Report for 2001OR4661B: Interactive Web Site for Streamflow Evaluations in Watershed & Habitat Restoration Planning

- Other Publications:
  - Bogavelli, Vaishali, 2002, Streamflow Research Web Site: General overview and detailed description of hydrologic analysis techniques included on the web site. Master of Science Report submitted to Civil, Construction and Environmental Engineering Department, Oregon State University.
  - Coles, Derron, 2002, Normalization of water-related projects in Oregon through development of a comprehensive web site. Master of Science Report submitted to Civil, Construction and Environmental Engineering Department, Oregon State University.

Report Follows:

Problem and Research Objectives:

The Research Problem

All soundly-based stream projects require careful and often extensive use of streamflow data. Such data may be needed for several types of conventional hydrologic analyses, depending on the nature of the project and type of information sought. Oregon is committed to watershed enhancement and to salmon recovery. Pressures periodically arise to use streams for other purposes, including diversion for water supply or energy generation.

The need for hydrologic assistance is illustrated by a recent newspaper article (Corvallis Gazette-Times Feb. 2, 2001) describing efforts by a watershed council to address salmon habitat restoration and water quality enhancement, involving over $370,000 for projects. Notably absent from the article was discussion of any streamflow evaluations. Subsequent discussion (2/5/01) with the Council coordinator indicated that some assistance was provided a participant from a federal agency to make streamflow hydrologic and hydraulic assessments. However, the main emphasis was on determining flood peaks at culverts. For other projects, assistance in placement of "structures" in streams subject to risks from large flows was based mainly on guidance from fishery biologists, rather than hydraulic engineers or hydrologists. For certain projects, engineering help was hired. But most of the expenditures were made with only rudimentary hydrologic and hydraulic guidance. This is not an isolated situation, but rather is symptomatic of state-wide and regional efforts by volunteer local groups to try to address significant watershed/stream/ecosystem issues with limited financial resources and preferences to invest in on-the-ground activities. The proposed web-site project is intended to assist such groups and their technical partners by providing hydrologic guidance for making needed analyses.

A major problem facing watershed, habitat and water development projects is the inadequacy of gaging station records to provide site-specific information. For example, there are less than 50 gaging stations in operation to cover the streams draining the Coastal Range along the entire Oregon coast, an area of about 8,050 square miles. Most of the long-term records are for stations with large drainage basins. Thus, for a project on a small ungaged stream there is little hope of finding streamflow records from a nearby small stream with which to make comparisons.

Research Objectives

The proposed project involves finding ways to create an interactive web site for the assessment of streamflow characteristics in conjunction with watershed and habitat restoration planning. Initial development of the web site focuses on use with streams along the Oregon Coast, extending between the Columbia River and California and from the Coast Range crest to the Pacific Ocean. Subsequent steps are geared to generalizing methods so that the geographic region may be expanded by users to other parts of Oregon.

The specific objectives of the project are to:

1. Learn web-site construction and use basics, map display techniques, and the requirements for developing the interactive use of a web site.
2. Develop and refine pertinent conventional hydrologic analyses into step-by-step formats for use by knowledgeable individuals without special or advanced training.
3. Incorporate these hydrologic analyses into the web site pages, along with an easy-to-use tutorial for users.
4. Assemble a list of the sources for pertinent hydrologic data into a table with links, with reference to specific river basins.
5. Assemble a table of streamflow gages for chosen river basins, with links to data on USGS web sites, beginning with the three Oregon coastal basins.
6. Perform statistical analyses of the hydrologic data for each of Oregon's 18 major drainage basins and provide estimations for drainage area, mean annual precipitation, typical monthly flow as a percentage of mean annual flow, and mean annual flow per unit of drainage area for each of these 18 basins.
7. Test the developed methods with selected individuals who have hydrologic skills.
8. Make the developed web site information available to a wide user group.

Methods, Procedures, and Facilities:

The OSU-WRRI participated in a regional study of low-head hydropower potential in the Columbia River Basin with the Water Research Institutes of Washington, Idaho and Montana, leading to reports WRRI-61 (with 18 data appendices for the 18 OWRD basins in Oregon) in 1979 and WRRI-62 (with 1 data appendix) in 1980. Work was done on large mainframe computers at the four participating universities. These allowed users to determine mean flows, monthly flows, flow duration curves, and low-head hydropower potentials for points along more than 6,700 miles of streams in Oregon, as well as for thousands of miles of streams in other parts of the Columbia River basin. The methodology has also been used over the past decade by various groups of Oregon State University students in CE 543 Applied Hydrology to refine and expand such analyses for particular basins (North Coast, Mid-Coast, South Coast, John Day, and Umatilla). The CE 543 work was done on PCs using spreadsheet techniques. These related research activities form the methodological basis for the project conducted here.

