

- planning activities such as the construction of sewage treatment plants
- selecting appropriate technology for effluent treatment
- diverting polluted water for agriculture usage
- finding suitable mechanisms for pollution monitoring

VALUE

- Ability to plan and evaluate workable interventions, monitor conditions, and maintain good water quality throughout the Yamuna River Basin
- Development of a future action plan to improve water quality based on the study result

LOCATION / COUNTRY

Yamuna River Basin, India

Over the years, the river has experienced severe degradation of its water quality, primarily caused by:

- rapidly changing land use
- over-exploitation of water resources for irrigation – approximately 90% of water resources are utilised for this sector. Nearly all the water received at Hathnikund Barrage during dry seasons is distributed to meet the irrigation-related demands of Uttar Pradesh and Haryana as well as the drinking water demands of Delhi
- domestic and industrial water use leading to low-flow or no-flow conditions in the river
- discharge of untreated wastewater from growing urban centres
- discharge of organic wastes from agriculture-based industries (including distilleries, sugar mills and paper mills)

The Yamuna River is in pristine condition and has a good water quality before it reaches the towns of Yamuna Nagar and Panipat, where it becomes highly polluted – mainly due to the discharge of untreated sewage. In Delhi, the Biochemical Oxygen Demand (BOD) ranges from 6 to 35 mg/l – with very low to zero Dissolved Oxygen (DO) and millions of coliform counts – in the 22 km stretch between Wazirabad and Okhla Barrage.

Downstream of the Okhla Barrage, the river receives partially treated sewage from East Delhi. This is the only water flowing into the river during the non-monsoon (dry) period, which causes increased pollution. Further downstream, the Yamuna also receives pollution from Mathura and Agra. The river remains polluted until it meets with the Chambal River, after which the Yamuna regains its good quality due to dilution. The low-flow and no-flow conditions prevalent over a considerable portion of the river and its tributaries have seriously impacted the Yamuna.

Our team measuring Dissolved Oxygen in the River Yamuna at Panipat

The discharge of domestic sewage, however, is the main cause of river's pollution. There is a large gap between the amount of wastewater generated and the amount of wastewater treated in all the cities and urban centres throughout the basin. Increasing urbanisation is further widening this gap. Treating sewage before it is discharged is not enough to restore the ecological integrity of the river. A number of options need to be considered to find a solution, including:

- using state-of-the-art technologies such as an interceptor sewer to treat sewage
- significantly reducing BOD in sewage before it is discharged into the river
- diverting treated sewage for agricultural purposes

HELPING TO RESTORE WATER QUALITY

To help water officials regain the good water quality of the Yamuna River, we conducted an Integrated Water Resources Management (IWRM) and water quality modelling study. As part of this study, we developed a Decision Support System (DSS) that uses baseline information on:

- topography
- land use
- river flow
- water quality
- wastewater discharges
- less water intensive crops

For this project, we used MIKE BASIN, MIKE 11 and ECO Lab (part of our MIKE by DHI software) to develop the DSS. We used MIKE BASIN to describe the catchment's hydrology, examine abstractive uses (such as irrigation and domestic water use) and their return flows, and estimate pollution load. We used MIKE 11 and ECO Lab to conduct river hydrodynamic and water quality modelling.

Our DSS integrates the mathematical models of system processes with decision variables to arrive at certain conclusions or decisions. It can take into account different wastewater loading and water availability situations – as well as management options and future changes – to predict water quality scenarios. Utilising the DSS, we generated water quality scenarios based on different actions in order to:

- control wastewater discharges to the basin
- increase the availability of water resources in the basin by using less water intensive crops

The scenarios will enable government planners to make sound decisions in order to help restore the quality of the Yamuna River and manage its pollution levels.

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