The EDEN surface-water model and its applications are valuable tools for characterizing current and historic hydrologic conditions in the Everglades and for assessing the potential impacts of restoration. EDEN allows scientists to make limited measurements in the field, and then tie those data into the network of data available from EDEN’s extensive hydrologic information. For example, during a 2006 study of 245 tree islands in Water Conservation Area 3 (Voin and others, 2008), researchers measured water level relative to the top of each island and near each island. Using an auger, they measured the depth to water from the top, and also measured the depth of the water surrounding the island, using the EDYN xylocator program, they input the UTM coordinates of the measurement sites to obtain the EDEN water-surface elevations at these islands on the date they made their measurements. Using these surface-water-elevation data, they were able to determine the elevation of the top of each tree island and the elevation of the land surrounding the island. Using this approach, they developed not only the elevation profiles of the tree islands, but they utilized the long-term EDEN database to look at changes in the tree islands with respect to water level over time. Periods of flooding, or inundation, for each tree island are generated for the period from January 2000 to present, by plotting the elevation of the top of the tree island and the ground surface surrounding the tree island with the EDEN time series water-level data (fig. 7).

**Utilizing EDEN Data and Tools—An Example**

**Figure 7.** Schematic of the process used in applying the EDEN data and xylocator application to a study of tree islands.

**Summary**

An important goal of Everglades restoration is to restore natural water levels, timing, and distribution of sheetflow. Five EDEN applications (tools) were developed for EDEN users to view, extract, plot, and manipulate EDEN data in a variety of ways. These tools provide information which will help hydrologists and resource managers monitor sheet-flow changes and other changes to the natural system. The EDEN tools will also provide biologists and ecologists with the information necessary to examine trophic-level responses to the hydrodynamic changes in the Everglades.

**References**


1 All EDEN publications are available at http://sofia.usgs.gov/publications.php


**Figure 1.** Location of EDEN domain and water-level gages.

**Background**

**Figure 2.** Everglades Depth Estimation Network (EDEN) Applications: Tools to View, Extract, Plot, and Manipulate EDEN Data

EDEN is a primary product of the hydrology module of the Restoration Coordination and Verification (RECOVER) Monitoring and Assessment Plan (MAP), and provides much of the hydrologic data that underpins many of the MAP’s restoration hypotheses (RECOVER, 2004; Telis, 2006). EDEN offers a consistent and documented dataset of ground-elevation measurements and continuous water-level data for the greater Everglades. The dataset can be used by scientists and managers to: (1) guide large-scale field operations, (2) integrate hydrologic and ecological responses, and (3) support biological and ecological assessments that measure the way the ecosystem responds to the implementation of the Comprehensive Everglades Restoration Plan (CERP) (U.S. Army Corps of Engineers, 1999).

Surface water-level data have been collected daily since 1999 at up to 253 wetland and canal gaging stations operated by the Big Cypress National Preserve, Everglades National Park, the South Florida Water Management District, and the U.S. Geological Survey (USGS) (fig. 1). Data are entered into the USGS National Water Information System (NWIS) database daily, with a 1-day delay from the date of collection. Once in NWIS, the data are available at http://sofia.usgs.gov/eden/nwisstation.php. EDEN water-level data are accessed through an interactive map showing the location of gaging stations in the network, which provides “clickable” access to gage data on a near real-time basis.

Ground-elevation data for the greater Everglades and the digital ground-elevation models (DEM) derived from them form the foundation for all EDEN water depth and associated ecological/hydrologic modeling. Ground-surface elevation data were collected by the USGS (Desmond, 2003) at more than 50,000 sites with an approximate spacing of 400 meters and covering almost the entire greater Everglades. Using the North American Vertical Datum of 1988 (NAVD 88) allows for comparing of water-level data and for computing of accurate water depths across the greater Everglades.

