19 August 2010
CENAB-PL-P

Decision Support Tools: Water Allocation and Water Management
Selected tools of interest

California

DST: Sacramento River Ecological Flows Tool

The Sacramento River Ecological Flows Tool (SacEFT) is a computer model that links flow management actions to focal species outcomes to improve the ecological representativeness of water operations. SacEFT can provide guidance on both target flows (to maximize ecological benefits) and avoidance flows (to minimize negative consequences), bracketing the range of discharges to be evaluated experimentally. Ultimately, the long-term goal is to work with leaders in water planning forums to continue the development of SacEFT to best meet the needs of these groups.

Working with The Nature Conservancy and Stillwater Sciences, SacEFT is a quantitative model that relates changes in a select set of management actions (such as changes in flow) to responses in physical habitats for six focal species on the upper Sacramento River: Chinook salmon; steelhead; green sturgeon; bank swallow; western pond turtle; and Fremont cottonwood. The model integrates existing ecological information, workshop input from technical experts, field investigations, and computer modeling to quantify selected linkages among the flow regime, channel characteristics, and specific valued ecosystem components. It is anticipated that this tool will be used to better inform managers and decision makers about the ecological implications and trade-offs of changes in flow management and other actions on this regulated system.

Funding for SacEFT was provided by the CALFED Bay-Delta Ecosystem Restoration Program.
http://www.essa.com/tools/saceft/index.html

Canada

DST: Okanagan Fish Water Management Tool (OKFWM)

Canadian Okanagan Basin Technical Working Group and Douglas County Public Utility District

The Okanagan Fish/Water Management Tool (OKFWM) is an internet-accessible (www.ok.fwmt.net) model developed by ESSA Technologies to guide real-time water release decisions at Okanagan Lake Dam. Natural variation, scientific complexity, competing objectives, staff (knowledge) turnover, and other multi-agency communication barriers are challenges faced by water managers who must decide how to allocate limited and variable water supplies. In the case of Okanagan Lake (British Columbia), water levels are managed to provide a balance between flooding, fisheries, urban/agricultural withdrawals and other interests. Specifically designed for day-to-day water and fisheries managers, the web user

interface and output reporting features of OKFWM provide an intuitive "traffic light" decision-making framework for choosing weekly water releases at Okanagan Lake dam. The OKFWM software developed by ESSA has undergone over 5 years of in-season use (2002-2008), and is now an embedded part of routine water operation decision-making by the Province and Fisheries and Oceans Canada.

OKFWM has been recognized as a cutting-edge and innovative computer model that allows all levels of government to participate and agree on trade-offs to best meet socio-economic and environmental goals associated with water management at Okanagan Lake Dam. Jim Mattison, Assistant Deputy Minister of the Water Stewardship Division noted, "The tool has really helped, not only improving our operation of the [Okanagan] River, but also greatly improving stakeholder and public understanding of the decisions that we make." In recognition of this achievement, the team and the tool received a 2007/2008 Premier's Innovation and Excellence Award.

Using the same external monthly inflow forecasts provided to the Okanagan basin water managers by the provincial Government's River Forecast Centre, water release decisions are passed to OKFWM's five state-of-the-science biophysical models (hydrology, socioeconomic water management rules, water temperature, kokanee and sockeye) that address lake and down-river considerations at a variety of sites. These submodels leverage web service automation for daily real-time updates on lake elevations, water temperatures and discharge in addition to manual information updates obtained from historical and ongoing field monitoring programs. This real-time information feeds into the hydrology and water temperature components of the model to "self-correct" inflow forecasts and adjust forecasts for accumulated thermal units (ATUs) which determine the windows of vulnerability for developing sockeye and kokanee eggs.