The specific project methods and procedures were as follows:

1. Learn web-site "how-to-do-it basics."
2. Learn the requirements for developing the interactive use of a web site.
3. Develop and refine the ways for incorporating conventional hydrologic analyses into a straight-forward step-by-step format so that knowledgeable individuals may easily obtain hydrologic information without special or advanced training in hydrology.
4. Assemble a table that lists all active USGS stream gages on Oregon coastal streams, with links that take the user directly to the desired streamflow data.
5. Add links to other data sets and give instructions for acquiring and new data as it becomes available at the end of each water year, and for modifying the analyses accordingly.
6. Test the developed methods with OSU graduate students, an OWRD hydrologist, a USGS hydrologist, a USDA-NRCS hydrologist, and an OSU Extension Service representative.
7. Provide illustrations for the use of the web site to assess streamflow characteristics for such applications as (1) stream habitat projects, particularly for EAS-listed species, (2) energy generation projects, (3) water supply projects, and (4) culvert evaluations.
8. Make improvements in the use of the web site, based on experience gained from testing.
9. Promote the use of the developed web site by providing information on the site and its use to the Oregon State University Cooperative Extension, the Oregon Watershed Enhancement Board, its various watershed councils (about 90 presently function), federal and state agencies, and consulting firms that provide hydrologic services.

The facilities used were PC computers available in the Civil, Construction and Environmental Engineering Department.

Principal Findings and Significance:

Principal Results

Because the goal of the web site is to guide individuals through hydrologic analyses of projects, it was imperative to create an appropriate layout that makes navigation intuitive. We decided to construct the web site with the logical steps of conducting a water related project in mind. Those project steps typically include: (1) collecting preliminary information on the project site, (2) compiling analysis techniques that will be used to facilitate project decisions, (3) performing analyses, (4) interpreting the results, and (5) implementing a design based on the results.

The web site is separated into eight sub-sections, as shown in Figure 1 below. Going in a clockwise direction through the figure, the right half of the circle addresses the project steps mentioned above. The left half of the circle contains information to help make navigating the site straightforward and to smooth the learning process.

Figure 2 gives an idea of how each of the sub-sections relates to the outlined procedures. As shown in Figure 2, each of the procedures is addressed by at least one subsection of the web site. The information provided in each subsection is listed in Table 1.

At this point, we have tested the layout of the web site through two water resources engineering graduate students and two water resources engineering professionals. We have received positive feedback stating that the configuration of information on the site is logical and easy to follow. Also, we have reorganized the data collection portion of the web site according to suggestions made by said participants.

