

WEMAS/DEWOOS -- A WATERSHED ENVIRONMENTAL MONITORING AND ANALYSIS SYSTEM FOR THE DELAWARE RIVER/BAY SYSTEM

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ABSTRACT

The Watershed Environmental Monitoring and Analysis System (WEMAS) will be an integrated watershed and coastal environmental system that can be applied to a variety of watersheds across the nation. Our particular application will focus on the Delaware River and Bay system and is called the Delaware Estuary-to-Watershed-to-Ocean Observing System (DEWOOS). At present, we have developed a prototype system, based on the successful Delaware Environmental Observing System (DEOS), which uses an Oracle[®] Database and ESRI's ArcGIS Server 9.2[®].

WEMAS and DEWOOS will demonstrate how a cooperative regional monitoring system can be linked to and enhance the National Water Quality Monitoring Network (NWQMN). DEWOOS is designed to be a one-stop storage, analysis, display, and retrieval system for real-time and historical environmental data in and around the Delaware River and Bay Region. In particular, the system will be designed to include a variety of types of observing platforms, including traditional fixed station data, temporal observations from specialized research or observational campaigns, and Lagrangian observations.

KEYWORDS

Data Analysis and Display, Environmental Observing System, Real-Time Assessment, Delaware River, Delaware Bay, Delaware Estuary

INTRODUCTION

The Watershed Environmental Monitoring and Analysis System (WEMAS) will be an integrated watershed and coastal environmental (meteorological, hydrological, oceanographic) system that can be readily ported to other watersheds in the mid-Atlantic region or other national implementations. The Delaware River and Bay Watershed will be the focus region for the WEMAS prototype, which will be called the Delaware Estuary-to-Watershed-to-Ocean Observing System (DEWOOS). Moreover, WEMAS/DEWOOS will demonstrate how a cooperative regional monitoring system can be linked to and enhance the National Water Quality Monitoring Network (NWQMN). WEMAS builds on the existing infrastructure of the Delaware Environmental Observing System (DEOS) and incorporates tools and concepts developed by several groups involved with the Watershed.

Environmental data of the highest spatial and temporal resolution possible are requisites for decision makers and researchers that focus on watersheds and wetlands. These data must include both real-time and historical assessments to both monitor current conditions and to place these conditions in an historical context. Important variables include weather observations, streamflow data (stage and discharge), groundwater levels, bay and ocean conditions (*e.g.*, water temperature, wave height and period), and air and water quality (*e.g.*, dissolved O₂ and turbidity). But most importantly, these data must be of the highest quality, readily available, and easily applied.

To provide this need, WEMAS will integrate existing observations from federal, state, and local sources and provide the data in real time. Data are archived in an Oracle® Database which allows for both historical analysis and retrieval as well as real-time alerting and research notification capabilities. Through the DEOS infrastructure, a user-friendly data analysis and display system to provide high-resolution, spatially distributed, digital data products from both surface observing systems as well as the National Weather Service's weather radars will be available. WEMAS also will support a number of analysis systems that are designed to provide decision support in a variety of environmentally-sensitive areas.

THE DELAWARE ENVIRONMENTAL OBSERVING SYSTEM (DEOS)

The Delaware Environmental Observing System (DEOS) is a real-time system dedicated to monitoring environmental conditions across the State of Delaware, the near-shore coastal waters and the Delaware Bay, and adjacent regions in Maryland, Pennsylvania, and New Jersey. Although DEOS is designed, in part, to be a source for real-time and archived environmental data, it specifically serves as a tool for decision makers involved in emergency management, natural resource monitoring, agriculture, transportation, and other activities throughout the State of Delaware and the Delmarva Peninsula. It is a cooperative venture supported by a number of state and federal agencies and many of its visualization and analysis tools are designed to be adaptable outside Delmarva (see Figure 1).

Our data 'warehouse', the DEOS Environmental Monitoring and Observing Network (DEMON), combines data from several environmental networks which are stored in an Oracle® database. These networks include weather stations installed and maintained by DEOS as well as USGS and DGS stream and tide gage data, ocean and near-shore buoy data from NOAA's National Data Buoy Center, and weather station networks from a number of other high-quality data networks around the Delmarva Peninsula. DEOS has installed twenty-four weather stations in the State of Delaware, Chester County PA, and Cecil County MD. Weather data are received every five minutes from most data networks and stream and tide data are received with a fifteen-minute resolution. Observations include both meteorological (*e.g.*, air temperature, atmospheric pressure, humidity, precipitation, soil moisture and temperature, solar radiation, and wind vector) and hydrological variables (*e.g.*, streamflow, tidal heights, wave height and period). Information on air and water quality as well as well levels will be incorporated soon. A significant effort is currently directed toward providing quality control and assurance (QA/QC) and preventive maintenance.