OKFWM operates in two modes: a) retrospective (or training) mode using historical data sets; and b) a prospective in-season management mode using real-time data to assist weekly water release decisions. In 2004, a comprehensive 25 year retrospective analysis was performed for the 1974 to 2003 period that included training of "apprentice" fish/water managers supported by senior managers. Results showed average sockeye smolt production gains from Osoyoos Lake of 384,000 — a 55% improvement — without adversely impacting flooding and economic interests. The system has also been used to evaluate climate change impacts and adaptation potential. In 2007, we assembled a basin-wide water budget for the 2050s period and ran these net Okanagan Lake inflows through the established operating rules embedded within the Okanagan Fish/Water Management Tool. Our study found that average egg-to-yearling survival for endangered Okanagan River sockeye may fall by as much as 44%. Additionally, our 2050 period fish/water managers were unable to achieve the current September 30 operating benchmark for Okanagan Lake even once in 28 simulated years. Consequences of extensive lake draw-downs would be catastrophic, highlighting the need for more serious preparations and quantitative water budget assessments.
http://www.essa.com/tools/OKFWM/index.html
http://www.ok.fwmt.net/

Colorado

DST: Colorado's Decision Support Systems

Colorado's Decision Support Systems (CDSS) is a water management system being developed by the **Colorado Water Conservation Board** and the **Colorado Division of Water Resources**. The goal of this system is to assist in making informed decisions regarding historic and future use of water.

The Decision Support System provides a wide range of water related research tools that are available online free of charge. These tools enable users to retrieve water data contained within HydroBase; including streamflows, lake levels, water rights, diversion records, calls, etc.
http://cdss.state.co.us/DNN/default.aspx

DST: Colorado Basin Roundtable Watershed Flow Evaluation Tool Project

The Colorado Basin non-consumptive needs assessment committee has been meeting since 2007 to complete the Colorado Basin's Nonconsumptive Needs Assessment which is required under HB05-1177. The committee's efforts have focused on three key efforts:

- Defined function environmental and recreational attributes in the basin
- Developed a matrix of attributes at risk and associated map of the areas within the Colorado Basin at risk
- Participated in pilot study of the Watershed Flow Evaluation Tool for the Roaring Fork Watershed

Project Tasks

As part of the Watershed Flow Evaluation Tool study, the project team in conjunction with the Colorado Basin non-consumptive needs assessment committee will complete the following tasks:

- Inventory hydrologic data
- Complete hydrologic modeling using the Colorado Water Conservation Board's Colorado Decision Support System model
- Review Watershed Flow Evaluation Tool Ecological Flow Curves and GIS Mapping of Flow Statistics/Ecological Flow Curves Using Risk Framework
- Compare Results of Watershed Flow Evaluation Tool with Other Basin Efforts
- Finalize Watershed Flow Evaluation Tool, Develop Draft and Final Report and Final Presentation

The Colorado Basin non-consumptive needs assessment committee is led by Ken Neubecker and Lane Wyatt.
http://www.cobasinwfet.org/

Pilot study completed in 2009.

DST: River GeoDSS

The Lower Arkansas River _LAR_ Basin in Colorado, like many intensively irrigated river basins in the Western United States, faces a variety of problems associated with inefficient irrigation, seepage from earthen canals, and inadequate drainage facilities. Upward flows from high water tables have salinized and waterlogged agricultural soils of the Valley, contributing to reduced crop yields and nonbeneficial water consumption on adjacent uncultivated lands. River water quality has also suffered since intensive irrigation of alluvial soils results in evaporative concentration and the accelerated dissolution of inherent salts and other mineral pollutants into the underlying aquifer, appearing as return flows that threaten the ecological health of the river. A geographic information system-based river basin decision-support system _River GeoDSS_ has been developed and applied to the LAR Basin for assessing basinwide strategies for improving agricultural productivity, salvaging water from nonbeneficial consumptive use, and reducing solute concentrations while maintaining compliance with decreed water rights and the Arkansas River Compact between Colorado and Kansas. Development and calibration of River GeoDSS, based on extensive field data collection programs in the LAR Basin, is described herein, with a companion paper detailing its application to evaluation of a wide range of agroenvironmentally focused water management strategies.

Enrique Triana, John W. Labadie, and Timothy K. Gates, "River GeoDSS for Agroenvironmental Enhancement of Colorado's Lower Arkansas River Basin. I: Model Development and Calibration," *Journal of Water Resources Planning and Management* 136, no. 2 (March 0, 2010): 177-189.

