Water-Level Record Extension of the Everglades Depth Estimation Network (EDEN)

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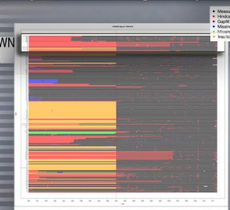
AREA SHOWN IN BANNER



EDENdb flags for 1990-2010

Introduction

The real-time Everglades Depth Estimation Network (EDEN) has been established to support a variety of scientific and water management purposes (Telis, 2006). The expansiveness of the Everglades, limited number of gaging stations, and sensitivity of the ecosystem to small changes in water depth has created a need for accurate water-level and water-depth maps. The EDEN water-surface elevation model (EDEN V2) uses data from 238 gages in the Everglades to create daily continuous interpolations of the water-surface elevation for the freshwater portion of the Greater Everglades from 2000 to the present (fig.1A). These maps provide hydrologic data previously unavailable for assessing biological and ecological impacts.

A need was expressed to the EDEN project team for daily EDEN water surfaces from 1990 to 2000. As one moves back in time from 2000, increasingly fewer of the EDEN gages used to generate water surfaces were in operation (fig. 1B,C). For the period 2005-2009, over 97 percent of the gages were operating as compared to the 1990 to 1994 period where 51 percent of the gages were operating. For the period 1990 to 1994, Everglades National Park had 52 percent of EDEN gages operational; Water Conservation Area 2A had only 20 percent of EDEN gages operational.

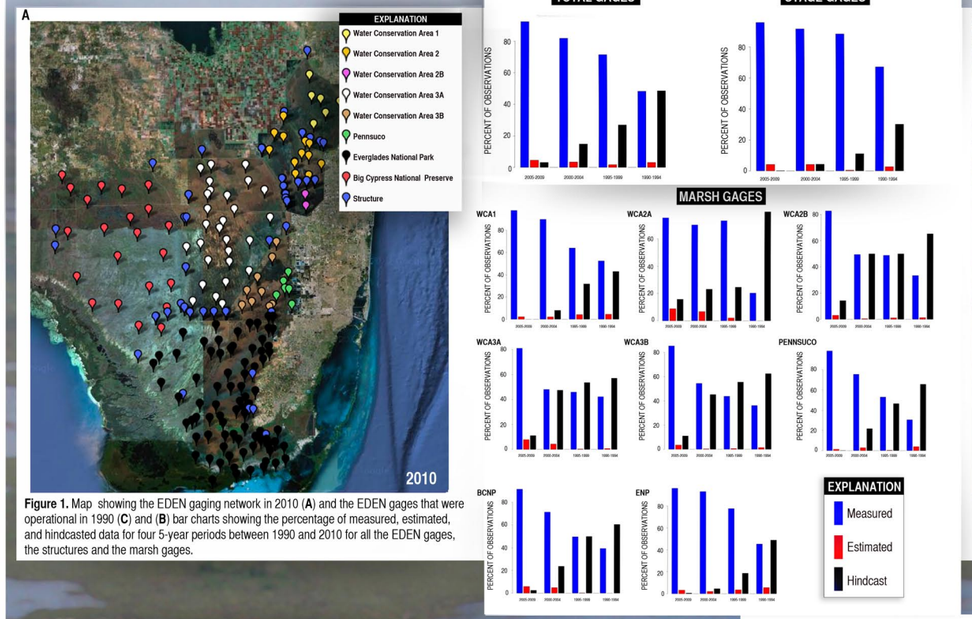


Figure 1. Map showing the EDEN gaging network in 2010 (**A**) and the EDEN gages that were operational in 1990 (**C**) and (**B**) bar charts showing the percentage of measured, estimated, and hindcasted data for four 5-year periods between 1990 and 2010 for all the EDEN gages, the structures and the marsh gages.

Discussion

The individual hindcast models can be evaluated through model performance statistics, but the quality of the hindcasts as a whole was evaluated using the EDEN water-level surfaces. Pre- and post-2000 water-level surfaces generated for similar water-level conditions were compared (fig. 5). For the hindcast period, the lowest water levels occurred in 1990 and all of the hindcast models extrapolate to estimate these low water levels. The water-level surfaces for the low water in 1990 showed problems in the extrapolation of many of the hindcast models, especially in areas with limited data, such as WCA2A. It was decided to limit the hindcasts to the period 1991 to 2001. The additional 10 years of hindcasts and estimates provide ecologists and resources managers with two decades (1991-2011) of water-level elevation surfaces to analyze hydrologic dynamics.

