Effective Use of Spreadsheets for Hydrology and Water Resources Education

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Abstract

Spreadsheet software such as Excel is commonly used by both instructors and students in courses on hydrology and water resources. However, the application of Excel is usually limited to basic manipulation of datasets and repetitious numerical calculations. In this paper, we describe some Excel spreadsheet applications from courses at Colorado State University that go beyond traditional spreadsheet usage. These spreadsheet applications have been developed with the goals of improving the presentation of subject matter for visual learners and making complex concepts in hydrology and water resources more accessible to students in introductory courses. Three specific applications are described. The first application demonstrates an innovative plotting technique ("dynamic graphs") that adds motion to spreadsheet graphs. Traditional spreadsheet graphs are static in the sense that they plot fixed, pre-specified sets of data. These graphs make it difficult to visualize datasets that include both spatial and temporal dimensions or datasets with variability over a wide range of scales. Through the use of table lookup functions combined with user controls, one can readily change the data that is plotted by clicking on a list box or spinner control. The dynamic nature of these graphs allows students to quickly analyze different aspects of a dataset or make comparisons between datasets. For example, they can watch precipitation patterns develop month-to-month, year-to-year, or location-to-location. Or they can make hydrographs evolve out from the origin to experience the temporal variation of the discharge. The second application shows how logical or knowledge-based rules, which are commonly used in water resources management, can be considered by students in introductory water resources courses. Traditional spreadsheet applications process only numbers, but spreadsheets can also process symbolic information. This capability allows students to readily see the impact of rule-based information on management of water resources systems. The use of rules is demonstrated here by a simple flood warning system. The third application shows how complex concepts such as stochastic variation and its impact on water resources systems can be presented in an introductory course. In this application, the impact of stochastic hydrologic forcing on reservoir storage and operation is considered. Data filtering tools in Excel can be used to rapidly select and model various years of available data. Rapid modifications to the simulations helps student experience the stochastic nature of reservoir operation. This application also demonstrates the potential to exploit the tremendous computation capacity of a spreadsheet, which allows students to easily consider very large data sets.