Research conducted at the field and regional scales in the Lower Arkansas River _LAR_ Valley of Colorado has identified water management alternatives with potential for enhancing agroenvironmental conditions in the basin by reducing waterlogging and soil salinity, salt loadings to the river, and nonbeneficial evapotranspiration in the irrigated stream-aquifer system. The LAR geospatial decision support system _GeoDSS_, presented in a companion paper as a customized version of the generalized River GeoDSS, is applied to the evaluation of the feasibility and performance of water management strategies at the basin scale. The LAR GeoDSS allows comparative evaluation of management options for improving irrigation efficiency, minimizing water shortages, and improving water quality at selected control points by augmenting groundwater return flows through dynamic regulation of reservoir releases to abide by legal and administrative constraints on river operations. Results show that conditions favorable to increased agricultural productivity and water conservation can be accommodated, along with the benefits of improved river water quality through reduction of excess irrigation recharge and canal seepage and augmented subsurface drainage, without violating existing water rights and the Colorado-Kansas Interstate Compact Agreement.

E. Triana et al., "River GeoDSS for Agroenvironmental Enhancement of Colorado's Lower Arkansas River Basin. II: Evaluation of Strategies," *Journal of Water Resources Planning and Management* 136 (2010): 190.

Michigan

DST: The Water Withdrawal Assessment Tool

In 2008, legislation was enacted to manage large water withdrawals in Michigan. The Groundwater Conservation Advisory Council (Council), originally formed in 2003, was appointed to develop a water withdrawal assessment screening tool that can assess the impact of a new or increased water withdrawal on local water resources and associated ecosystems. A Great Lakes Protection Fund (GLPF) project entitled "Restoring Great Lakes Basin Water Through the Use of Conservation Credits and an Integrated Water Balance Analysis System," from January 1, 2005 to December 31, 2006, facilitated an understanding of the potential for this approach and some related policy questions.

The Water Withdrawal Assessment Tool (WWAT), designed to be used by individuals preparing a new or increased water withdrawal, was jointly developed by the Council, US Geological Survey, Department of Natural Resources, the Department of Environmental Quality, Michigan State University's Institute of Water Research, and the University of Michigan. The web-based interface WWAT helps users with potential large quantity (70 g/m or more) water withdrawals to determine whether their proposed withdrawal will have an adverse resource impact on nearby streams; http://www.miwwat.org.

The WWAT consists of several science-based models that use watershed characteristics, summer low flow stream measurements (baseflow or index flow), resident fish communities in streams throughout the state, and groundwater modeling to assess whether a water withdrawal will have an adverse resource impact on a nearby stream. The term "adverse resource impact" or the ARI was defined as decreasing that part of the index flow to a degree that the stream's ability to support characteristic fish populations will be functionally impaired. The tool uses the Michigan Department of Natural Resources fish survey data collected at more than 1700 survey sites across the state, and uses 11 different fish response curves for 11 habitat types. Gaging data from 132 gaged streams with at least 10 years of records, over 22,000 flow measurements, and 3,690 miscellaneous measurements were used to determine the base flow conditions for 9000 small watersheds across Michigan.

A user can enter a proposed location of where a well might be placed, and input information on well depth, pumping capacity, and whether the well is in bedrock or glacial materials. Based on the data, the user is provided with the screening results and receives either a "Proceed," a "Caution," or a "Warning". If the user does pass the screening, he/she can register the proposed water withdrawal online with the Department of Environmental Quality.
http://www.miwwat.org/

New Jersey

DST: New Jersey Hydrologic Tools (NJHAT and NJSCT)

The initial development of the Hydroecological Integrity Assessment Process occurred under a joint project between the U.S. Geological Survey (New Jersey Water Science Center, West Trenton, New Jersey, and the Fort Collins Science Center, Fort Collins, Colorado) and the New Jersey Department of Environmental Protection. Out of this work, two software tools were developed specifically for New Jersey: the New Jersey Stream Classification Tool (NJSCT), and

the New Jersey Hydrologic Assessment Tool (NJHAT). Eighty-eight streams were used in the stream classification analysis, and four stream types were identified (Fig. 1).

