P2.4 A PILOT PROGRAM FOR A LOW FLOW IMPACTS DATABASE AT THE NATIONAL WEATHER SERVICE

Cody L. Knutson*[1], Mark D. Svoboda[1], and Doug R. Kluck[2]
[1]National Drought Mitigation Center
University of Nebraska-Lincoln
Lincoln, Nebraska

[2]NOAA National Weather Service
Central Region Climate Services
Kansas City, MO

1. INTRODUCTION

Monitoring the stage and flow of rivers and streams is critically important for ensuring the well-being of riparian ecosystems and human activities that rely on these water sources. With the invention of systematic forecasting tools, which have improved the prediction of flooding and water supply, immense progress has been made in providing early warning information for hazard mitigation and response. For example, the National Weather Service Hydrology Program has developed the Advanced Hydrologic Prediction System (AHPS), a river monitoring database that incorporates both current stage/flow information and river forecasts at nearly 4,000 forecast points across the nation [http://www.nws.noaa.govoh/ahps/]. Routine 7-day forecasts are made for many of the forecast points, but some forecast points only contain such information when the situation warrants (usually due to flooding). With the AHPS system fully implemented at all forecast points, both 7-day forecasts and seasonal (3 month) probability plots will be available. These probability plots currently exist for 1,522 forecast points and provide the chance of exceeding flood levels for the next 3 months. The system is expected to become fully functional in the near future.

In developing the AHPS system, research was also undertaken in order to provide a list of potential flood impacts which are likely to occur within the upstream and downstream influence of each river forecast point. Based on the impact information, flood levels were established for each forecast point. These levels are categorized as minor, moderate, and major, depending on the impacts that are expected to result as the river rises. For example, the term “minor flooding” is the stage/flow at which minimal or no property damage is expected, although some public inconvenience is possible. The term “moderate flooding” is used to indicate the inundation of secondary roads where some evacuation and transfer of property may be required. The term “major flooding” is used to indicate extensive inundation and property damage, usually characterized by evacuations and the closure of both primary and secondary roads.

The database of river stages and flows allows forecasters and the public to know when the flood level is likely to be reached and the corresponding potential flood impacts near each river forecast point across the United States. This information is essential for reducing the surprise of flooding events and helping people better prepare and respond to flooding conditions. In addition to preventing loss of life, the fully implemented AHPS system is expected to save approximately $760 million per year in flood losses and economic benefits to water resource users (NWS 2004).

Although providing great benefits for flood protection, the AHPS system does not provide the same information for low flow events. A lack of water in rivers and streams can have similar deleterious effects in terms of health, economic, and environmental consequences. Individuals, industries (e.g., agriculture, energy, and recreation), communities, government, and the environment are all impacted by water shortages. As a more proactive approach to drought management, a report by the National Drought Policy Commission (2000) stresses a need for the expanded use of observation networks, monitoring, prediction, and information gateways for enhanced drought mitigation and response. The need to systematically assess the effects of low flows has also been recognized by the US Drought Monitor Forum (a national group of scientists tasked with monitoring drought in the United States). These groups recognize that a low-flow impacts database would be a useful tool for assessing and mitigating the significant effects of low flows on local economies and society in general.

2. THE LOW FLOW PILOT STUDY

In order to incorporate low flow information into the current AHPS river forecast database, the National Weather Service has undertaken a pilot study to obtain relevant low flow information near 21 forecast points in the Upper Mississippi River Basin. The study area included the cities of Minneapolis and St. Paul, MN, to the headwaters of the Minnesota and Mississippi rivers.

*Corresponding author address: Cody L. Knutson, National Drought Mitigation Center, 156 LW Chase Hall, Univ. of Nebraska-Lincoln, Lincoln, NE 68583-0749; email: cknutson1@unl.edu

The National Drought Mitigation Center [http://drought.unl.edu/] was contracted to obtain the low flow impact information within the study area. In addition to a literature review, 112 people were contacted via email and/or telephone to participate in a survey of potential low flow impacts. Survey participants included representatives from various water districts and water officials from all levels of government within the study area (municipal, county, regional, state, and federal). Four basic questions were asked of the survey participants: 1) What are the impacts of low river levels and at what stage/flow do these impacts occur?; 2) Is there a specific time of year when the impacts will occur?; 3) Which AHPS site (or sites) best reflect(s) conditions at the locale?; and 4) Are there any other factors that affect low flow/stage impacts at the locale? Approximately 39 percent of the potential informants responded to the survey between April and August of 2004, yielding a variety of potential low-flow impacts.