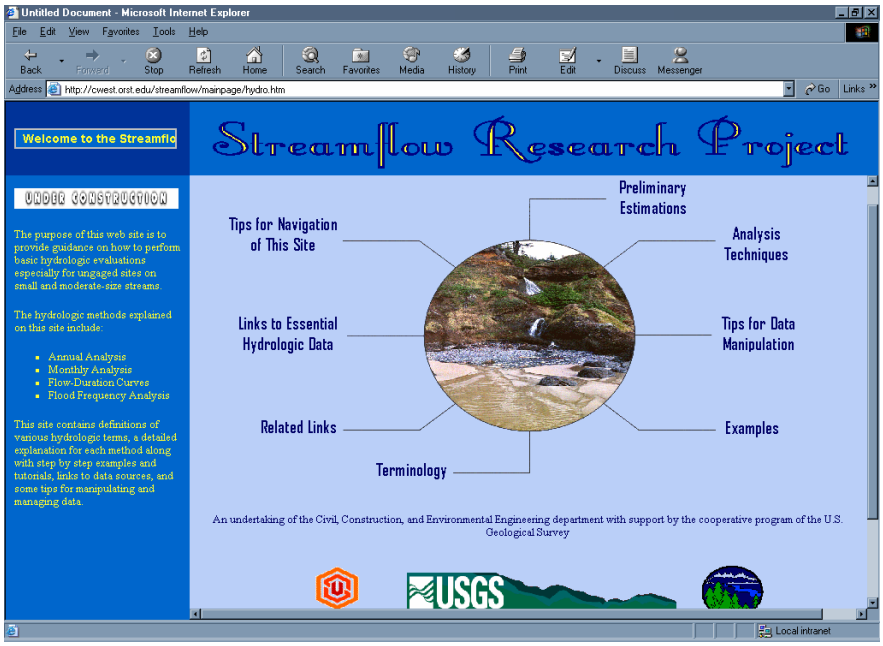

Figure 1: Main page of the Streamflow Research Project web site

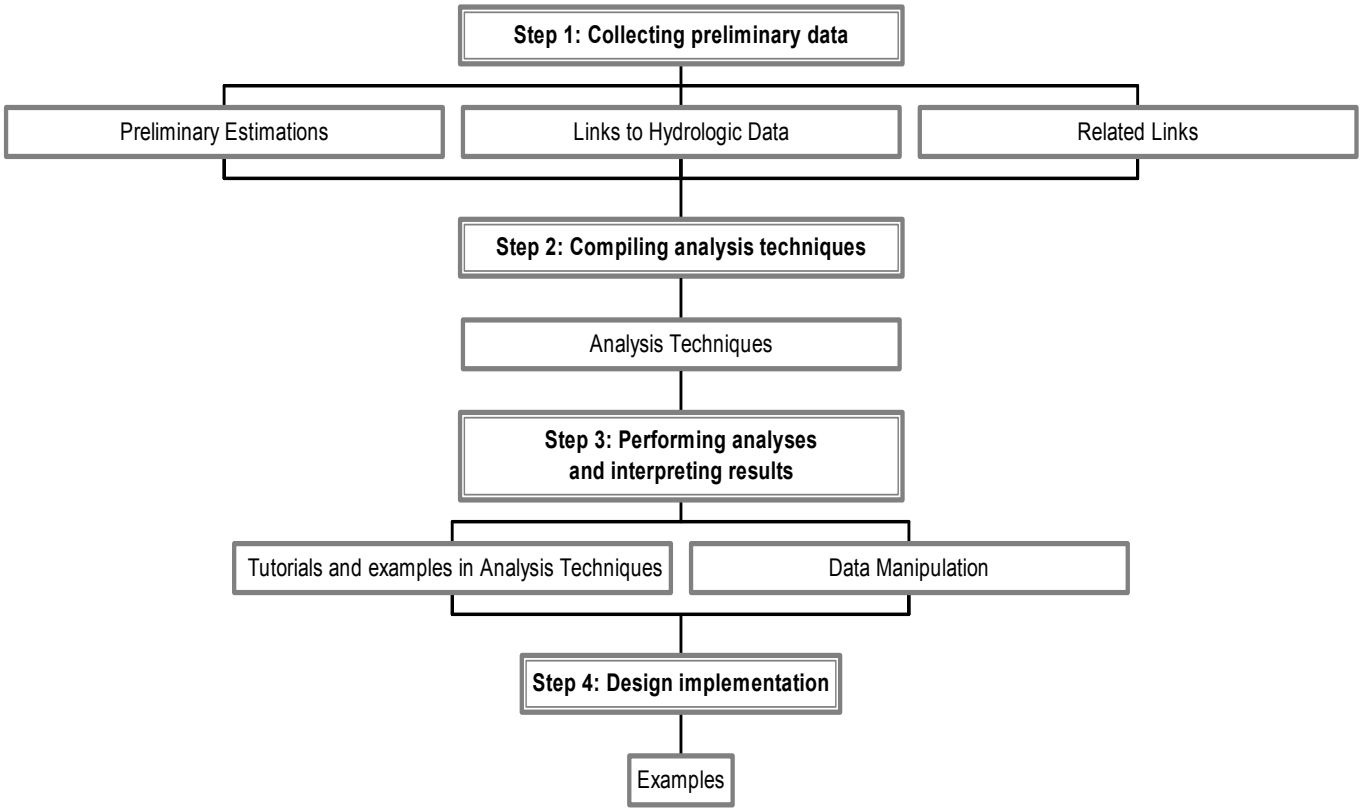

Figure 2: Typical project procedure and associated web site sub-sections

Table 1: Information for project procedures provided by web site subsections

SUBSECTION	RELATED PROCEDURE	INFORMATION PROVIDED
Preliminary Estimations	Collecting preliminary information	Values are provided for ▪ Discharge per sq. mile for Oregon watersheds ▪ Annual precipitation estimations for Oregon ▪ Percentage of annual flow for each month for Oregon watersheds
Analysis Techniques	Compiling analysis techniques and performing analyses	Definition and explanation of how to conduct ▪ Annual analyses ▪ Monthly analyses ▪ Flow duration/Exceedance Probability Analyses ▪ Flood frequency analyses
Tips for Data Manipulation	Performing analyses	▪ How to copy data ▪ How to perform time conversions on data ▪ Spreadsheet tutorial
Examples	Design implementation	Examples of completed analyses and conclusions for hypothetical water projects
Tips for navigation of this site	N/A	Explanation of the sub-sections and layout of the web site
Links to Essential Hydrologic Data	Collecting preliminary information	Links to streamflow and precipitation data for Oregon
Related Links	Collecting preliminary information	Links to hydrology related data such as meteorological, snow pack, and fish data
Terminology	N/A	Definitions of relevant terms

Significance of Project

It is expected that a person or group (e.g., watershed council) will be able to access the web site and work through a series of steps in order to develop hydrologic information for a project. This information would provide a basis for conducting a feasibility evaluation for the project, as well as for deciding whether more extensive data should be collected at the project site to improve the feasibility evaluation. Such evaluations are routinely needed for dozens of projects in Oregon each year, particularly to help determine whether these projects can be expected to realistically meet streamflow-related expectations.

The project results provide a straightforward step-by-step process for conducting hydrologic assessments of projects. The user would first begin by determining the geographical location of the project stream on a reference map and the topographic boundaries of the drainage basin. From the boundaries, the value for corresponding drainage area of the basin above the project site may be determined. The user is then able to work through the web page process. It is initially necessary to identify an appropriate streamflow gage from the web-page station list and location map. The user then follows the methods outlined on the web site to determine: (1) locations of nearby gaging stations, (2) sources for the data from those stations, (3) estimated long-term mean annual flow at the site, (4) estimated long-term mean monthly flows for each month, (5) variability of these 13 month-characterizing values (their standard deviations and extremes), (6) long-term patterns of past wet and dry periods, (7) flow-duration curve for mean daily flows, (8) and flood