NJHAT is used to (1) establish a hydrologic baseline (reference time period), (2) establish environmental flow standards, and (3) evaluate past and proposed hydrologic modifications of streams in New Jersey. It accomplishes this by using flow statistics, trend analysis, and ecologically relevant indices that address the five major components of the flow regime (magnitude, frequency, duration, timing, and rate of change) by using 10 nonredundant indices.

NJSCT is used to classify stream reaches that were not classified during the initial classification of streams in New Jersey.
http://www.fort.usgs.gov/products/Software/NJHAT/

Ohio

DST: Water Resources Management Decision Support System for the Great Lakes

Supported by the Great Lakes Protection Fund, the two-year project lays the framework for the data, information and processes required to ensure timely and well-informed public policy decisions concerning the use and management of surface and groundwater resources. In so doing, this binational effort will support ongoing efforts of the Great Lakes - St. Lawrence governors and premiers to develop and implement a management regime to address water withdrawal, consumptive use, diversion and related issues.

Since work began in August 2000, a Project Management Team (PDF), comprised of federal, state, provincial, and regional members, was established to guide effort and focus the project tasks. Three technical sub-committees were instituted to provide the hands on labor for addressing the three prime project elements:

- A Status Assessment of data and information;
- An Inventory of Water Withdrawal and Use which will build upon the existing Great Lakes Water Use Database; and
- An Analysis of Ecological Impacts to magnify and correlate the understanding of the cumulative impacts of water use and withdrawal.

A Stakeholders Advisory Committee (PDF) was also formed to act as a sounding board for the Project Management Team and to provide objective, but pointed, input to the process.

This multi-agency, multi-disciplinary, multi-faceted team approach to addressing the science and policy of a Great Lakes water management regime will produce such application-oriented products as a water use web site, updated annual water use inventories, ecological evaluations of the system, and an integrated binational role for future Great Lakes-St. Lawrence endeavors.
http://www.glc.org/wateruse/wrmdss.html

Virginia

DST: WOOOMM

http://deq1.bse.vt.edu/wooomm/
http://deq1.bse.vt.edu/wooomm/doc/tutorial_02.html

West Virginia

DST: Water Withdrawal Guidance Tool

WVDEP has developed guidance and a tool to help individuals know when it is environmentally safe to withdraw water from a stream. The guidance is based on percentages of mean annual flow, based on a ten year period that afford an appropriate flow to protect the aquatic habitat.

Knowing when it is environmentally safe to withdraw water from a stream is difficult. In many instances, it is simply impossible to be able to look at a stream and determine if you will be degrading the stream by pumping water from it. This guidance will assist you in deciding where and when you should consider withdrawing water from a stream.

The guidance is based on stream flow. As stream flow decreases aquatic habitat decreases accordingly. This guidance is based on percentages of mean annual flow, based on a ten year period, that should afford an appropriate flow to protect the aquatic habitat.

In a given area, the larger streams generally flow longer, and at higher rates than the small streams that feed into them. So, typically there is a stream flow in the larger streams that is above the minimum flow necessary to provide aquatic habitat when nearby small streams may have already fallen below that limit. So, there is a flow rate where it is probably still safe to remove water from portions of the larger streams, but not from the smaller streams in an area. And obviously, there is a higher flow rate that should permit withdrawals from all streams in the area.

As you move up a stream – even a large stream – the flow decreases as you approach the headwater. At some point, even if the guidance indicates it is safe to remove water from the stream, you will reach a point where the flow is too small to support that withdrawal, and you should not remove water from the stream.

You may determine whether it is probably safe to withdraw from streams in your area using this web-site. However, this is only guidance. You must still use your best judgment when withdrawing water from any stream. For example, a stream may be flowing at 50% of its annual average flow, but if you are taking out 90% of the average flow, you are degrading the stream. So, use your "common sense" when making a stream withdrawal. Even if the guidance indicates there is sufficient flow in a stream for withdrawal, if it looks like you will be de-watering the stream, you should go to a larger stream.

