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DEPARTMENT	**:**	**CIVIL ENGINEERING / FACULTY OF ENGINEERING AND TECHNOLOGY**
TITLE	**:**	**HYDRODYNAMIC SIMULATION OF RIVER YAMUNA FOR VARIOUS RETURN LEVEL FLOODS**

A flood is an unusually high stage that overflows the natural or man-made banks resulting in the inundation of its flood plains. With the availability of sophisticated forecasting models, it is possible to predict the occurrence of floods to a reasonable extent. Analysis of flood records at a particular location is required for computing the magnitude of various return-level floods at that location. The flood protection measures at a particular location can be planned and designed based upon the likely magnitude of flood at that location. Although it is possible to provide protection against flood to a large extent but it is not possible to provide absolute protection against floods. Modeling procedures that allow the transformation of discharge to stage at a particular location are an important part of water resources planning and management.

The major objective of the present research is to assess the vulnerability of various bridges and barrages in the reach of Yamuna River between Wazirabad and Okhla Barrage to various return-level floods. To put the work carried in this thesis in context, an analysis of trends in observed temperature and precipitation data for the city of Delhi has been carried out using Mann-Kendall nonparametric test. The trend analysis of average maximum temperature (TMX) and minimum temperature (TMN) data of Delhi revealed a clear warming pattern in the city. Both the monsoonal and the annual rainfall showed an increasing trend. With increased warming in Delhi, the stress on water resource systems is likely to increase. Correlation analysis for TMX, TMN, and rainfall data has also been carried out in this thesis. Results of correlation analysis indicate a strong negative correlation between annual rainfall and TMX for all three periods of analysis considered. The correlation between annual rainfall and average annual TMX was found to be strongly negative, whereas the correlation between annual rainfall and average annual TMN was negative and weak.

To evaluate the vulnerability of different bridges/barrages in the study reach, estimation of flood with various return-levels was carried out using a number of techniques. However, for the purpose of vulnerability assessment the flood magnitudes obtained using Gumbel's method were used. The model based on Soil and Water Assessment Tool (SWAT) was first calibrated, validated and then applied to simulate streamflows for the period 2021-2050 at different locations in the study reach. . The climate data set for the SWAT model was derived using the PRECIS outputs obtained from Indian Institute of Tropical Meteorology (IITM), Pune, India. Based upon the simulated streamflows, the flood magnitudes corresponding to different return-levels were computed.

Since the overarching aim of the present research was to conduct an assessment of the vulnerability of different hydraulic structures in the reach of River Yamuna between Wazirabad Barrage and Okhla Barrage, the HEC-RAS model was used to simulate water surface profiles in the study reach. The HEC-RAS model was first calibrated and validated and then applied for the simulation of water surface profiles under different return-level floods. The output from the HES-RAS model was utilized to determine the extent of overtopping of bridges/barrages in the study reach when subjected to flood of a given magnitude. Except the Old Railway Bridge, all the Bridges/Barrages can be expected to safely carry the 25-return level floods. For floods corresponding to return-levels of 50 years and 100 years, the Old Railway Bridge and Wazirabad Barrage were found to be unsafe. Under 200 year return-level flood, both the Wazirabad and Old Railway bridge are likely to experience overtopping of more than 1 m. Results of vulnerability assessment under future streamflows indicated that the vulnerability of the basin to high magnitude flooding events is likely to increase under future climatic change in the Yamuna River basin.

MAJOR achievements of the present research include development and application of: (1) a framework for the identification of trends in meteorological variables; (2) development of SWAT model that can be utilized for the simulation of streamflows at different locations in the study reach., and (3) development of HEC-RAS for simulating water surface profiles for the study reach under a given flow. With flood magnitudes of various return-levels as the major input, the vulnerability assessment of different bridges/barrages can be easily conducted using HEC-RAS. The methodology used to conduct vulnerability assessment is generic in nature, and is transportable with minimal changes to other study areas. It can be concluded that the results presented herein could provide valuable aid to policy makers in formulating mitigation strategies to counteract the adverse impacts of flooding in the Yamuna River basin.