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WETMUST

INTEGRATED MULTIPLE LEVEL WETLANDS MONITORING SYSTEM

USING INNOVATIVE TECHNOLOGIES

WP 4 - Action 1

Design and technical and functional specifications of the monitoring network

2007

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INTEGRATED MULTIPLE LEVEL WETLANDS MONITORING SYSTEM USING INNOVATIVE TECHNOLOGIES” financed by Interreg III B Archimed 2000-2006.

Project Partners

P1: Region of Central Macedonia (Lead Partner)

P2: Region of Western Greece

P3: Region of Northern Aegean

P4: Aristotle University of Thessaloniki, School of Agriculture, Laboratory of Applied Soil Science

P5: University of Basilicata (Italy), Department of Crop Systems, Forestry and Environmental Sciences

P6: Prefecture of Thessaloniki

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1. Introduction

Wetlands are not considered any more as mucky, buggy and disease-ridden mires, because society has recognized their unique and highly valuable quality. A large legislative umbrella has been adopted, so as to protect and manage in the best way all kinds of wetlands. Common characteristic of legal texts (e.g. Directives 92/43/EEC 2000/60/EC) is the protection of environment as well as the conservation of natural ecosystems, under the frame of different objectives. From 1971, Ramsar Convention has pointed out the international interest for protecting and preserving wetlands. Ramsar Convention focuses in the conservation and wise use of all wetlands through local, regional and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world. In the framework of both European environmental policy and Ramsar Convention, **monitoring** constitutes a basic tool for management, as it contributes to the estimation of achievement of the general and special management objectives.

The WETMUST project is aiming to develop and evaluate an innovative multi-resolution monitoring system for wetlands of international importance. The selected test sites (Figure 1) are the following: (i) Lakes Koronia and Volvi (Greece), (ii) Gulf of Kalloni (Greece), (iii) Kotychi Lagoon (Greece), and (iv) Lakes Monticcio (Italy).

The objective of this work is to describe the design, the technical and functional specifications of the monitoring network under development in the WETMUST project.

Figure 1. Test sites of the WETMUST project

2. The concept of the WETMUST monitoring network

The monitoring network is aiming to collect, analyse, and present the environmental data from the 4 test sites of the project. The design of the network is summarized in Figure 2.

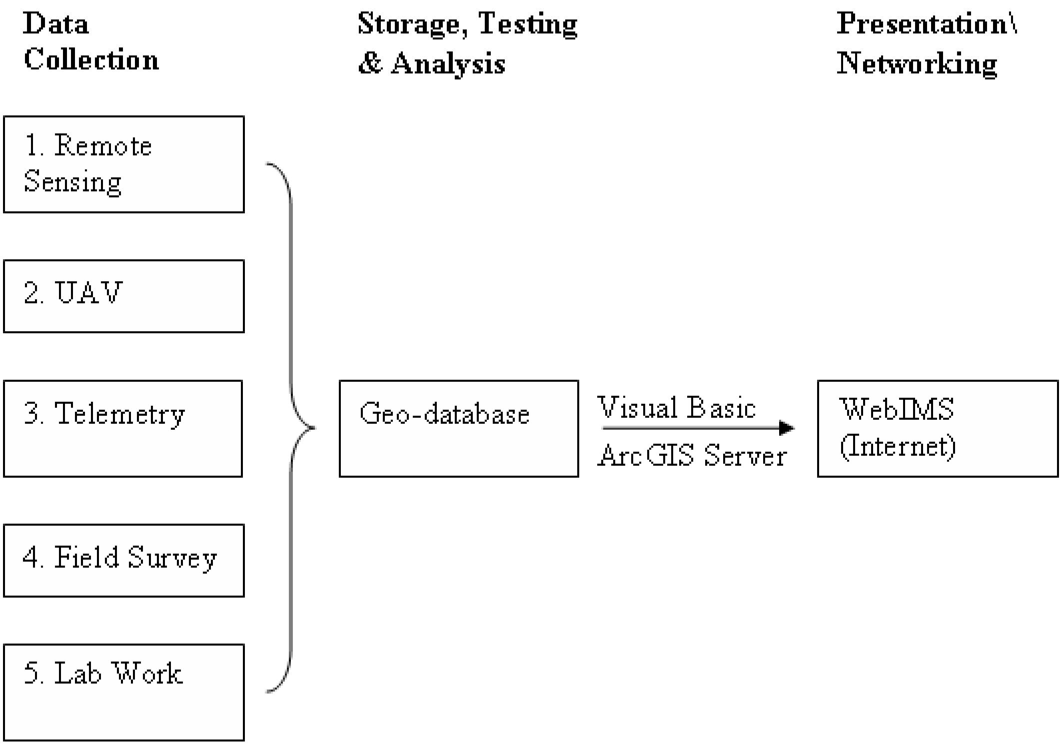

Figure 2. Design of the monitoring network.

The first step in the establishment of the monitoring network is the development of a customized monitoring protocol for each site that will address the needs and requirements of the site. However the customized monitoring protocols have to be based on the same principles and build according to the guidelines provided by the Generic Monitoring Protocol of the WETMUST project in order to provide compatible and relible data. Data will be collected from various levels (five) for the nececcary manipulation and analysis.. The spatiotemporal data and the products of the analysis (thematic maps) will be stored in a Geo-DataBase and will be available to all partners through an online WebIMS Information System.