Persons withdrawing water should also be aware of, and take steps to avoid, transferring unwanted aquatic plants and/or algae from one water body to another. Before use trucks, hoses, pipelines and other equipment used for water withdrawal should be visibly inspected for aquatic plants. Any vegetation on the equipment should be removed before the equipment is put in contact with the stream. Likewise, any residual water in the equipment should be drained and/or disinfected to prevent transfer of undesirable algae into other waters.
http://www.dep.wv.gov/WWE/wateruse/Pages/WaterWithdrawal.aspx

Other Tools and Information

DST: StreamStats

StreamStats is a Web-based Geographic Information System (GIS) that provides users with access to an assortment of analytical tools that are useful for water-resources planning and management, and for engineering design applications, such as the design of bridges. StreamStats allows users to easily obtain streamflow statistics, drainage-basin characteristics, and other information for user-selected sites on streams. StreamStats users can choose locations of interest from an interactive map and obtain information for these locations. If a user selects the location of a U.S. Geological Survey (USGS) data-collection station, the user will be provided with a list of previously published information for the station. If a user selects a location where no data are available (an ungaged site), StreamStats will delineate the drainage-basin boundary, measure basin characteristics and estimate streamflow statistics for the site. These estimates assume natural flow conditions at the site. StreamStats also allows users to identify stream reaches that are upstream or downstream from user-selected sites, and to identify and obtain information for locations along the streams where activities that may affect streamflow conditions are occurring.

Separate applications have been established for each state that has implemented StreamStats. The State Applications link at the left provides access to a web page that shows where StreamStats is available and where it is being implemented. Users can select an individual state application from the map or the pull-down list on the State Applications page to view an introductory page for the state, which contains a link to the StreamStats user interface. The introductory pages explain any unique functionality that is available for the state and provides citations to reports that document the methods implemented for the state.
http://water.usgs.gov/osw/streamstats/

DST: GeoDSS

Geo-Decision Support Services (GeoDSS) provide interoperable access to distributed geospatial web services to aid decision makers in forming, analyzing, and selecting alternatives. GeoDSS includes workflow management to produce context-specific results from information and knowledge from multiple communities. The GeoDSS subtask will extend the Decision Support and the Information Interoperability work done in OWS-3 to include multilingual interoperability and compressed GML data. Enhanced decision support using information provided from an increasingly wide variety of services places more demands on the ability of the user client software. The GeoDSS thread will develop and demonstrate client programs that will integrate many services, provide stand-alone relatively light-weight open-source GML visualization and 3D CAD visualization. Each of these clients offers an opportunity to exploit the wide variety of data for decision support. GeoDSS will also continue to explore extensions/enhancements to the underlying OGC services to address a greater extent of emergency response scenarios.
http://www.ogcnetwork.net/node/234

DST: mDSS4

The mDSS4, originally developed in the context of the project MULINO (MULti-sectoral, INtegrated and Operational Decision Support System for Sustainable Use of Water Resources at the Catchment Scale) and further developed and applied with a contribution of several other projects (including DSS-GUIDE, TRANSCAT, NOSTRUM-DSS, NEWATER and

BRAHMATWINN) is a generic DSS developed to assist water authorities in the management of water resources. It can help you:

- to better understand or explain (to stakeholders) the problem at hand,
- to facilitate public participation required by the WFD,
- to take the edge of the conflict related to alternative water uses,
- to extend collaboration with and within different stakeholder groups.

DST: L-THIA

Long Term Hydrologic Impact Analysis

L-THIA estimates changes in recharge, runoff, and nonpoint source pollution resulting from past or proposed development. It estimates long-term average annual runoff for land use and soil combinations, based on actual long-term climate data for that area.

Land use changes can significantly impact groundwater recharge, stormwater drainage, and water pollution. The Long-Term Hydrologic Impact Assessment (L-THIA) model was developed as an accessible online tool to assess the water quality impacts of land use change. Based on community-specific climate data, L-THIA estimates changes in recharge, runoff, and nonpoint source pollution resulting from past or proposed development. It estimates long-term average annual runoff for land use and soil combinations, based on actual long-term climate data for that area. By using many years of climate data in the analysis, L-THIA focuses on the average impact, rather than an extreme year or storm.

The model produces maps of runoff depth and volume along with nonpoint source pollution loading of the area.