magnitudes and frequencies of occurrence. Thus, the user should be able to develop a set of hydrologic estimates of streamflow conditions and have access to the original data for validation and other purposes.

Results from this project will also provide a basis for training in web-site techniques and hydrologic applications for future students. Members of the OSU Cooperative Extension Service will receive special instruction in use of the web site, as they are likely to interact directly with many potential users.

Training and publications:

This type of activity has been used in the course CE 543 Applied Hydrology several times in recent years. Each class contained 10-20 graduate students (MS, PhD, special -- from Civil, Construction and Environmental Engineering Dept.; Bioresources Engineering Dept.; Forest Engineering Dept.; Forest Sciences Dept., Geosciences dept.; Environmental Sciences Dept., etc.) who received training in the data workup methodology.

Direct training support on this project was provided for two graduate students. They worked on this project full time for most of summer 2001 and at a reduced commitment during the 2001-2002 school year while they completed coursework for the MS degree. They were previously involved in development of portions of the CE543 date base for the Oregon coast and were thus familiar with the hydrologic methods involved in this project. Primary training efforts focused on learning web page design techniques, data manipulation, and graphics development. It was critical to learn how to establish a user-friendly web site and how to assemble extensive databases. Training further included determining how to make improvements in the previously-used analytical schemes so as to make them more user-friendly for people who have not taken graduate coursework in hydrology.

Two publications are in progress of completion as of this report:

1. Bogavelli, Shali. 2002. Streamflow Research Web Site: General overview and detailed description of hydrologic analysis techniques included on the web site. Master of Science Report submitted to Civil, Construction and Environmental Engineering Department, Oregon State University. (expected completion in July 2002)
2. Coles, Derron. 2002. Normalization of water-related projects in Oregon through development of a comprehensive web site. Master of Science Report submitted to Civil, Construction and Environmental Engineering Department, Oregon State University. (expected completion in July 2002)