Figure 1 – DEOS (<http://www.deos.udel.edu>)

www.deos.udel.edu

Delaware Environmental Observing System

DEOS

Home Data Analysis Tools Information RSS XML

Current Advisories

DEOS Network Station Problems:

8/6/07- DMRJ (Slaughter Beach, DE) is currently offline due to communication problems with the station.
Expected time of return: Unknown.

News

DEOS Upgrades System - 03/19/08

DEOS recently upgraded its system to improve the overall quality and speed of the website, and also improve the overall reliability of the system.

To find out more, click [here](#).

New Climate Roundups:

[January 2008](#) (added 02/29/08)
[December 2007](#) (added 02/08/08)

Data Requests

DEOS has two methods for filling data requests. The preferred method is using our web services, which provide data in an XML neutral format. This is ideal for anyone with recurring data needs. To access our web services, go to the [sign up](#) page to get an account.

If you encounter problems using the web services, or if you have other data questions, go to our [feedback](#) page and send us a message.

Current Snow Conditions:

Real Time Snow Conditions

Our Mission:

The Delaware Environmental Observing System (DEOS) is a support tool for decision makers involved with emergency management, natural resource monitoring, transportation, and other activities throughout the State of Delaware. DEOS primary goal is to provide both State agencies and the citizens of Delaware with immediate information as to environmental conditions in and around the State.



DEOS GeoBrowser:

DEOS has a new mapping tool available to its users. This tool utilizes an interface with Google Maps to provide the underlying geographic data, while DEOS generates an overlay of the stations and their data.

Click the image below to go to the GeoBrowser
(Note: This will appear in a new window).



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The DEOS Integrated Visualization and Analysis System (DIVAS) will integrate these surface observations with NWS WSR-88D radar precipitation estimates using ESRI's ARC GIS 9.2 Server[®] and provide real-time calibration. DIVAS will generate estimates of meteorological and environmental variables over a high spatial resolution grid which can be input to a variety of agricultural or other numerical models or viewed over the Internet. Currently, the prototype DIVAS system is being used to monitor drought in Delaware. DEOS Analysis Systems (DAS) will provide easy access to the data stored in the Oracle[®] database, allowing informed decision making for a variety of environmentally sensitive applications. For example, during the passage of tropical storms, nor'easters, or heavy snowfall, DEOS provides up-to-date information on developing weather events. DEOS data also are used to assist with developing emergency management situations (such as toxic spills, hazardous chemical releases, and flash flooding

events), to provide information for pesticide management and mosquito control, to schedule controlled burns of invasive plant species along the coast, to assist with refuse disposal activities, and with research projects to assist with evapotranspiration modeling.

THE WEMAS/DEWOOS PROTOTYPE

WEMAS is based on the existing DEOS infrastructure and incorporates tools and concepts developed by a number of groups that have been involved with the Delaware River/Bay watershed. DEWOOS is a particular implementation of the WEMAS design for the Delaware River/Bay watershed. Both DEWOOS and WEMAS are designed to advance national and regional IOOS goals by providing a holistic monitoring system to provide environmental managers who have control of watershed/estuarine resources.

DEWOOS is now a functionally working prototype for a watershed and coastal environmental (meteorological, hydrological, oceanographic) monitoring system that can be adapted to other watersheds in the mid-Atlantic (MACOORA) region or other national implementations (Figure 2). Moreover, WEMAS/DEWOOS will demonstrate how a cooperative regional monitoring system can be linked to and enhance the National Water Quality Monitoring Network (NWQMN).

In particular, WEMAS will utilize the successfully-proven infrastructure of DEOS including use of the Oracle[®] database and the ODD-DIVAS[®] tools developed by DEOS. WEMAS consists of (1) a separate computer to provide database and web support, (2) an independent web domain for the DEWOOS implementation (*i.e.*, www.dewoos.udel.edu), (3) a database that is based on but physically separated from DEOS to support WEMAS activities, and (4) a website that provides functional support for DEWOOS with a common 'look and feel' that is unique to DEWOOS (Figure 3).

Website visualization tools will be developed around an ESRI ARC GIS Server 9.2 interface that allows for panning, zooming, and the display of both point data (*e.g.*, observation locations) and gridded fields (*e.g.*, interpolated surface fields such as air temperature, humidity, water temperature, salinity, satellite-derived estimates of chlorophyll concentrations, or wave conditions as determined from HF-Radar). Specific GIS overlays provided by the DRBC and the Partnership for the Delaware Estuary are included into the prototype (Figure 4).

