ADVANCES
in Hydrologic Engineering
Fall 2006

Director's Comments

By Christopher N. Dunn, P.E.

On May 3, 2006, Darryl Davis long time Director and employee of the Hydrologic Engineering Center retired. On the day he retired he had provided over 37 years of dedicated service to the hydrologic profession. Shortly after he retired, Darryl came back to the Corps as a rehired annuitant for the Institute of Water Resources. Working out of HEC, Darryl's role has been to enhance and promote risk analysis procedures in the Corps' flood damage reduction, risk management, and levee certification programs. Although he would like to work only twenty hours per week, I suspect he is working much more than that.

The day after he retired, I became the fourth Director in HEC's 42-year history. For those who don't know me, I served as the Chief of the Water Resource Systems Division here at HEC for five years before becoming Director and was a Senior Hydraulic Engineer in the same Division before that. I have over twenty years of public service working as a Regional Hydraulics Engineer for the Federal Highway Administration prior to transferring to the Corps. I am a member of ASCE and a Registered Professional Engineer in Oregon.

One of the most frequently asked questions I receive now that Darryl has retired, is what you are going to do differently. HEC is recognized for having an effective and efficient business model and I can't see

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Streamgaging Workshops: Dokan and Feish Khabour, Iraq (15-14 April 2006)

By Matt McPherson

For decades the Iraqi Ministry of Water Resources (MoWR), previously known as the Ministry of Irrigation, operated an extensive hydrologic monitoring network, which reliably quantified the volumes, timing, and quality of water moving through Iraq. The network's infrastructure has deteriorated significantly over the past thirty years. During that period, significant technological advances in streamgaging and telemetry instrumentation and practices have occurred. Technical training was needed to develop expertise by MoWR staff in the operation and maintenance of hydrologic monitoring instrumentation and computer wares needed to collect, relay, analyze, distribute, and archive data.

In spring of 2005, the Hydrologic Engineering Center (HEC) coordinated a team of James Hathorn from the U.S. Army Corps of Engineers Mobile District (USACE-SAM), and Steve Lipscomb from the U.S. Geological Survey (USGS), to travel to Dokan, Iraq, as part of the USAID Iraq Marsh Restoration Program, administered by Development Alternatives, Inc. (DAI). For five days James and Steve trained a group of seventeen engineers and scientists from the MoWR in the operation and installation of streamgaging equipment. The equipment consisted of an automated streamgaging station and an acoustic Doppler current profiler (ADCP) for making discharge measurements.

The success of the 2005 workshop led to the creation of a gage renovation task force within the

Installing orifice line

MoWR, and the continuation of the partnership between USACE, USGS, and USAID/DAI. Under the USAID/DAI Strategic Water and Land Resource in Iraq (SWLRI) program, follow-up efforts during 2006 provided technical assistance as the MoWR developed its renovation plan, solicited and evaluated proposals from vendors and consultants, and coordinated with other international partners, such as the New Eden project.

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Director's Comments (continued)

making any radical adjustments to our model. I will continue to emphasize HEC's role as the Corps' Center of Expertise for Hydrologic Engineering. I will pursue business relationships from non-traditional sources while honoring the values and integrity that have always defined HEC. HEC is currently well staffed, thanks to Darryl's foresight, and I couldn't be more excited about HEC's future.

So what has HEC been doing for the past 6 months?

National Activities:

HEC is participating on several national teams. These include Dam Safety, Levee Assessment, Map Modernization, and Dam Break Methodology. Dam Safety efforts involve working with the Corps Portfolio Risk Assessment team for the development of flow frequency extension methods. Levee Assessment work included groundwork for incorporating information from the levee assessment database into HEC-RAS. Map Modernization efforts included documentation of approximate methods for floodplain delineation. The Dam Break Methodology team helped to develop dam break modeling methods.

International Activities:

The amount of International work that HEC has performed has increased substantially over the last few years. We have compiled and reconstructed the water resources database and developed a water management model for Ministry of Water Resources in Iraq. Partnering with the USGS, we have also assisted with the renovation of the Iraq streamgage program. At this time it is unclear if we will be doing additional work in Iraq but the HEC-ResSim model which will be handed to the MoWR could ultimately become a negotiation tool in that part of the Middle East.

HEC has also been performing similar work in Helmand Valley watershed of Afghanistan. A water budget was created for the Helmand system using the HEC-ResSim software. We are developing a draft operations manual for the Kajakai Reservoir on the Helmand. To complete the operations manual, we have been working with the Cold Regions Research and Environmental Laboratory and the Portland District. Early next year, Engineers from HEC and the Wilmington District will go to Kabul, Afghanistan to provide hydrologic, hydraulic, and reservoir modeling training. Our HEC-HMS, HEC-RAS, and HEC-ResSim software will be featured.

