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Development of a Synthetic Hydrograph Application to Generate Inputs to the Everglades Depth Estimation Network (EDEN) Water-Surface Model

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Introduction

The Everglades Depth Estimation Network (EDEN) has provided principal investigators and other water-resources managers with quality-assured water-surface maps for the period January 1, 1991 to the present (2012). There is interest among principal investigators and water-resource managers to use the EDEN water-surface model to generate water-surface maps for hypothetical hydrologic conditions. The use of the EDEN water-surface model for hypothetical conditions is challenging due to the need for daily model inputs for 240 monitoring stations within the freshwater domain of the Everglades. To generate a 10-year simulation with the EDEN water-surface model would require defining over 875,000 data points. The synthetic input hydrographs also must reflect the dynamic relations of timing and magnitude between stations for the water-surface model to execute successfully. The limitations of the number of input stations, the number of input values, and historical dynamic relations between the stations were addressed by using a sub-domain (subarea) model of the EDEN model domain and thereby limiting the number of gages to those of the subarea. This poster describes the development of the EDEN-Syn application to generate user-defined synthetic hydrographs for a subarea model for EDEN.

Approach

The objective of the EDEN-Syn development was to minimize the number of station hydrographs that a user needs to determine, to minimize the number of values for a user to input to define a 10-year daily water-level hydrograph, and to maintain the dynamic correlations between all the water-level input stations. An experimental subarea water-surface model was developed for Water Conservation Area 3A-South (WCA3AS) that uses 31 real-time stations from the EDEN network to generate water-surface elevation maps (fig. 1).

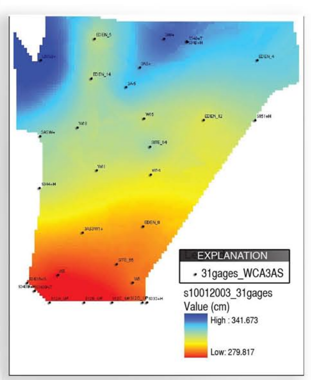

Figure 1. Water-surface elevation from the EDEN Water Conservation Area 3A-South subarea model for October 1, 2003. The mean error of the simulation is 0.12.

To determine the minimum number of stations that a user would need to input to the application, the 31 stations were grouped by site types of marsh and canal structures (table 1). A dynamic time-series clustering technique (Roehl and others, 2006) was used to cluster time-series data of each group into classes of similar behaviors. The results of the dynamic clustering showed two classes for the marsh and canal structure stations (table 1, fig. 2).

Station	Type	Class	Comment
3AS	Marsh	1	Index station
3A-5	Marsh	1	
3A9	Marsh	1	
3ASW	Marsh	1	
EDEN_14	Marsh	1	
EDEN_5	Marsh	1	
L28S2	Marsh	1	
W15	Marsh	1	
W18	Marsh	1	
SITE_64	Marsh	2	Index and user input station
3AS3W1	Marsh	2	
EDEN_12	Marsh	2	
EDEN_4	Marsh	2	
EDEN_8	Marsh	2	
SITE_65	Marsh	2	
W11	Marsh	2	
W14	Marsh	2	
W2	Marsh	2	
W5	Marsh	2	
S340_T	Canal Structure	3	Index station
S151_H	Canal Structure	3	
S340_H	Canal Structure	3	
S343B_T	Canal Structure	3	
S12C_H	Canal Structure	4	Index and user input station
S344_H	Canal Structure	4	
S12A_H	Canal Structure	4	
S12B_H	Canal Structure	4	
S12D_H	Canal Structure	4	
S333_H	Canal Structure	4	
S343A_H	Canal Structure	4	
S343B_H	Canal Structure	4	

Table 1. Marsh and canal structure stations, behavioral classes, index and user-input stations.

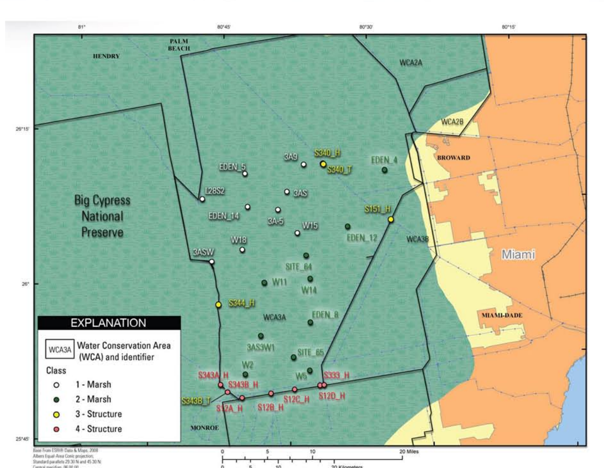

Figure 2. The 31 stations used in the EDEN-Syn application clustered into 4 classes of similar hydrologic behaviors.

For each class of stations, the gage with the highest correlations with the other stations in the class was selected as an index station and used to estimate the other stations in the class. Of the two index sites for each type (marsh or canal structure) of data, one was selected for the user to input water-level values. The conceptual architecture of the EDEN-Syn application is shown on figure 3.

