

**AN INTEGRATED APPROACH FOR MODELING OF
WATER QUALITY OF AN URBAN RIVER REACH**

by

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Submitted

In fulfillment of the requirements of the degree of Doctor of Philosophy

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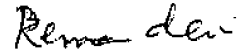


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CERTIFICATE

This is to certify that the thesis entitled, An Integrated Approach for Modeling of Water Quality of an Urban River Reach, being submitted by Naved Ahsan for the award of degree of Doctor of Philosophy, is a record of bonafide research work carried out by him. He has worked under my guidance and supervision for submission of this thesis, which to my knowledge has reached the requisite standard. This thesis, or any part thereof, has not been submitted to any other University or Institute for the award of any degree or diploma.



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ABSTRACT

Rivers and river systems play a variety of key roles in maintaining environmental quality and also provide resources for socioeconomic improvement. River water is used in-stream as in navigation, recreation etc., and off-stream as is used to meet irrigation, municipal and industrial demands, hydroelectric power generation etc. Each of these uses has the potential to adversely affect water quality. Extensive increase in urbanization, industrialization, agriculture, the presence of storage structures etc. over the recent past have resulted in heavy pollutant loads on rivers, particularly in their urban reaches. It is necessary to maintain the pollutant concentration in the rivers to the level acceptable to the desirable riverine ecosystem.

The urban river reach of interest in the present study that is the reach of river Yamuna that passes through the Delhi - New Delhi Metropolitan Complex (DNDMC) is an example of such heavily polluted urban stretches.

The present study aims to assess the water quality in the DNDMC urban river reach and to understand the transport of pollutant mechanism therein. The study includes collection of primary data on some of the important parameters of water quality, mathematical modeling of part of the river reach using Finite Element Methods (FEM) with inputs from newer techniques such as remote sensing and geographic information system (GIS). Two dimensional advection-dispersion (AD) equation is applied over the modeled segment.

The tests for relevant water quality parameters, done on the samples of water collected from significant locations, reveal that the urban reach of river Yamuna within DNDMC is in a highly polluted state, during the crucial lean flow season. Dissolved oxygen has been found to be absent at almost all the locations. Biochemical oxygen demand is observed to

be significantly high with the local maximum concentrations reaching up to 310 mg/l with an average concentration of 58.5 mg/l. Similarly, other pollutants such as free ammonia, coliforms and heavy metals are found in concentrations that are likely to damage the riverine ecosystem.

Remotely sensed data in the form of imageries from IRS 1C and IRS ID satellites have been used to determine the planar characteristics of the river reach. Remote sensing analysis has led to the detection and sizing of sandbars present in the river reach. Three sandbars have been detected in the reach of interest, which may significantly influence the flow characteristics and consequently the dispersion behavior of pollutants in the reach. The detailed data so extracted, has been input in configuring the elements for finite element analysis, resulting in a better representation of real life morphometry. Further, GIS has been used to store spatial data obtained from remote sensing analysis to form the mesh for finite element analysis.

The present study also includes a comprehensive review of various models available in literature for prediction of longitudinal dispersion coefficient. A comparative analysis of these models has been carried out to arrive at the best model for further use in mathematical modeling using two dimensional AD equation.

Mathematical modeling, using FEM, has been carried out to understand the dispersion mechanism of pollutants in the DNDMC river reach. Finite element method has been found to be effective in incorporating the irregular planform of the river reach as well as sandbars. Significant effects of the presence of sand bars have been brought out. These include those on the values of maximum concentration, location of the most polluted reach, effect of decay etc.

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