Another International Activity that we continue to participate in is the Civil and Military Emergency Response Preparedness Program. In this program, GIS and Hydraulic Engineers from the Corps work with former Eastern Block nations to perform exercises to develop plans to prepare for emergencies such as dam failures. One thing that makes this work so interesting is that the watersheds often cross international boundaries. We plan on continuing these exercises in FY07.

Corps Water Management System:

CWMS continues to make advancements with the recent release of Version 1.4. Essentially a bug release, Version 1.4 addressed many of the issues the field raised about CWMS. The major revision expected in FY06 will now be released in FY07. This version will include an improved database structure and an interface that greatly facilitates migration from existing legacy data systems to the CWMS database. Information about CWMS can be found on the HEC website: http://www.hec.usace.army.mil.

NEXGEN Software:

Significant releases of HEC software are expected in FY07. Version 3.1 of the Hydrologic Modeling Software HEC-HMS is due in the second quarter. It will include additional reservoir diversion features and other enhancements. Version 4.0 of HEC-RAS, River Hydraulics Systems, will also be released in the second quarter. It will include sediment transport and water temperature modeling capabilities. The long awaited release of HEC-ResSim, Version 3.0, is expected in FY07 as well. It will include the system power features paid for by the Savannah District. More about this tool can be found in another article in this newsletter. Two flood damage reduction tools are to be released this FY. They include the event analysis software HEC-FIA, Flood Impact Analysis, and Version 1.3 of the flood damage reduction analysis software HEC-FDA. It will be the inaugural release for HEC-FIA, while Version 1.3 of HEC-FDA will include many additional features and bug fixes that have been identified by the field over the last seven years. Finally, a beta release of a comprehensive planning tool, HEC-WAT or Watershed Analysis Tool, is expected in the second

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Director: Christopher N. Dunn, P.E.

Water Resource Systems Chief: Michael K. Deering, P.E.

Director's Comments (continued)

quarter of FY07. The WAT is also described in detail in another article in this newsletter.

Overview for FY07:

As you can tell from all the software releases noted above, HEC anticipates a busy 2007. With twelve training courses and continuing to be involved in many National and International activities we should have a diverse reimbursable program. FY06 we should have a diverse reimbursable program. FY06 proved to be one of our healthiest R&D programs in years. The FY07 R&D program may not be as good as the President's budget includes a 1/3 cut to the overall R&D program. Regardless, HEC has many work units within the System Wide Water Resources Program and the Flood and Coastal Storm Damage Reduction Program. Maintenance funding trickles in year and can be considered a small but sustainable funding source. Our CWMS funding decreased last year commensurate with the decline in the Corps O&M funding which unfortunately means fewer betterments will be made. Perhaps the O&M reductions will be compensated by additional reimbursable projects.

Training Program

FY 2007 PROSPECT Training Program

By Michael Deering

The PROSPECT training program for FY 2007 has started. The first two courses for FY 2007 - Water and the Watershed and Advanced Steady Flow Analysis with HEC-RAS were taught 13-17 November 2006 and 4-8 December 2006, respectively. As shown in the table below, HEC will provide twelve classes; some basic and some advanced. The classes range in topics from hydrology (Advanced Application of HEC-HMS) to hydraulics and hydrology (H&H for Dam Safety Studies) to ecosystem restoration (Hydrologic Analysis for Ecosystem Restoration) and risk analysis (Risk Analysis for Flood Damage Reduction Projects).

There are spaces still available for most of our FY07 classes, contact HEC for availability. To register for our classes, please contact the appropriate party in your office or contact the **USACE Professional Development Support Center (PDSC),** Huntsville, AL (http://pdsc.usace.army.mil) for further information on the various ways to register. Registration is handled by Training and Operations (CEHR-P-RG).

Course descriptions are provided in the "Purple Book" at the PDSC site (http://pdsc.usace.army.mil/Purple_Book.aspx). A short description along with course agendas are also provided on HEC's website. To obtain enrollment information, please contact the Huntsville office. When doing so, please note the course number, name, data, and location, and contact:

CEHR-P-RG
USACE Professional Development Support Center (PDSC)
550 Sparkman Drive
Huntsville, AL 35817
Phone: (256) 895-7421
FAX: (256) 895-7465

