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Assessment of information production by streamflow data at varying time/space scales

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A river monitoring network for water quantity and/or water quality is often developed on the basis of both the spatial and the temporal design criteria to evaluate space-time tradeoffs. The approach in such combined design programs is to compensate for lack of information with respect to one dimension by increasing the intensity of efforts in the other dimension. An increase in the sampling interval decreases the common information between the stations in a given network combination; whereas an increase in the number of stations increases the redundant information for a given time frequency. One would look for the best combination with respect to time and space for reduction of the total uncertainty about the particular hydrologic variable observed. The problem is essentially one of assessing the information produced at alternative space/time scales of monitoring.

The proposed paper aims to assess the information produced by a streamgaging network at varying time/space scales. In the time dimension, monitoring frequencies such as daily, weekly, biweekly and monthly are considered against alternative numbers and locations of streamgages to represent the space scale. The study uses measures of informational entropy, particularly the concept of transinformation which represents the level of redundant information in the network either at time or space scales, or jointly at both scales.

To analyze spatial and temporal frequencies on a joint basis, first, the best combination of monitoring stations is selected. Next, starting with the first priority station, the number of stations is successively increased by adding to the combination the next station on the priority list. For each number of stations, the temporal frequencies are decreased to identify how much information is provided by those stations at different

sampling intervals. Finally, changes in information are plotted on the same graph with respect to both the increases in the number of stations and the decreases in temporal frequencies of sampling. The particular information measure used in this analysis is transinformation, and the objective is to select a space/time combination that produces the least amount of transinformation. The output of this procedure is a graph of transinformations versus space/time frequencies. Increases in either the space or the time frequencies implies increases in accruing costs so that one has to compare loss of information due to decreased space/time frequencies versus decreased costs, or vice versa.

The above analysis is applied to the streamgaging network in the Gediz River Basin along the Aegean coast of Turkey. The results obtained by the entropy method are then compared to those derived by a network optimization procedure based on dynamic programming. Both methodologies can be applied to any type of monitoring network provided that adequate and reliable data are available to test various time and space frequencies.