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Development of Sub-area Surface-Water Models within the Everglades Depth Estimation Network (EDEN) Model Domain

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The Everglades Depth Estimation Network (EDEN) surface-water model has provided principal investigators and water-resource managers with water-depth and water-surface maps of the freshwater portion of the Florida Everglades since 2006 (fig. 1). Often an investigator or manager is only interested in a specific location within the Greater Everglades, such as one of the Water Conservation Areas (WCAs) or Everglades National Park (ENP). Several subarea models have been developed to use within the revised EDEN model (EDEN V2) and as standalone models (fig. 2, table 1). The use of sub-area (or sub-domain) models, rather than the monolithic EDEN model encompassing the entire EDEN domain, offers several advantages, such as:

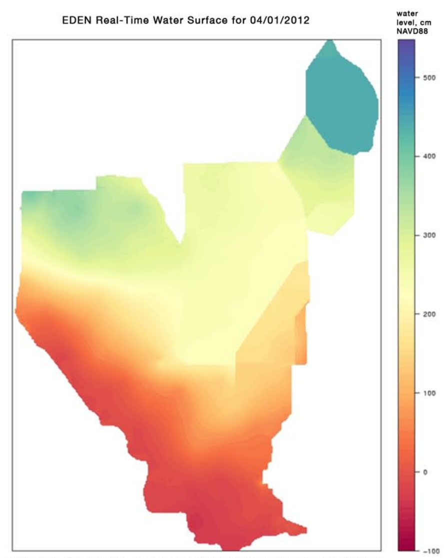

Figure 1. An example of output from the EDEN V2 model showing the surface-water elevation for the freshwater portion of the Everglades.

1 A more realistic representation of water-level discontinuities between sub-basins.

The discontinuities in water-surface elevations at canals and levees in the first version of the EDEN water-surface elevation model (Pearlstine and others, 2007) were simulated by linearly interpolating along both sides of the canals using headwater and tailwater stage data measured at canal structures. These linear estimates were implemented as pseudo-stations situated every 200 meters along boundaries, and were used as input data to the EDEN V1 model. At some locations, insufficient gage data exists to adequately define the boundary using these pseudo-stations. To account for insufficient boundary data, subarea models were developed for the EDEN V2 model for four areas; WCA1, WCA2B, WCA3B, and Pennsuco Wetlands (fig. 2). The subareas are then modeled without the canal boundary by extrapolating the water surface in space beyond the canals. The EDEN grid is then used to "clip" the water surface for each subarea model and incorporated into the overall EDEN model domain.

Table 1. Table 1. Subarea models in the EDEN modeling domain, their status, number of input stations, relative runtimes, and output file sizes.

[kb, kilobyte; WCA, Water Conservation Area; EDEN V2, Everglades Depth Estimation Network surface-water model - version 2; %, percent; BCNP-ENP, Big Cypress National Preserve - Everglades National Park]

Subarea Model	Status	Number of input stations	Relative runtimes[1]	Output file sizes (kb)	Relative output file sizes[1]
WCA1	EDEN V2	12	20%	111	22%
WCA2B	EDEN V2	10	20%	51	10%
Pennsuco Wetlands	EDEN V2	6	20%	71	14%
WCA3A-South	Standalone - provisional	31	7%	136	27%
WCA3B	EDEN V2	9	20%	103	20%
BCNP-ENP	Standalone - provisional	81	13%	213	42%