Course Number	Course Title (all classes located in Davis, CA)	Dates
164	Water and the Watershed	13-17 Nov 2006
067	Advanced Steady Flow analysis with HEC-RAS	4-8 Dec 2006
098	Reservoir System Analysis with HEC-ResSim	22-26 Jan 2007
508	Statistical Methods in Hydrology	26 Feb - 2 Mar 2007
369	Advanced Applications of HEC-HMS	19-23 Mar 2007
161	Hydrologic Analysis for Ecosystem Restoration	16-20 Apr 2007
320	H&H for Dam Safety Studies	30 Apr - 4 May 2007
155	CWMS Modeling for Real-Time Water Management	14-18 May 2007
057	Hydrologic Engineering for Planning	18-22 Jun 2007
219	Hydrologic Engineering Applications for GIS	16-20 Jul 2007
122	Sediment Transport Analysis with HEC-RAS	20-24 Aug 2007
209	Risk Analysis for Flood Damage Reduction Projects	10-14 Sep 2007

Training Program

FY 2008 Proposed PROSPECT Training Program

By Michael Deering

HEC has submitted our proposed FY 2008 PROSPECT training schedule to the Corps' Professional Development Support Center (PDSC). The PDSC, located in Huntsville, AL, will soon be conducting the Corps' annual training survey which will be used to help decide which classes will actually be taught. Only the classes that have enough subscriptions will be taught. For your review and use, HEC has provided the proposed FY 2008 class list below. If you are interested in one or more of the classes make sure you let the training program in your District/Division know so that they can report your interest to the PDSC.

HEC is offering the traditional classes such as Unsteady Flow analysis, CWMS Modeling for Real-Time Water Management, Water and Watershed, along with a class that has not been presented in awhile - Groundwater Hydrology. To help ensure that all these classes will be taught, please sign up early if you are at all interested.

To register for our classes, please contact the appropriate party in your office or contact PDSC, http://pdsc.usace.army.mil. Registration is handled by Training and Operations (CEHR-P-RG).

Course descriptions are provided in the "Purple Book" at the PDSC site (http://pdsc.usace.army.mil/Purple_Book.aspx). A short description along with course agendas is also provided on HEC's website. To obtain enrollment information, please contact the Huntsville District. When doing so, please note the course number, name, data, and location, and contact:

CEHR-P-RG
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Phone: (256) 895-7421
FAX: (256) 895-7465

Course Number	Course Title (all classes located in Davis, CA)	Dates
164	Water and the Watershed	5-9 Nov 2007
123	Flood Frequency Analysis	26-30 Nov 2007
155	CWMS Modeling for Real-Time Water Management	10-14 Dec 2007
320	H&H for Dam Safety Studies	21-25 Jan 2008
178	Hydrologic Modeling with HEC-HMS	25-29 Feb 2008
152	Water Data Management with HEC-DSSVue	17-21 Mar 2008
161	Hydrologic Analysis for Ecosystem Restoration	14-18 Apr 2008
188	Unsteady Flow Analysis with HEC-RAS	12-16 May 2008
209	Risk Analysis for Flood Damage Reduction Projects	16-20 Jun 2008
098	Reservoir System Analysis with HEC-ResSim	14-18 Jul 2008
219	Hydrologic Engineering Applications for GIS	4-8 Aug 2008
114	Steady Flow with HEC-RAS	18-22 Aug 2008
124	Groundwater Hydrology	8-12 Sep 2008
176	Hydrologic Engineer Role in Planning	15-19 Sep 2008

Publications

The HEC Publications Catalog is HEC's library of publications that document its computer programs, hydrologic engineering and planning analysis procedures, project studies, and seminars. An effort is under-way to provide these publications electronically through the HEC web page (www.hec.usace.army.mil).

To-date all the International Hydrological Decade (IHD) Volumes, Training Documents, Research Documents, Seminar Proceedings, and Project Reports have been placed on the web site, thirty-four percent of the Computer Program Documentation has been completed and a few Technical Papers are available. In the next several months HEC hopes to complete the Computer Program Documentation and Technical Papers, and hopefully by the end of January 2007, will have completed this endeavor.

All documents are in Adobe® format (7.0 and later) and are for printing only. To download and view the documents, a user will need to have the latest version of Adobe® Reader (7.0.8) from Adobe® (www.adobe.com). If you have any questions regarding this issue, please contact Ms. Penni Baker (email: penni.r.baker@usace.army.mil) of our office.

