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Streamflow Frequency Assessment for Water Resource Evaluation

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Abstract

Streamflow frequency estimates for two major watersheds, the Mackinaw and Vermilion River watersheds in the Illinois River Basin, were prepared for use with the Illinois Streamflow Assessment Model (ILSAM). ILSAM is a water resource planning and management tool that produces statistical estimates of flow quantity at both gaged and ungaged sites on Illinois streams. The ILSAM flow estimates are representative of long-term climatic conditions, with base periods covering the past 50 years or more, but also account for recent man-made modifications to the flow amount such as have been caused by reservoirs, water-supply withdrawals, and discharges from wastewater treatment plants. With these recent additional watersheds, the ILSAM model has now been developed for roughly half of Illinois, including for eight major watersheds: the Fox, Kankakee, Kaskaskia, Little Wabash, Mackinaw, Rock, Sangamon, and Vermilion. Basic watershed data, including measurements of selected watershed characteristics, were also prepared as a first step in the development of an additional ILSAM application for the LaMoine River basin. An abridged on-line version of the ILSAM was also recently completed and can be accessed at: http://gismaps.sws.uiuc.edu/ilsam/.

Background

Water resource management requires an understanding of the quantity and frequency of streamflow within a river's watershed and the effects of various potential water use practices on the flow characteristics. The status of Illinois rivers and streams is monitored by stream gaging stations, which measure the flow of water over a period of time, providing information on the amount and distribution of surface water passing the station. Since it is not feasible to monitor all streams in a basin, gaging stations are established at selected locations, and the data collected are transferred to other parts of the watershed by applying hydrologic principles. The Illinois

Streamflow Assessment Model (ILSAM) was created in 1985 to apply these hydrologic principles for estimating streamflow frequency at gaged and ungaged sites throughout Illinois. Over the years, ILSAM has been updated and applications developed for the Fox, Kankakee, Kaskaskia, Little Wabash, Rock and Sangamon River Basins, and soon will be completed for the Spoon River Basin. The work supported by the IBHE this year on streamflow frequency assessment has produced two additional products: 1) completion of an on-line version of the ILSAM; and 2) additional applications of ILSAM to the Mackinaw and Vermilion River Basins. Analysis has also been conducted that will lead to the future application of ILSAM to other major watersheds.

Three undergraduate students at the University of Illinois, Jeremy Wildhaber, Jill Baty and Danica Pearson, were hired to conduct this work. As part of this work, these students learned fundamentals of hydrologic data analysis, map interpretation skills, and applied and improved their database management, computer, and analytical skills using software packages as Microsoft Access and Excel.

Completion of the On-line Version of ILSAM

The on-line version of ILSAM has been completed and is currently being reviewed for placement on the ISWS web site. Once the review is completed, ILSAM will be accessible to the public at the following web address: http://gismaps.sws.uiuc.edu/ilsam/. With the new on-line version, there is a point-and-click tool where model users can use GIS maps to locate the stream on which that they want information. For any selected location, ILSAM will provide information on 154 different flow parameters, including flow duration parameters (percent frequency at which a flow is exceeded), monthly flow frequency, and low flows.

Preparation of Data and Hydrologic Analysis for Additional Watersheds

1) *Development of data tables for new ILSAM databases for the Vermilion and LaMoine River Basins*. All components for the Vermilion River ILSAM database have been developed, including the hydrologic analysis described in the following task. For the LaMoine River Basin, completed tasks include: a) delineation of watershed characteristics at 300 locations in the LaMoine River basin, including drainage area and rainfall characteristics; b) definition of a stream coding structure that identifies the stream network and its hierarchy within the

basin; c) identification of water resource facilities, including reservoirs, wastewater treatment plants, and stream withdrawals that are expected to modify the character of the streamflow from its "unaltered" condition; and d) analysis of records from the water use inventory at the State Water Survey and effluent discharge records from the Illinois EPA to quantify the extent of flow modification from water resource facilities.

2) *Hydrologic analysis to complete the ILSAM applications for the Mackinaw and Vermilion River Basins*. Streamflow records from ten USGS gaging stations in the Mackinaw and Vermilion River Basins were analyzed to determine their statistical flow characteristics. The analyses included: a) evaluating differences in period of record at various gages, and for short-term records extending the flow characteristics records to represent condition over the long-term, such as might be reflected in continuous gaging records lasting 50 years or more, b) estimating how the flow at the gages is affected by upstream human influences such as reservoirs or discharges from wastewater treatment plants, c) in cases where the amount of human modification has changed over time, evaluating the level of modification that represents present-day conditions, d) conducint flow frequency analysis to determine the frequency of uncommon events such as low lows during drought, e) estimating both unaltered and present-day flows at all gaging stations, and e) computing streamflow characteristics for certain ungaged locations where there is significant human control, such as downstream of reservoirs. Flow estimates at all sites were compared, and, when necessary, adjusted so that they maintain consistent hydrologic relationships between any two locations. The products of the analysis are tables of 154 different streamflow parameters for each gaging station and ungaged control locations. Regional equations developed in previous analysis are used in conjunction with these tables to determine flow characteristics at ungaged sites throughout the Mackinaw and Vermilion River Basins.