Materials of Conferences

MOBILE SOLUTIONS FOR ENVIRONMENTAL MONITORING OF WATER BODIES: HARDWARE, SOFTWARE AND COMPUTER MODELING

Bobyrev S.V., Tikhomirova E.I., Podolsky A.L., Uglanov N.A., Markina T.A., Anokhina T.V.
Saratov State Technical University, Saratov,
e-mail: tichomirova_ei@mail.ru

Ecological monitoring is an integral part of the system of decision-making related to ecosystem management [1]. Therefore, it is necessary to measure the environmental variables of interest to ensure the effectiveness of the natural resource management.

We chose mobile solutions based on the principle of remote sensing [2] as a main feature for the newly developed system of environmental monitoring of water bodies. In this system, the database is distributed between the mobile computer and stationary server. Incoming information is generated through a system of sensors that have an interface to connect to the computer. For sensors that do not have such interface, we developed the paring devices and relevant device drivers for the transmission of information. Using highly integrated elements for developing the hardware system made the system small and easily configurable. Sensors are connected to the computer by means of USB-2 or wireless interface. Functioning of the described system allows accomplishing the following tasks:

1. Creating a vector map of the region representing all water bodies in the region with high accuracy, using the ArcGIS-type software to address geographic information tasks and to present the solutions of these tasks in common formats.
2. Compiling the databases containing all important variable on the basis of the vector map along with the data obtained from other specialized organizations and in our own research.
3. Creating a knowledge base reflecting the patterns and relationships among the processes affecting the performance of water bodies on the basis of the hydrological regime dynamics studies.
4. Establishing an expert system producing practical recommendations on business solutions concerning rational water resource management in the region on the basis of the above knowledge base.

The goal of our computer modeling approach was to define the influence of water levels on the configuration of the shallow parts in the Volgograd Reservoir. Background information used to build the model was a vector map of the Volgograd Reservoir with isobaths. The main type of such maps is a navigation map. However, navigation maps deal primarily with fairway tracks. We were mainly interested in coastal swamps and meadows along with shallow waterways and floodplain forests. That is why, prior to building a model, we supplemented the navigation map with depth measurements at the points of interest. These areas are located mainly in the upper part of the reservoir, in the Saratov region. Measurements were made from a recreational craft equipped with an echo sounder, GPS Navigator and a Locarus device. All digital and analog gauges were connected to Locarus, and measurement data were transmitted via Internet to the server with the software converting the monitoring results into data formats compatible with a computing mathematical model.

We selected a function of two variables of the second order as a mathematical model of the riverbed topography:

$$Z = a_{20}x^2 + a_{02}y^2 + a_{11}xy + a_{10}x + a_{01}y + a_{00}.$$

Where Z is depth, x and y are the coordinates of sampling points, and $a_{i,j}$ are the coefficients determined by the simulation.

Second order in the equation allows eliminating the extremes and also generates sufficiently smooth function describing configuration of the water reservoir bottom, which in its shallow parts is smoothed out by years of sedimentation. Configuration of water surfaces of the modeled areas of the reservoir was represented by the horizontal cross-section of the function describing the topography of the riverbed. The model describes how water surface configuration depends on water levels and specifies the critical values corresponding to the beginning of flooding. Also, the modeling results can be used for calculation of thermo-clines and computing the concentrations of dissolved gases in water (e.g. oxygen).

References

1. Burden F.R. Environmental Monitoring Handbook. – McGraw-Hill Professional, 2002. – 1100 p.

2. Ustin S. Manual of Remote Sensing, Remote Sensing for Natural Resource Management and Environmental Monitoring. – New York: John Wiley & Sons, 2004. – 768 p.

The work is submitted to the International Scientific Conference «Current problems of environmental pollution», Canary Islands (island of Tenerife), 9-16 March 2012, came to the editorial office on 07.02.2012.