Projects

Streamgaging Workshops: Dokan and Feish Khabour, Iraq (15-14 April 2006)

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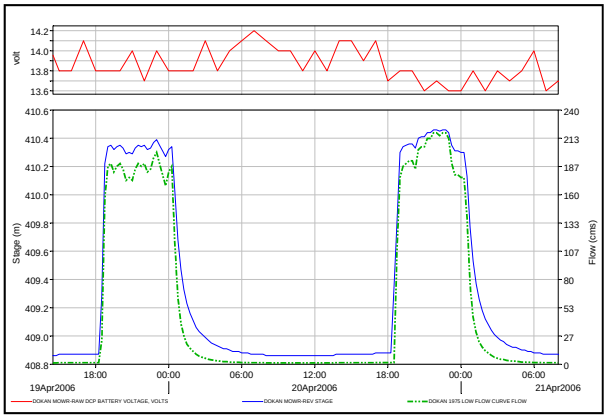
The highlight of the 2006 effort consisted of a five person team returning to Dokan for a ten-day workshop in April to repeat the training covered in 2005, and expand the agenda to include data archiving, management, and quality assurance. It also initiated satellite transmission of data from the station established in 2005 on the Lesser Zab River, and established a new automated station on the Tigris River at Feish Khabour. The 2006 project team again included Steve Lipscomb and James Hathorn, as well as Matt McPherson of HEC. They were joined by two additional members from the USGS, Bill Damschen and John Shelton, who brought critical expertise regarding telemetry and discharge measurement.

Approximately 24 employees of the MoWR attended the training, including members of the MoWR's gage task force. The task force gave presentations and facilitated throughout the activity. Student-led discharge measurements confirmed the stability of the rating curve at Dokan. The instructors oversaw the trainees' relocation of the streamgaging station to a higher and more secure location.

At Feish Khabour, the students installed two more modern acoustic Doppler velocity meters (ADVMs) that had been installed and then abandoned by the U.S. military. One of the units still worked, and was connected to the datalogger and satellite transmitter. The data from the Feish Khabour and Dokan sites are currently being relayed from the satellite to a USGS server in Boise, Idaho U.S. There the data are posted on a restricted access website for use by the workshop attendees and the MoWR.

The MoWR finds HEC-DSSVue attractive as a water control database because it is powerful, simple, and free. Mr. McPherson provided four days of instruction in the use of HEC-DSSVue for retrieving and storing the gage data, editing and quality control procedures, math functions, and creation of plots and reports.



HEC-DSSVue Plot

Many relationships were developed and will continue to stimulate interactions between the various participating agencies and ministries. Future plans include a 2 ½ month intensive training course for selected MoWR personnel to be held in Boise, U.S. during the spring of 2007.

Katrina - IPET Report Findings

By Jeff (David) Harris

This article is a follow up to the Katrina – IPET article (http://www.hec.usace.army.mil/publications/HEC_Newsletter_Spring2006.pdf) which appeared on page 3 of the Spring 2006 issue.

On June 1st, 2006, General Strock, Chief of Engineers, Corps of Engineers released the Interagency Performance Evaluation Task Force (IPET) Draft Final Report (https://ipet.wes.army.mil/). This report contains nine volumes:

I. Executive Summary and introduction
II. Geodetic Vertical and Water Level Datum
III. Hurricane Protection System
IV. The Storm
V. The Performance – Levees and Floodwalls
VI. The Performance – Interior Drainage and Pumping
VII. The Consequences
VIII. Engineering and Operational Risk and Reliability Analysis
IX. General Appendices

All of these volumes are available for online reading or download from the IPET website. In general, the Executive Summary provided an overview of what is in all of the volumes as well as findings and lessons learned from the tragic Katrina event. HEC was instrumental in the writing, analysis and support of the work that went into Volume VI. Below is an abstract of findings taken directly from Volume 1 of the IPET Draft Final Report.

Findings

The system did not perform as a system: the hurricane protection in New Orleans and Southeast Louisiana was a system in name only. The system's performance was compromised by the incompleteness of the system, the inconsistency in levels of protection, and the lack of redundancy. Incomplete sections of the system resulted in sections with lower protective elevations or transitions between types and levels of protection that proved to be weak spots.

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The storm exceeded design criteria, but the performance was less than the design intent: sections of the hurricane protection system were in many ways overwhelmed by the conditions created by Hurricane Katrina. This is particularly true for the sections of the Gulf Intracoastal Waterway (GIWW) along New Orleans East, and the levees in St. Bernard and Plaquemine Parishes where the combination of record high surge and long period waves exceeded the design conditions and devastated the levees. This devastation, however, was aided by the presence of incomplete protection, lower than authorized structures, and levee sections with erodible materials.

Foundation failures occurred prior to water levels reaching the design levels of protection. Within two of the three outfall canals in Orleans Parish, and at one site within the Inner Harbor Navigation Canal (IHNC), foundation failures occurred prior to water levels reaching the design levels of protection, causing breaching and subsequent massive flooding and extensive losses. These failures were all associated with I-wall structures and a common failure mode involving the formation of a gap on the canal side of the floodwall that precipitated and accelerated the failure in the foundation materials.