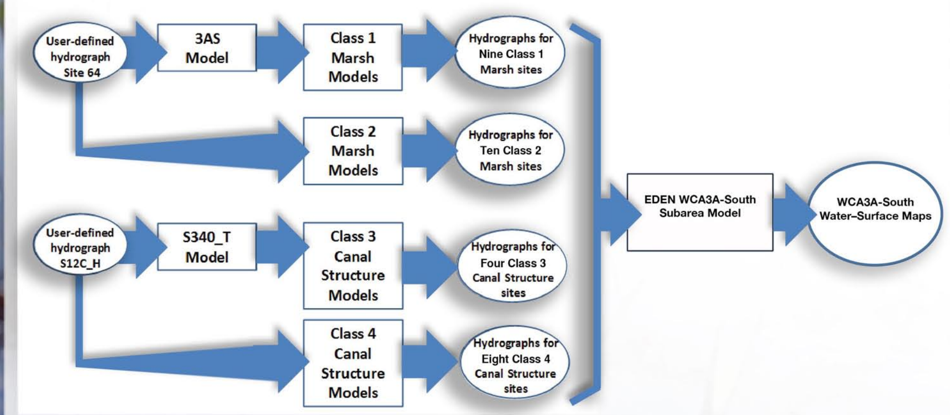

Figure 3. Architecture for the EDEN synthetic hydrograph generation application (EDEN-Syn) for Water Conservation Area 3A-South.

To minimize the number of values for the 10-year time series for the user to input, it was decided the user would input monthly water-level values rather than daily values. Therefore, for a 10-year hydrograph for WCA3AS, a user has to input 240 values rather than 7,300 values.

EDEN-Syn Application

There are three user input options in EDEN-Syn: a percent of the historical values, the percentile of the frequency of historical water levels, or a constant value for the month (fig. 4). The user inputs a monthly value and EDEN-Syn will generate daily values for the month. To assist the user in selecting monthly values, a monthly duration hydrograph can be displayed that shows the range of monthly water-level values for the period 2000 to 2011 (fig. 4).

After the two user input hydrographs are entered, the user selects to generate the synthetic hydrographs for the other 29 stations in WCA3AS and the estimation models generate the synthetic hydrographs (fig. 5). The output file includes historical daily values for all 31 sites, the user-input options (percent historical, percentile, or constant) for the two user-input stations, and the daily synthetic hydrographs for all 31 stations.

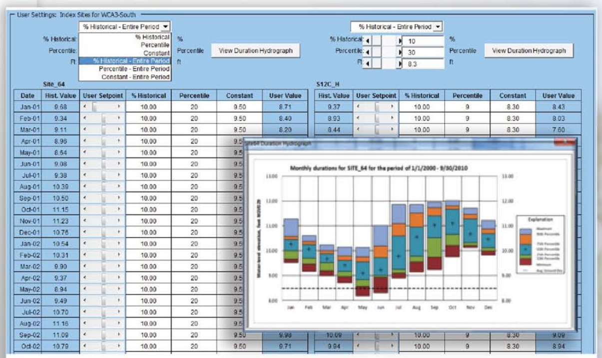

Figure 4. Screenshot of the EDEN-Syn user-defined monthly hydrograph inputs form for stations Site_64 and SC12C_H. The drop down menu (A) allows user to input changes for each month or input the same change for the entire period. The duration hydrograph (B) for the input stations are displayed to show user the historical distribution of water levels for each month of the year.

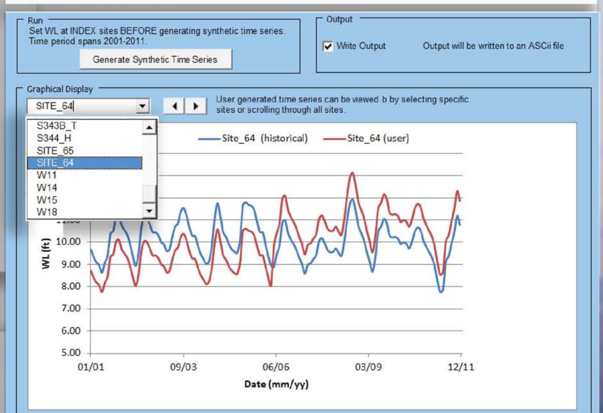

Figure 5 Screenshot of the EDEN-Syn control page to generate synthetic hydrographs, select whether output is written, and display monthly hydrographs. The user-defined hydrograph represents a 10 percent reduction in historical water levels prior to June 2006 and a 10 percent increase in historical water level after June 2006. The drop down menu (A) allows user to select any of the 31 stations of EDEN-Syn and display the historical and user-defined monthly hydrographs for that station.

Discussion

The generation of synthetic hydrographs for input into a subarea model of EDEN adds an important utility for EDEN users to be able to simulate hypothetical water-management scenarios. Previously, EDEN had solely been used to simulate historical conditions and users could ask "what was" the water level at an ungaged location on a particular day. By generating synthetic hydrographs, users can now ask "what if" a certain hydrologic conditions occurred and what would the water level be at an ungaged location on a particular day.

References

Roehl E., Risley J., Stewart J. and Mitro M., 2006, Numerically optimized empirical modeling of highly dynamic, spatially expansive, and behaviorally heterogeneous hydrologic systems – Part 1, Proceedings for the Environmental Modeling and Software Society Conference, Burlington, Vermont, USA, 6 p.

For more information, please visit the EDEN web at:
http://sofia.usgs.gov/eden

EVERGLADES DEPTH ESTIMATION NETWORK
EDEN

U.S. Department of the Interior
U.S. Geological Survey

Water Conservation Area 3A of the Florida Everglades
Photograph by Christa Zweig,Research Assistant, Florida Cooperative Fish and Wildlife Research Unit, University of Florida.

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