The prototype uses real-time sensors from existing national networks (*i.e.*, National Weather Service ASOS data, USGS tide and stream data, and observing buoy data) to illustrate the capabilities of the system. After testing and approval of the prototype, funding for development of the full system will provide the ability to include any available real-time data provided to WEMAS by other entities. This may include sensors from more diverse and specialized networks and provide integrated analyses including, but not limited to, spatially interpolated fields and remotely-sensed products. We also will then seek to extend the database back in time to better support research activities, provide specific products to support environmental forecasting and modeling efforts, and make available information and tools to support both emergency and natural resource management.

Figure 2 – DEWOOS (<http://www.dewoos.udel.edu>)

The Delaware Estuary "Watershed-to-Ocean" Observing System (DEWOOS)

DEOS | DRBC | MACOORA

The Delaware River Basin
 The Delaware is the longest un-dammed river east of the Mississippi, extending 330 miles from the confluence of its East and West branches at Hancock, N.Y. to the mouth of the Delaware Bay where it meets the Atlantic Ocean. The river is fed by 216 tributaries, the largest being the Schuylkill and Lehigh Rivers in Pennsylvania. In all, the basin contains 13,539 square miles, draining parts of Pennsylvania, New Jersey, New York, and Delaware. Included in the total area number is the 782 square-mile Delaware Bay, which lies roughly half in New Jersey and half in Delaware.

DEWOOS
 The Delaware Estuary "Watershed-to-Ocean" Observing System (DEWOOS) is a prototype developed by the Delaware Environmental Observing System (DEOS) to demonstrate the potential for a regional data management and visualization system for the Delaware River Basin. To this end, DEWOOS provides a web-based GIS interface to real-time environmental data throughout the basin. Initially, data will include US Geological Survey streamflow and water quality data, National Weather Service meteorological data, and DEOS meteorological data.

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Figure 3 – Hyperlinks showing real-time data access capabilities of DEWOOS