Breaches due to overtopping and scour. Two other sites within the IHNC experienced I-wall breaches due to overtopping and scour behind the walls which reduced the stability of the structures. These breaches added to the flooding in Orleans (East Bank) and the Lower Ninth Ward. The storm surge levels in the IHNC exceeded the design levels, Structure elevations, reduced over 2 ft by 35 years of subsidence, contributed to the amount of overtopping that occurred. Reduced protection elevations at transitions between structure types and incomplete sections of the system similarly reduced protection levels and increased flooding.

The flooding and the consequences of the flooding were pervasive, but also concentrated. Consequences of the flooding and the associated losses were greater than any previous disaster in New Orleans and, in themselves, create a formidable barrier to recovery. Loss of life was concentrated by age, with more than 75 percent of deaths being people over the age of 60. Loss of life also correlated to elevation, in terms of depth of flooding, especially with regard to the poor, elderly and disabled, the groups least likely to be able to evacuate without assistance.

The majority, approximately two-thirds by volume, of the flooding and half of the economic losses can be attributed to water flowing through breaches in floodwalls and levees. Losses and in many respects recovery can also be directly correlated to depth of flooding and thus to elevation. In some areas flooded by Katrina, where water depths were small, recovery has been almost complete. In areas where water depths were greater, little recovery or reinvestment has taken place.

The repaired sections of the hurricane protection system are likely to be the strongest parts of the systems until the remaining sections can be similarly upgraded and completed. Since there are many such areas where the protection levels will be the same as before Katrina, the New Orleans metropolitan area remains vulnerable to any storm creating surge and wave conditions that rival those from Katrina.

This is just a very small part of the information in the IPET Draft Final Report. For more information please view the full report on the IPET website.

Experimental and Numerical Development of Bed Mixing Technology: A Joint Lab Venture

By Stanford Gibson

Sediment transport modeling is highly sensitive to the bed mixing assumptions and algorithms used. The implementation of sediment transport capabilities in HEC-RAS 4.0 exposed the historic bed mixing algorithms to renewed scrutiny. Existing bed mixing approaches were conceptually sound and have served the Corps well for decades. However, these algorithms were developed to address sediment modeling needs historically faced by the Corps. As the organization greens, sediment modelers are increasingly interested in habitat considerations and environmental indices. These investigations require advanced mixing algorithms with variable porosity that resolve interstitial sorting on a finer scale.

Drained flume following an experiment

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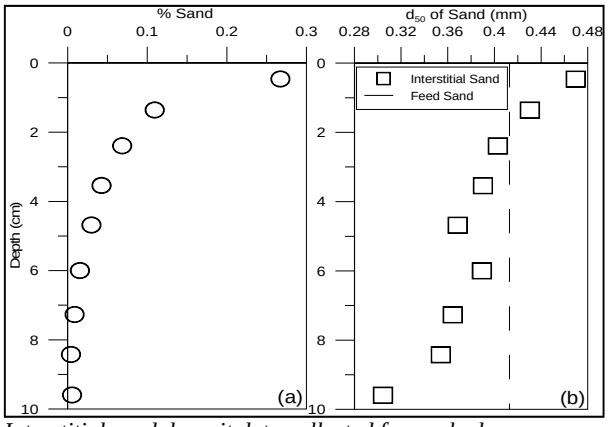
Projects (continued)

As HEC set out to develop updated algorithms it became apparent that the desired experimental data did not exist. So HEC contacted David Abraham and Ronald Heath at the Corps experimental facility, the Coastal and Hydraulics Lab (CHL) at the Engineering Research and Development Center (ERDC). Together CHL and HEC received funding from the System-Wide Water Resource Program (SWWRP) to conduct a series of flume experiments to investigate the vertical, interstitial sorting mechanism of a fining system.

Bedform and sand intrusion

A flume in Vicksburg was selected but needed restoration before the work could begin. The CHL investigators worked hard to get it into a usable state. In FY06 the joint research team performed thirteen experiments, took over a hundred samples, performed nearly a thousand gradation analysis and processed over forty tons of material. Data collected will be used to develop and validate new bed mixing algorithms in HEC-RAS.