[1] As compared to the EDEN V2 model

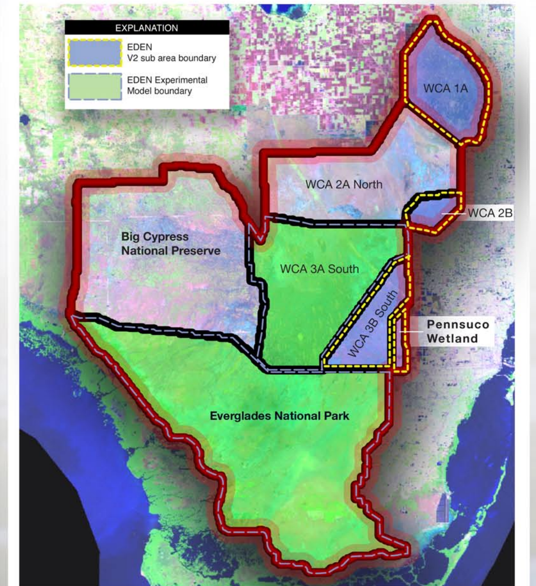

Figure 2. Location of the subarea models within the EDEN surface-water domain. Subarea models of Water Conservation Area (WCA) 1, 2B, 3B and Pennsuco Wetlands are incorporated in the revised EDEN model. Subarea models for WCA3A-South and Big Cypress National Preserve and Everglades National Park (BCNP-ENP) are experimental subarea models.

2 The improvement of marsh water-level prediction near canals through elimination of virtual "pseudo" gages used to model water-level discontinuities.

The water-level gages in the canals were examined and edited (added or removed) and the locations of pseudo-gages were re-computed to create more realistic interpolated surfaces across boundaries. Figure 3 shows water-level surfaces with 2-centimeter contours on June 29, 2010 for an area north and south of Tamiami Trail at the intersection with the L28 canal. The water-level surface generated from the revised canal definition in the V2 model has been dramatically improved compared to the water surface contours simulated with the EDEN V1 model.

3 Facilitation of the development of new EDEN hydrologic data and analysis applications using a subset of the 240 gages of the full EDEN domain.

An experimental subarea water-surface model was developed that uses 31 stations from the EDEN network to generate water-surface elevation maps for WCA3A-South (table 1, figure 2). An application, EDEN-Syn, is currently (2012) being developed that will generate synthetic 10-year daily hydrographs for input to a subarea model. For WCA3A-South, a dynamic time-series clustering technique was used to group stations with similar behaviors (Roehl and others, 2006). The results of the dynamic clustering showed four classes of water-level behaviors – two groups of marsh stations and two groups of canal structure stations (fig. 4). For each group of marsh and canal structure stations, two monitoring stations (one for the marsh stations and one for the canal structure stations) were selected as user-defined input stations used to estimate the water-level hydrographs for the other stations. To generate synthetic-input hydrographs for the WCA3A-South water-surface model, a user specifies the monthly values for these two stations and the application generates the hydrographs for the other 29 stations using hydrograph estimation artificial neural network models (fig. 5). These empirical correlation models maintain dynamic relations between stations.

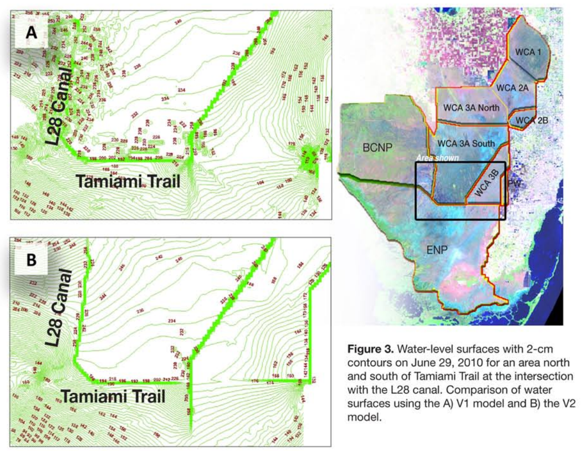

Figure 3. Water-level surfaces with 2-cm contours on June 29, 2010 for an area north and south of Tamiami Trail at the intersection with the L28 canal. Comparison of water surfaces using the A) V1 model and B) the V2 model.