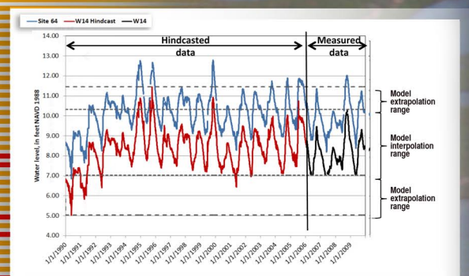


Figure 2. Example of the hindcasting of W14 in Water Conservation Area 3A

Approach and Discusssion

The datasets for gages in the EDEN network that were not measured before 2000 were extended to provide estimations of hydrologic time-series histories. The general steps for record extension (hindcasts) to 1990 were to:

- create a database of available data for each conservation area from 1990 to the present (2012),
- convert all data to the North American Vertical Datum of 1988 (NAVD),
- perform dynamic cluster analysis (Roehl and others, 2006) to group gages with similar hydrologic behaviors, for conservation areas with large number of gages,
- use results from the cluster analysis to select candidate explanatory variables,
- develop linear regression and(or) artificial neural network models to extend water-level records,
- hindcast water-level records and fill periods of missing record, and
- evaluate record extensions with model performance statistics and comparison of water-surface maps for similar hydrologic conditions from the hindcasted period (1990-1999) and measured period (2000-2011).

An example of a hindcast dataset is shown in figure 2. The measured data for W14 begins on January 26, 2006. The hindcast model for this site is a linear regression model that uses Site 64 as the explanatory variable (coefficient of determination, R^2, 0.99). Models, both empirical and mechanistic, are more accurate when interpolating within the historical range of the data used to develop the model than extrapolating beyond the range of the data used to develop the model. The model of W14 is interpolating within the range of the measured data (7.03 to 10.32 feet NAVD 88) 90 percent of the time.

In addition to hindcasting datasets, data gaps in time series for gages with measured data prior to 2000 were estimated. For these sites, empirical models were developed and the estimates for the data gaps were evaluated. Often the estimated values follow the trend of the data but are offset from the measured data. For these cases a "shift" was computed (the difference between the measured and modeled value at the beginning and ending of the data gap) and the modeled data was linearly adjusted to fill the gap. Figure 4 shows eight data gaps in a 9-month record for site NP46 along with the modeled estimates, and the final shifted modeled data used to fill the data gaps.

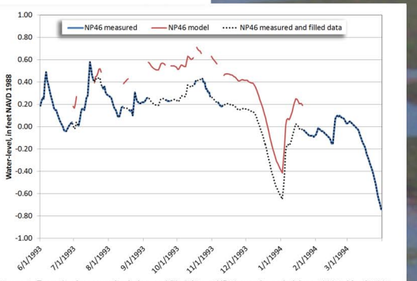


Figure 4. Example of measured, missing, and filled data at NP46 over the period June 1993 to March 1994.

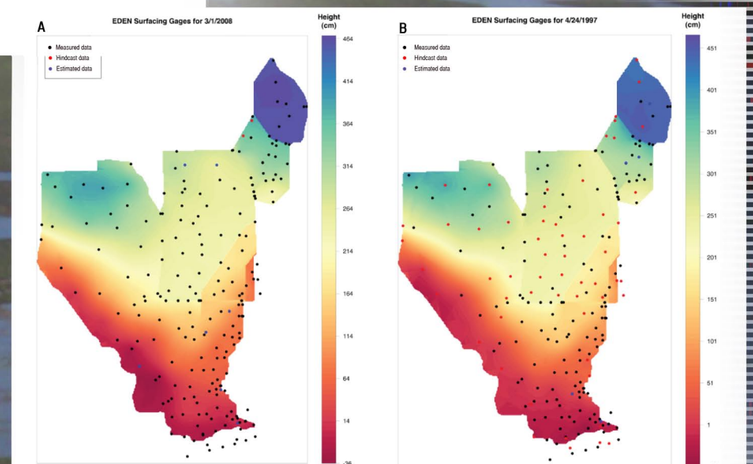


Figure 5. Example comparison between two water-elevation surfaces for similar water-level conditions in Everglades National Park for A) March 1, 2008 and B) April 24, 1997.

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.

Telis, Pamela A., 2006, The Everglades Depth Estimation Network (EDEN) for Support of Ecological and Biological Assessments: U.S. Geological Survey Fact Sheet 2006-3087, 4 p.

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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

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