Interstitial sand deposit data collected from a bed core

Forecast-Coordinated Operations using HEC-ResSim

By Joan Klipsch

A group of agencies has requested HEC's assistance in developing reservoir models that includes a new approach to flood control and water control operations on the Yuba and Feather Rivers in California. This project, called "Forecast-Coordinated Operations" or F-CO, brings together the Corps of Engineers, the California Department of Water Resources (DWR), the Yuba County Water Agency (YCWA), and the National Weather Service's California-Nevada River Forecast Center (CNRFC). HEC's role in the project is to assist with the adaptation, installation, and application of the HEC-ResSim reservoir simulation computer program for the Yuba-Feather river system.

The F-CO group is developing an enhanced forecasting model for the coordinated flood operations of the Bullards Bar Dam and Reservoir (a YCWA project) on the Yuba River and the Oroville Dam and Reservoir (a DWR project) on the Feather River. Both of these reservoirs contain "Section 7" regulated flood control space making them subject to oversight from the Sacramento District of the Corps (CESPK). CNRFC, who is managing the development of the model, has requested that HEC enhance the HEC-ResSim program to better represent the regulation plans and policies for these reservoirs. DWR proposes to implement the ResSim model into the system used by the state of California for real-time data and modeling used in managing the Oroville reservoir project and also expanding it for joint use with YCWA for the Bullards Bar reservoir project.

To meet the requirements of the Yuba-Feather F-CO, the HEC-ResSim program will be modified to add a number of new features including: extended downstream rule logic to account for rate-of-change constraints, a new variable contingency factor applicable to a downstream constraint, an enhanced induced surcharge rule with the capability to manually specify a family of curves for the emergency spillway release diagram, and an inflow factor editor.

CNRFC has also requested that in conjunction with the ResSim enhancements, HEC provide assistance for integrating HEC-ResSim into the National Weather Service River Forecast System (NWS-RFS) suite of software used by CNRFC and other weather service river forecast offices nation-wide. This will require a Linux version of HEC-ResSim and a few additional features, including a "hot-start" ability, and execution of model runs without use of the graphical user interface.

These modifications are expected to benefit all users of HEC-ResSim. The design work for these enhancements was completed in November 2006 and implementation is expected to begin in January 2007. These enhancements will be included in a general release of HEC-ResSim, to be labeled version 3.1, with a planned release date late in 2007.

Software

Introducing the Regime Prescription Tool (HEC-RPT)

By John Hickey

The Regime Prescription Tool (HEC-RPT) is now available for download at HEC's website. HEC-RPT is a software tool whose purpose is simply to help groups of people reach informed agreements about how to manage the flow regime of a river.

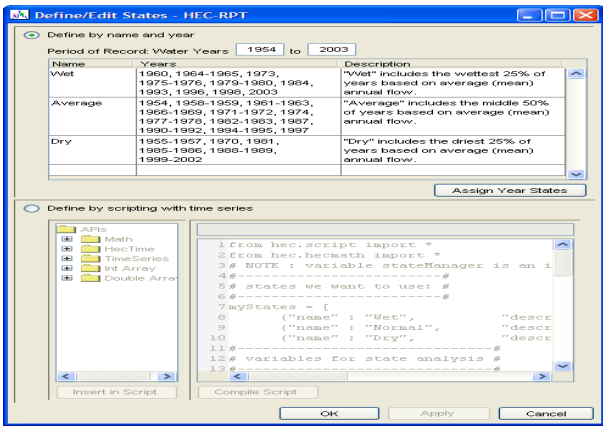
The idea for this tool was conceived during a workshop for the Savannah River, where 47 scientists collaborated to formulate ecological recommendations for flows in the Savannah River. During this two-day workshop, sets of flow recommendations were created for three ecotypes of particular importance in the Savannah Basin (shoals, floodplain forest, and estuary) and then unified into a single set of recommendations by merging flow features specified for each of the ecotypes.

Throughout this formulation and unification process, many hydrographs were created, morphed, and discarded. Facilitators were pressed to track all of the recommendations and lacked an easy way to present results electronically. It was noted that a tool capable of rapidly displaying, adjusting, and documenting hydrographs would make the formulation process easier and, if it were also capable of accessing and plotting historical hydrologic data to guide the scientists upon their request, then the product as well as the process would be improved.

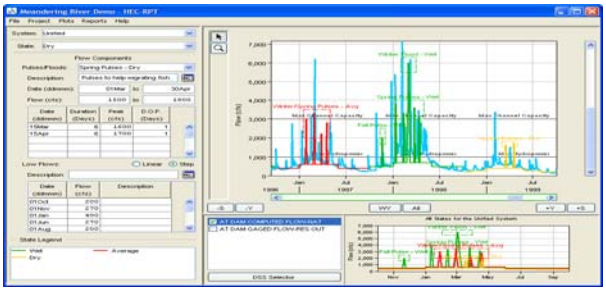
HEC-RPT is designed to meet these needs by facilitating entry, display, and documentation of flow recommendations in real-time, public settings. It is primarily a visualization tool and is not intended to perform the detailed quantitative analyses (e.g., statistical analyses or reservoir and river routing) already performed by other software packages. Instead, HEC-RPT seeks to complement those packages by making it easier to create flow times series that other software can import and use in their analyses.