A water-surface elevation dataset is comprised of the daily median values of up to 240 of the EDEN network water-level gages in the freshwater Everglades to create spatially continuous interpolations of the water-surface elevation. EDEN’s daily water-level surfaces are georeferenced gridded surfaces that can be viewed with the EDEN Data Viewer and most georeferencing programs, such as ArcGIS. More information regarding EDEN is provided in Telis (2006) and on the EDEN website, http://sofia.usgs.gov/eden. These water-level surfaces are posted on the website daily, with the following specifications:

- Daily water surfaces are generated from daily median water-level gage data from January 1, 2000 to current (Pearlstein and others, 2007; Palmason and Pearlstein, 2008);
- Verticals are created on a 400 x 400 meter grid (Jones and Price, 2007a);
- Water-level surfaces are in centimeters;
- Vertical datum is North American Vertical Datum of 1988 (NAVD 88);
- Surfaces are available as NetCDF and GeoTiff files;
- There is a 4-day delay to allow the collecting agencies to address initial quality control issues with provisional real-time data.
EDEN Applications (EDENapps)

Three EDEN applications were developed to make the data more accessible, by allowing users to view, extract, plot, and manipulate the data in a variety of ways. Two additional applications were developed to create data files formatted in netCDF file format for further manipulation by ArcGIS and other georeferencing programs. By combining the daily water-level surfaces with the ground-elevation model (Jones and Price, 2007b) and using the EDEN applications, a full suite of hydrologic data is made available to scientists and others, including:

- Water depth,
- Hydroperiod (computation of days since last dry),
- Water-surface slope,
- Surface animations of water elevation and water depth over time, and
- Transects of water depth animated over time.

EDEN uses the NetCDF data format, which more efficiently supports large array-oriented datasets than the commonly used ESRI Grid format. The EDEN applications are programmed to read the netCDF format (nc). Users with ESRI ArcGIS installations (version 9.2 or higher) can import the netCDF file into ESRI ArcMap and easily animate daily EDEN files. EDEN daily files of water level are also created in the standard GeoTiff file format for use with multiple geospatial programs. EDEN tools, installation instructions, and user manuals are available for download at http://sofia.usgs.gov/eden/edenapps/index.php. Each of the tools is briefly described below.

The EDEN Data Viewer displays daily EDEN surfaces of water level, ground elevation, water depth, and days since last dry (hydroperiod) (fig. 2). The entire EDEN domain can be viewed, or the user can query the layers for data values at user-specified locations by zooming in using the cursor or by entering UTM coordinates. Additionally, the user can view changes through time with animation; by selecting a starting date, the displays can travel backward or forward in time, at the user-specified animation speed.

The EDEN xyLocator is a program for extracting data for user-specified locations from spatial hydrologic time-series, such as water surface, water depth and days since last dry, and the EDEN ground-surface DEM. The user specifies the locations needed by identifying the UTM position coordinates. The output is a text file which can be opened in a text editor or opened and plotted in a spreadsheet program such as Excel (fig. 3 A,B,C).

The EDEN Transect Plotter is a program for plotting daily water-level surfaces and ground-elevation profiles for user-specified transects across the Everglades (fig. 4). The water-surface slope is calculated and displayed along the transect for user-specified distances (fig. 5), and the water surface can be animated over a user-specified time period. Observations of water depth and water level along the transect and within a user-specified distance perpendicular to the transect can be input for comparison and plotting of the profile. Likewise, the user can specify that the locations of nearby water-level gages be plotted.

The EDEN Depth&DaysSinceDry tool creates daily surfaces (in netCDF file format, nc) of water depth and days since last dry. For each 400 × 400 meter grid cell in the EDEN database, the daily water-level surface is subtracted from the ground-elevation model to obtain the water depth for the grid. The daily water-depth surfaces are bundled in quarter-year periods (Jan.-Mar., 2004, Apr.-June, 2004, and so forth); the user can specify which quarters to include. The days since last dry (hydroperiod) indicates the number of consecutive days that an EDEN grid cell surface has had a water-depth value greater than zero (fig. 6). NetCDF files of daily surfaces of water depths and days since dry, bundled by quarter year, are produced for use in georeferencing programs.

NetCDFtoGrid is a program for converting EDEN water level, water depth, and days since dry gridded surfaces from NetCDF (.nc) format to ESRI Grid format. Users who wish to use ESRI ArcGIS (version earlier than 9.2) must use Grid file format to view and manipulate the EDEN surfaces.

Also, some users are more familiar with the Grid format than NetCDF format and may wish to convert to Grid before using a georeferencing program.