3. SURVEY RESULTS

The primary impacts reported by state and federal officials are the potential suspension of water withdrawal permits for activities such as irrigation, industry, golf courses, and aquaculture in order to protect in-stream flows; river flow adjustments to minimize hydropower losses; reduced recreational access to quality water flow for boating, canoeing, and tubing; additional dredging to maintain navigation channels; and the activation of state drought plan responses. In general, it was found that most state-level policies in Minnesota are tied to the Q90 flow of a river. That is, low-flow response actions will begin when flows are reduced to the tenth lowest percentile (based on a station's period of record) for a 72-hour period. Another important river level is the nine-foot stage that the US Army Corps of Engineers is responsible for maintaining to support river navigation.

The survey also found that most local communities in the study area receive their domestic and industrial water from ground water sources. Because of this fact, many communities felt that they were minimally affected by low river flows. However, where impacts were reported, most sources had difficulty linking potential impacts to specific river stages or flows. Larger communities were more likely to report low flow impacts because of a heavier reliance on rivers and increased planning obligations. For example, the City of Minneapolis relies solely on the Mississippi River for its water supply. Concerns for larger communities primarily revolve around exposure of infrastructure below the water line, effects of the river level on ground water recharge, potential loss of domestic and industrial water supplies, lockage restrictions, dredging to maintain barge traffic, and actions to fulfill low flow wastewater permit requirements. In general, these communities are primarily affected by low flows when river levels interfere with intake structures and water suppliers' ability to provide safe effluent discharge.

4. POTENTIAL USE OF SURVEY INFORMATION

Similar to current flood data, survey information on the impacts associated with low river stages and flows will be incorporated into the AHPS database and presented on the associated websites. The potential impacts will be listed on the websites along with the stage at which each impact is expected to occur. This information will also be utilized to establish critical stage/flow determinations, which will be incorporated into weekly and 3 month hydrographs of stage exceedence probabilities. The severity of impacts in relation to low stages and flows will be analyzed to establish critical stage/flow thresholds similar to the process that was undertaken with flooding. In the case of flooding, impacts were categorized into minor, moderate, and major flooding. Depending on the findings of low flow studies, critical thresholds may be represented by a single primary critical stage/flow threshold or several thresholds as in the flooding counterpart (e.g., minor drought, moderate drought, major drought). This type of information can benefit local, tribal, state, and federal authorities in a number of ways. Identifying low flow impacts allows entities to better understand their low flow vulnerabilities so that they can be addressed before a hazardous condition occurs. It also points out areas or sectors where little information is known. For example, many communities and agencies had difficulty linking impacts to specific river flows and stages. Additional research is needed in these areas to better understand their reliance on river flows and their drought vulnerability. When incorporated into the AHPS system, the information will also provide early warning that low river levels may soon affect local activities. Because drought is generally a more slowly developing natural hazard, this information will give entities more time to develop alternative measures. Developing a low flow monitoring network will also help states and federal interests better understand regional differences in the impacts of low river levels, and provide information necessary for appropriate water resources and drought planning.

In order to better understand the impacts of low river stages and flows, a similar low flow study is underway in the Upper North Platte River Basin of Nebraska, Wyoming, and Colorado. Additional studies have also been proposed for the entire Platte, Republican, and Upper Missouri river basins including portions of Nebraska, Colorado, Kansas, Wyoming, South Dakota, North Dakota, and Montana. These

areas have been hard hit by drought for the last several years, and could directly benefit from a low flow impact monitoring system.

5. CONCLUSIONS

Enhanced low flow monitoring networks are essential for the development of appropriate drought mitigation and response actions. Gaining a better understanding of the impacts caused by low river flows is essential for creating a complete river monitoring system. Developing a better understanding of low river impacts at the local level will provide more detailed information that can be used in a wide variety of water resources planning applications at all levels of government, as well as in advancing the development of the AHPS system.

6. REFERENCES CITED

National Drought Policy Commission, 2000. Preparing for Drought in the 21st Century. May.

National Weather Service (NWS). 2004. Working Together to Save Lives: NWS Hydrologic Prediction Service. Factsheet. [http://www.nws.noaa.gov/oh/ahps]