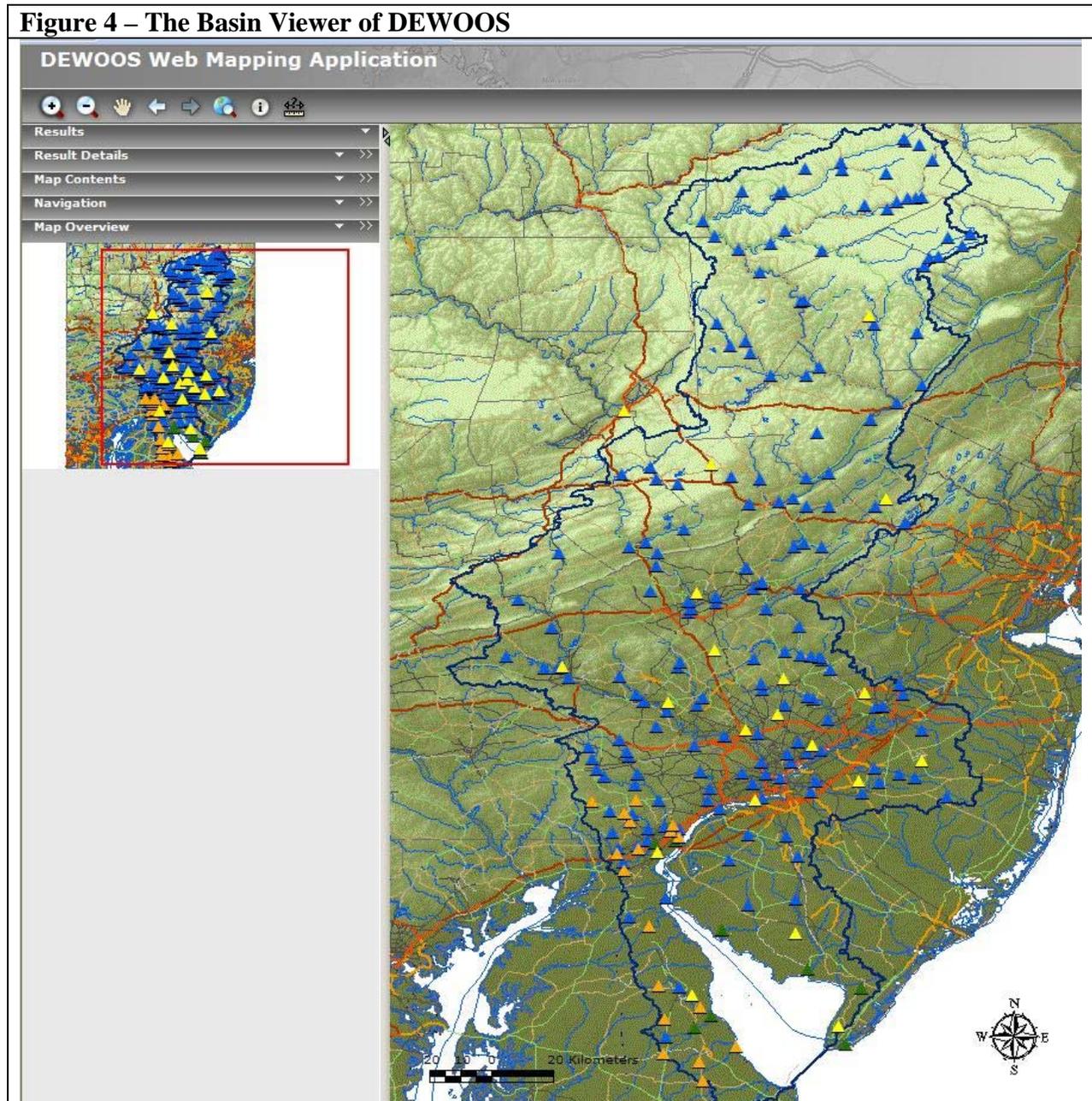
Newark, DE-Ag Farm Station

ID	DAGF	Network	DEOS
City/State	Newark/DE	Elevation	106 ft.
Latitude	39° 40' N	Longitude	75° 45' W
Updated	4:25 pm	Date	November 27, 2007

Observations

Data Type	Measurement	Time	Chart	Data
Rainfall	0.00 in	4:25 pm		
24-Hour Rainfall	0.09 in	4:25 pm		
Air Temperature	47.4 °F	4:25 pm		
Dewpoint Temperature	26.4 °F	4:25 pm		
Relative Humidity	44 %	4:25 pm		
Barometric Pressure	30.12 inHg	4:25 pm		
Solar Radiation	12 W m ⁻²	4:25 pm		
Wind Speed	3.6 mph	4:25 pm		
Wind Gust	4.8 mph	4:25 pm		
Wind Direction	294.9 ° (WNW)	4:25 pm		
Volumetric Water Content	30.3 %	4:25 pm		

Change to SI units
 Station updates every 5 minutes

Figure 4 – The Basin Viewer of DEWOOS

BEYOND THE DEWOOS PROTOTYPE

When fully developed, DEWOOS will have a number of capabilities beyond the basic prototype. All meteorological, hydrological, and oceanographic data available for the region, including data on weather, air quality, water quality and quantity, and remotely-sensed products and their derivatives, will be incorporated. This includes four different types of data. First are the standard 'station-based' data where an observing platform remains in a fixed position and records data on a regular basis. Second are research-specific measurements that may be taken

for a short time period. These are data that probably are not available in real-time but which may be of interest to researchers and data managers for event analysis.

A third type of data that DEWOOS will store and analyze are Lagrangian observations. Unlike fixed location observations, these data are from observing platforms that move, either by self-propulsion or drift with the currents. Ferry (*e.g.*, Cape May-Lewes Ferry) or bus/truck (*e.g.*, DelDOT) platforms can be used to provide data for transects across water or land areas. Specific ship surveys of the Delaware River and Bay provide transient data of water conditions at the time of the ship transect. Unmanned submersibles have also been used to provide assessments of the vertical and spatial structure of the Delaware Bay. These Lagrangian observations are useful measurements of environmental conditions and it is imperative that a comprehensive environmental monitoring system include these data in the archive.

Finally, but certainly not least, are gridded data acquired by remote sensing technology and spatial interpolation methodologies. Weather radar, satellite platforms (in both geostationary and low-Earth orbits), and HF-Radar scanning the water surface provide a highly detailed spatial structure to the field they measure. Often available in real-time, these data can be used to supplement direct observations, or 'ground truth', and in many cases, to provide spatial fidelity that cannot be obtained through ground-based measurements. Similarly, sophisticated spatial interpolation techniques which use GIS-enhanced methods can provide a clearer spatial picture of various fields measured at a number of locations (*e.g.*, air or water temperature).

Archiving of both real-time and off-line sources of environmental data are essential for any successful environmental monitoring system, including DEWOOS. In addition, DEWOOS will seek to extend the database back in time to include all available historical archives and provide a longer time-series of data to facilitate assessments of change and variability. DEWOOS also will focus on the development of specific products to support environmental forecasting and modeling efforts, and make available information and tools to support both emergency and natural resource management.

SUMMARY

WEMAS and its specific application to the Delaware River and Bay watershed, DEWOOS, are designed to be an integrated watershed, estuarine, coastal, and land-surface environmental system that can be ported to virtually any watershed in the world. The prototype is currently operational and although it has very limited functionality, the ultimate goal will be to provide the most comprehensive regional-scale environmental observing system available. Moreover, WEMAS and DEWOOS will serve to demonstrate how a cooperative regional monitoring system can be linked to and enhance the efforts of the National Water Quality Monitoring Network (NWQMN). As a one-stop storage, analysis, display, and data retrieval system for both historical and real-time data, it is hoped that WEMAS and DEWOOS will provide an integration and synthesis of environmental data for watershed and estuarine monitoring that heretofore was not readily available.