II -142 Use of Sewerage Pumping Station as a Gauging Station

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INTRODUCTION:

Rapid growth of urban activities and economic well being of urban people is making urban drainage problem more complex and very sensitive. In one hand rapid urbanization, increase of impervious area and smoothened flow paths, is causing high runoff volume and peak. On the other hand uplifted living standard of urban people is producing more waste water and raising concern regarding the living amenity. Further, the factors affecting the rainfall-runoff process viz. landuse, increased hydraulic efficiency etc. are changing quite rapidly in urban areas compared to rural areas. But in contrast, there is still very little data on hydrological change as a consequence of urbanization, and most conclusions in drainage studies are, of necessity, based on model projections rather than hard data (O'Loughlin et al - 1996). Statistical method of hydrological analysis are quite convincing for the rural basin as the spatial and temporal changes are quite slow but is very much dynamic for the urban basin. This is justified if we observe the drainage situation of Tokyo, Japan. Tokyo has just completed the construction of sewer system for her main city area, the 23 wards, by 1994. But together with the completion, improvement has been felt necessary and such plan are undergoing because of the inadequacies of the existing system.

The design was based on a rainfall intensity of 50 mm/hr with a return period of 2 years. The improvement plan will be based on a intensity of 75 mm/hr with a return period of 17 years for the short term. Long term improvement will be based on a 100 mm/hr intensity with a return period of 70 years (Higuchi et al - 1994). This raises a serious question why the just accomplished sewerage infrastructure system is inadequate. This clearly indicates the previous design method based on statistical methodology is unable to address the dynamicity of urbanization and its consequences on hydrological analysis. Furthermore, the nature of drainage problem is also multi-dimensional. It may be inundation due to the inadequacy of locational elements; like manhole, pumping station , treatment plant or that of the conveyance element, the sewer line. It may be a problem of downstream flooding or that of the water quality and amenity. It varies quite. It refers to the paramount need of runoff database of a urban basin as the availability of rainfall database is quite satisfactory.

In this context, a study on the possibility of fulfilling this need with the use of already established infrastructure, sewerage pumping stations, is attempted in this paper. The sewer system acts as a artificial drainage network and the pumping stations as the gauging stations. Some conclusions are made with the reference of findings.

STUDY AREA:

For this study, Kosuge drainage area, one among ten drainage areas of the Tokyo 23-ward area is considered. Kosuge drainage area lies on the eastern part of Ara river. It has combined sewer system. The drainage area is 1633 ha. for municipal wastewater and 1363 ha. for storm drainage. There are three pumping stations covering 720 ha. of storm drainage area and 655 ha. for municipal waste water area to convey the water either to treatment plant or to the natural rivers. The data from the three pumping stations are analyzed for the fiscal years (April - March) 1992, 1993 and 1994. As shown in table 1, 1992 represent the normal rainfall whereas 1993 as a wet and 1994 a dry year.

Table 1: Comparison of Plant Inflow Volume

Year	Average Rainfall (mm)	Total Flow Entering Kosuge Treatment Plant (cu. m.)		
		Computed	Reported	Difference (%)
1992	1439	75,961,505	89,402,850	15.03
1993	1609	77,891,529	93,578,150	16.76
1994	1024	65,216,563	74,656,830	12.64

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BASIC ASSUMPTIONS:

Following are the assumptions made to analyze the data as per the availability of information:

- The fine weather day flow into the pumping stations represent the dry weather flow.
- The average rainfall representing the three pumping stations represents the rainfall for the whole drainage area.
- The land use and topographical pattern of the area under pumping is similar to the remaining area within the drainage area producing similar runoff.

COMPUTATION PROCEDURE:

Following steps explain the computation procedure:

- Compute average daily waste water flow based on the fine weather days within a month.
- Separate the volume of waste water and storm water pumped out on the basis of average daily waste water flow and pumped out volume.
- Sum up the annual volume of waste and storm water flowing to the treatment plant through pumping stations.
- Extrapolate the volume of waste and storm water flowing to the treatment plant from the remaining area with respect to population and drainage area respectively.

RESULT AND DISCUSSION:

- As shown in table 1 the difference in the computed and reported (as published by the Tokyo Metropolitan Government, Sewerage Bureau) is about 15% for the normal rainfall year. The difference is more for the wet year and less for the dry year compared to the normal year, 1992. This indicates that the major part of the difference is associated with the volumetric separation of waste and storm water based on the fine weather days. The employed assumption to separate waste and storm water volume do not consider the delayed part of the runoff which might have much contribution to make the differences.
- As the area outside pumping is relatively of higher level and step topography compared to the area under pumping which needs pumping to drain out the sewer flow. This indicates that the runoff from the area outside pumping is of higher order than from the area under pumping. It shows the value based on the extrapolation of the runoff volume is under-estimated making the difference.
- The extrapolation of waste water volume is based on the population in this analysis. The industrial waste water might have caused some difference in the result as the location of industries has not been considered in this analysis.

CONCLUSIONS:

From this analysis it can be concluded that the pumping stations can be used as a gauging stations for the preliminary studies in projecting the volume of inflow to a treatment plant. The difference in the result can be minimized with the improvement in the crude assumption of fine weather day representing the daily waste water production and extrapolation. Further, use of more data about population, water consumption rate of residential as well as industrial use can provide a better understanding of the urban rainfall-runoff system.

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