4 More computationally efficient model architecture for evaluating and testing aspects of the surface-water model.

The relative computer runtimes for all the subarea models are approximately 5 to 15 times faster than the EDEN V2 model (table 1). For the subarea model in EDEN V2, increase in runtimes is not proportional to the decrease in the number of inputs stations in the model. Rather, there are pre- and post-processing routines configured in the client-server architecture of the EDEN server that are independent of the number of gages. The experimental subarea models have improved computational efficiency with larger decreases in runtime as compared to the EDEN V2 subarea models. Decreased runtimes could be important; for example, the 10-year simulations of hypothetical water-management scenarios, which applications such as EDEN-Syn will facilitate.

5 Smaller output data file sizes for analysis of particular areas of interest.

The reduction in the output file size for the subarea models is proportional to the spatial extent of these models (the number of input stations is an indication of the spatial extent of the subarea model). This reduction in file size will increase the computational efficiency of post-processing the EDEN subarea model output data for analysis and for input into ecological models.

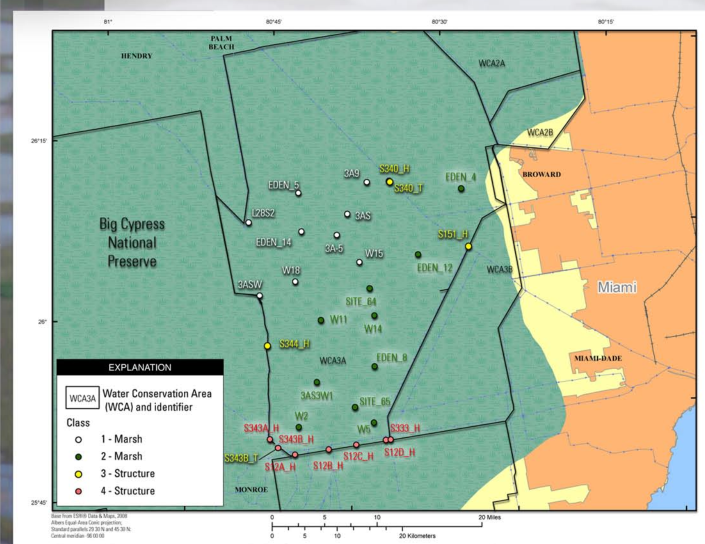

Figure 4. The 31 stations used in the EDEN-Syn application clustered into 4 classes of similar hydrologic behaviors.

The development and use of subdomain models in the EDEN domain have improved the performance of the EDEN V2 model and have added the capability of using the EDEN model platform for scenario simulations in addition to historical simulations.

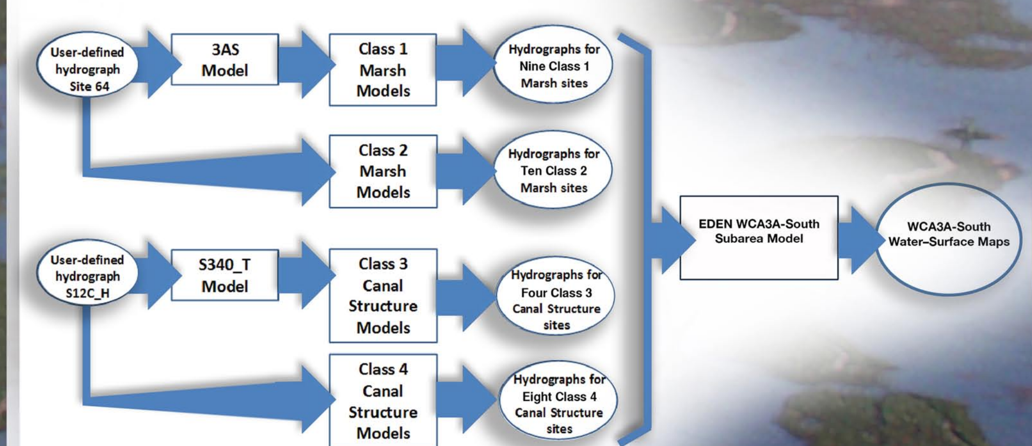

Figure 5. Architecture for the EDEN synthetic hydrograph generation application (EDEN-Syn) for Water Conservation Area 3A-South.

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

EVERGLADES DEPTH ESTIMATION NETWORK EDEN

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