Indiana, Illinois, Wisconsin, Minnesota, Michigan, Ohio

DST: Eflow Calculator

USGS, TNC: Chris Konrad

Goal: Develop a simple program that will…

- calculate statistics from a daily streamflow time series,
- allow the user to create scenarios with specified environmental flow standards and allocation limits in terms of those statistics; and
- apply the environmental flow standards and allocation limits to the daily streamflow time series to generate a daily streamflow time series and associated statistics for each scenario

Next Steps:

- The Eflow Calculaor has not been peer reviewed or published, so it is only available for testing. Don't use it for any purpose when the accuracy of the results are important to anyone!
- Water availability assessment will be added to the version that will be released planned for 2010.

DST: Aquarius

Aquarius: *A Modeling System for River Basin Water Allocation*

Aquarius is a state-of-the-art computer model devoted to the temporal and spatial allocation of water among competing uses in a river basin. The model is driven by an economic efficiency operational criterion requiring the reallocation of stream flows until the net marginal return in all water uses is equal. This occurs by systematically examining, using a nonlinear optimization technique, the feasibility of reallocating unused or marginally valuable water storage and releases in favor of alternative uses. Because water-system components can be interpreted as objects of a flow network, the model considers each component as an equivalent node or structure in the programming environment as well. This is done using an object-oriented programming language (C++).

http://www.fs.fed.us/rm/value/aquarius.html

DST: HIP

Managing rivers and streams to maintain healthy aquatic ecosystems is a challenge for resource managers across the country. Demand for competing uses of water resources grows with escalating development, increasing recreational use, and the vagaries of climate and weather. For many species of concern, instream flow and associated water quality is critical for survival. Balancing these ecosystem needs with proposed changes in flow regimes requires a process managers can use to classify streams and determine the ecological and hydrological impacts of changes in streamflow.

In response, USGS scientists have developed the Hydroecological Integrity Assessment Process (HIP) and a suite of software tools for conducting a hydrologic classification of streams, addressing instream flow needs, and assessing past and proposed hydrologic alterations on streamflow and/or other ecosystem components. The HIP recognizes that streamflow is strongly related to many critical physiochemical components of rivers, such as dissolved oxygen, channel geomorphology, and water temperature, and can be considered a "master variable" that limits the disturbance, abundance, and diversity of many aquatic plant and animal species.

The HIP is intended for use by any federal or state agency, institution, private firm, or nongovernmental entity that has responsibility for or interest in managing and/or regulating streams to restore or maintain ecological integrity. In addition, the HIP can assist researchers by identifying ecologically relevant, stream-class-specific hydrologic indices that adequately characterize the 5 major components of the flow regime (magnitude, frequency, duration, timing, and rate of change) by using 10 nonredundant indices. The process is developed at a state or other large geographical-area scale but is applied at the stream-reach level (Figure 1).

To date, the HIP has been fully developed for the State of New Jersey and is in development for several additional states, including Missouri and Massachusetts. Among the set of tools, federal agencies involved in water management issues (such as the U.S. Fish and Wildlife Service, the Bureau of Reclamation, and the Army Corps of Engineers) will find the National Hydrologic Assessment Tool of particular value.

http://www.fort.usgs.gov/Resources/Research_Briefs/HIP.asp

DST: AgroClimate

AgroClimate is an interactive website with climate, agriculture, and forestry information that allows users to assess resource management options with respect to their probable outcomes under forecast climate conditions. AgroClimate uses crop simulation models along with historic and forecast climate data to allow decision makers to compare changes in probable outcomes under different climate conditions.

AgroClimate is a product that is still under development. At present it includes: 1) background climate information and a climate tool that allows decision makers to compare climate variability under different ENSO conditions; 2) crop information and tools for peanut, tomato, and potato; 3) forest management and wildfire risk assessment; and 4) links to other sources of related information of value to decision makers. Planned additions coming soon to AgroClimate include: 1) tools for assessing management options for additional crops, pastures, and livestock that are important to the agricultural economy of the southeastern USA; 2) a tool to help decision makers to assess the value of irrigation water; 3) a tool to help decision makers assess the value of crop insurance; and 4) a county-level database that links historic agricultural production data with climate so that decision makers can assess the effects of past climate variability of agricultural commodities.

http://agroclimate.org/