Using the software involves two main steps, defining hydrologic states and creating flow recommendations. HEC-RPT offers two methods for defining states. The first is easy. Users simply name a series of hydrologic conditions (wet, average, dry, extreme dry, etc.) and list the water years that fall into each category. The second is more complex. Users create an algorithm that imports time series (i.e., natural flow, reservoir storage, precipitation, etc.) and performs math and logic functions on those time series to determine the prevailing hydrologic state. Though this method can be tricky to set up, it is more realistic from an operational perspective where hydrologic conditions often change from day to day or week to week rather than hold for an entire water year.

Most features in HEC-RPT support the creation of flow recommendations. The main interface has text entry fields where users can record pulse, flood, and low



Interface for Defining and Editing Hydrologic States



Main interface of HEC-RPT. Flow recommendations are displayed for different hydrologic conditions or "states" (wet state in green, average in red, and dry in yellow). Changes to the flows would be made via the text boxes on the left.

flows recommended by formulation teams. Two plotting windows display different aspects of the recommended flows, automatically updating with each new entry. Existing time series can also be plotted to show how recommendations compare with natural flows or past water management.

HEC-RPT will be available as an option from the Tools menu of the reservoir simulation model HEC-ResSim (version 4.0) and also has the ability to "stand alone" as an independent executable capable of accessing hydrologic data for reading, writing, and plotting data. Flow recommendations formulated in HEC-RPT can be exported to HEC-DSS and are thereby available for immediate analysis in other HEC software, including reservoir system simulation, river hydraulics, and ecosystem functions.

HEC-RPT is the first joint software development by the Corps and The Nature Conservancy. Development costs were shared between the Hydrologic Engineering Center, Portland District, and The Nature Conservancy. This work was undertaken in support of the Sustainable Rivers Project, which is an ongoing nation-wide partnership between the Corps and The Nature Conservancy to improve the health and life of rivers by changing the operations of Corps dams, while maintaining or enhancing project benefits.

Software (continued)

Watershed Analysis Tool (HEC-WAT)

By Penni R. Baker

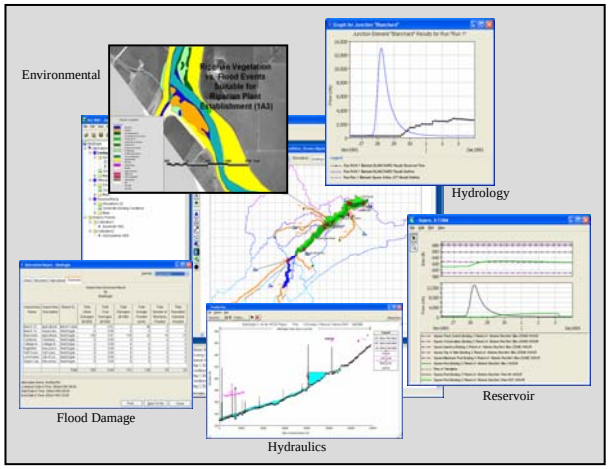
The Watershed Analysis Tool (HEC-WAT) is a new piece of software being developed by the Hydrologic Engineering Center (HEC). The goal of the WAT is to help Corps offices perform all types of studies in a coordinated and comprehensive fashion including watershed and/or system-wide studies. The development process began in FY 2004 and a Beta Version of the WAT is expected to be released in the second quarter of FY2007.

The Corps (USACE) along with its study partners conducts watershed and water resources management studies. These studies often begin with the definition of problems, issues, and opportunities and continue with various analyses to determine impacts so that appropriate decisions may be made. The studies often require hydrologic, hydraulic, economic, environmental, and social impact analyses. In most cases, varying sections within a district office perform these analyses independently with the reporting and visualization of modeling results through independent models. For the project study, coordination, file/data sharing, logistics, reporting of modeling results, and status reporting are often a problem for the modeling teams as well as project management.

To address these needs, HEC is developing the WAT. It will streamline and integrate the tools commonly applied by the district and division offices so that more efficient and coordinated modeling and planning may be performed. Modeling teams will benefit because they will develop their models in a closely coordinated manner, track progress of other models, and automatically retrieve results from previous model runs thus assuring more efficient and coordinated results. The management team will benefit by using a common interface to track project status through each modeling component and displaying results during public and project status meetings.

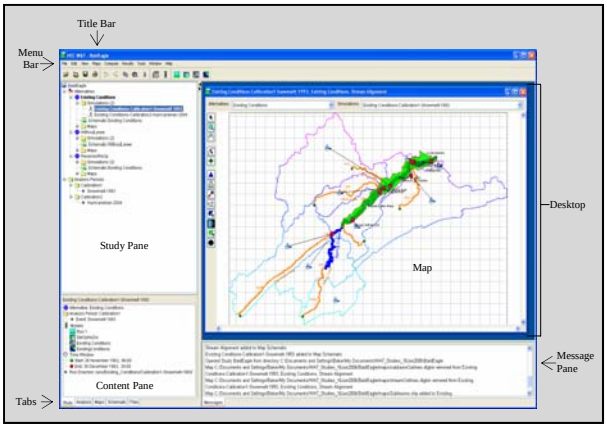
The WAT interface streamlines and integrates the analytical process using the tools commonly applied by multi-disciplinary teams (HEC-HMS, HEC-RAS, HEC-ResSim, and HEC-FIA etc.). The integration of the models and tools is accomplished through the use of a concept called a "plug-in". The "plug-in" concept allows the WAT to remain oblivious of the individual software, but provides an analysis framework for the models. A "plug-in" can provide the ability to access model parameters and view results in the model from the WAT framework. In other cases the "plug-in" only provides the viewing of results, with the changing of model parameters being done outside of the WAT.

A common, central framework is provided through the WAT. From the framework, GIS based layers can be loaded such as shapefiles and DEMs; stream networks



HEC-WAT Integration of Models

and schematics can be established; locations (common computation points) can be identified where models would share information; the modeling programs and their sequence order are defined; existing models are imported; and new models are developed. The WAT framework will meet the following objectives: organize and develop alternatives; access modeling programs directly; view and compare alternative results; facilitate the entry of the data necessary for Risk and Uncertainty (R&U) computations (Version 1); and, facilitate NED (National Economic Development) plan selection (Version 1).



HEC-WAT Framework

The alpha version of the WAT was demonstrated at a Peer Review in June 2006. Fourteen different Corps offices and one engineering firm representative participated in the review. The Peer Review lasted one day with presentations and a demonstration of the WAT given by Christopher Dunn and Penni Baker (HEC), and John DeGeorge from Resource Management Associates (RMA). Following are the recommendations made during the Peer Review. HEC needs to: find a scheme where the DSS mapping is handled better; address concerns regarding the integrity

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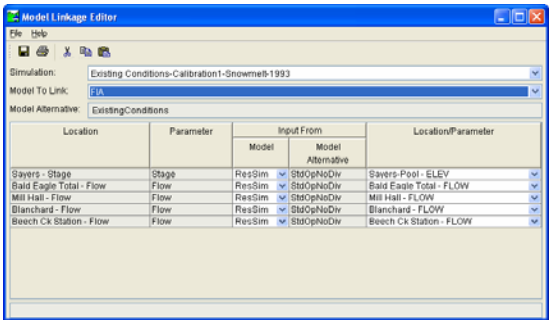
of modeling data; answer the question is the WAT run from a server or is it an application on an individual workstation; find a study to be used as an early application of the WAT; and, address the question should the "trial" concept that is present in CWMS be added to the WAT.

Several of the recommendations from the Peer Review have been addressed in the Beta version of the WAT:

- The Model Linking Editor provides an easy way to link (DSS mapping) models in the WAT, including observed data, and provides a mechanism where the linking will only have to be done once per alternative. For Version 1 of the WAT plans are to include a way to link models spatially through locations (common computation points).



Model Linking Editor

- Integrity of modeling data, which also includes the workstation/server issue, for the Beta release will have minimum capability. This means the WAT will still be a single user application, with some low level locking of files implemented. Therefore, when two users open the same study, the last user to save wins. For Version 1 of the WAT, HEC is investigating handling the integrity of modeling data by using the concepts present in version control software. From the WAT this would be transparent, changes would be automatically committed, would give the user information on who did what and when, and would also work across the network (addressing the workstation/ server issue).
- The Nashville District has requested to use Mill Creek as a pilot study for the WAT.

The Beta release distribution and documentation for the WAT is scheduled for the second quarter of FY2007. Development of code will end in December 2006, with testing and debugging proceeding through the first part of the second quarter for FY2007. For further information regarding the WAT contact Christopher Dunn (christopher.n.dunn@usace.army.mil) or Penni Baker (penni.r.baker@usace.army.mil) at 530 756-1104.