3. Monitoring Protocol

For the needs of the project a generic monitoring protocol will be developed by the the Aristotle University of Thessaloniki (P4) and the University of Basilicata (P5). Since every test site has its own particularities, characteristics the generic monitoring protocol must be customized on occasion in order to meet the local needs and demands (Figure 3). The responsible partners for the customization of the protocol are:

- For lakes Koroneia and Volvi the Aristotle Univesrity of Thessaloniki
- For lakes Monticcio the University of Basilicata
- For Kalloni gulf the Region of North Aegean
- For Kotychi lagoon the Region of Western Greece

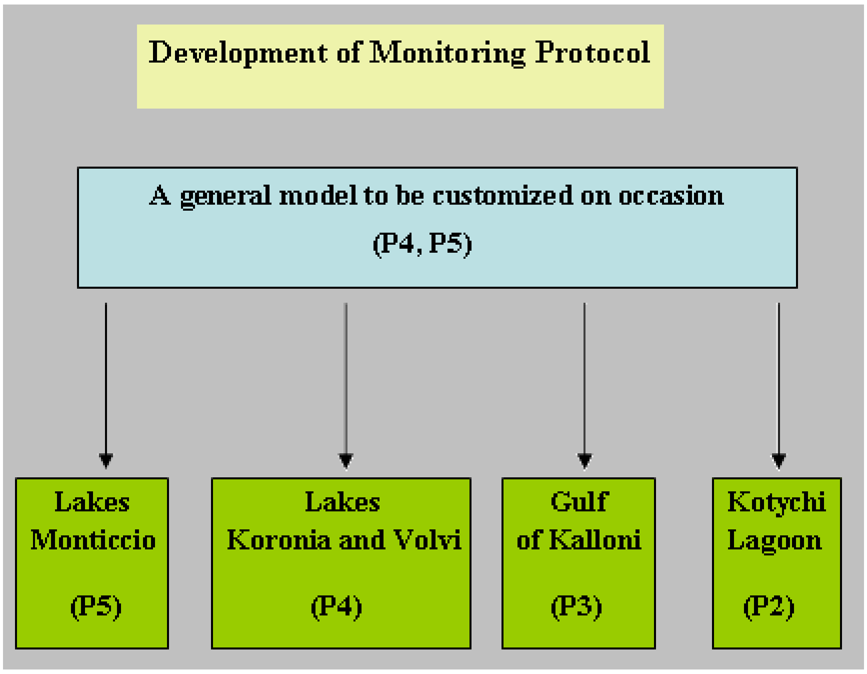

Figure 3. Development of customized monitoring protocols

The customized monitoring protocols include:

- Guidelines for parameters collection.
- Covers spatial, temporal scales, level of detail.
- Methods to be used for measurements, calibration, assessment of accuracy

4. Data Collection

1. Remote Sensing. The parameters that will be tested through the acquisition and subsequent analysis of satellite images are: vegetation, water quality (chlorophyll, sediments – TDS), land cover/use and water level.
2. UAV. Low altitude images will be acquired by an unmanned aerial vehicle at the visible and infrared spectra. An optimum path will be set via a mission planning algorithm and the parameters that will be tested will be vegetation and water level. The low flight observations will also partially facilitate the field survey measurements.
3. Telemetry. The data collected from the field-measurement telemetric stations will be continuously forwarded (via GSM) to the geo-database where they will be presented online at a near real time rate. The parameters that will be measured telemetrically will be D.O., water level and temperature, pH, EC and TDS.
4. Field Survey. Field surveys will be conducted. partially with in-situ measurments and partially with the aid of UAV. The parameters that will be examined will include hydrogeomorphic characteristics, water quality and land classification (land use – habitats).
5. Lab Work. Laboratory techniques will be applied for the analysis of soil and water samples in order obtain detail environmental quality information, calibrate the field and telemetry equipment and occasionally to verify field measurements.

5. Storage, testing and Analysis

All the data collected (raw or processed) will be stored in the same geo-database for testing and further processing. Through the comparative testing of the results of the different monitoring levels their accuracy can be validated. The parameters which involve more than one monitoring levels and the corresponding levels are the following:

Monitoring Level	**Parameters**			
	Habitats	*Water Quality*	*Water Level*	*NDVI (vegetation)*
1. Remote Sensing	YES	YES	YES	YES
2. UAV	YES		YES	YES
3. Telemetry		YES	YES	
4. Field Survey	YES	YES	YES	
5. Lab Work		YES		

The data from the different levels will be analyzed and integrated in various thematic layers in the geo-database. Several spatial-temporal indicators will be calculated which describe the pressures posed on the wetland, and its state as a result of the pressures.

6. Geodatabase

The geodatabase is the common data storage and management framework for ArcGIS and can be utilized wherever it is needed—on desktops, in servers (including the Web), or in mobile devices. It supports all the different types of data that can be used by ArcGIS such as

- Attribute tables
- Geographic features
- Satellite and aerial imagery
- Surface modeling data
- Survey measurements

The geodatabase not only defines how data is stored, accessed, and managed, but it can also implement complex business logic such as

- Modeling of spatial relationships between data (e.g., topologies, networks, and terrains)
- Data validation (e.g., subtypes and domains)

- Long transactions (e.g., versioning)

This enables users to leverage spatial data to its full potential and maintain a consistent, accurate database. ArcGIS implements the geodatabase either as a collection of files in a file system or as a collection of tables within a relational database management system (RDBMS).

With its scalable architecture, the geodatabase is the foundation that enables to assemble intelligent geographic information systems that can be adapted for many different applications.

In summary, the geodatabase offers the ability to:

- Store a rich collection of data types in a centralized location.
- Apply sophisticated rules and relationships to the data.
- Define advanced geometric relational models (e.g., topologies, networks).
- Maintain integrity of spatial data.
- Work within a multiuser access and editing environment.
- Integrate spatial data with other IT databases.
- Easily scale the storage solution.
- Support custom features and behavior.

7. Presentation\Networking

All data raw or processed will be forwarded online through a WebIMS Information System which will be implemented on ArcGIS Server with the use of Visual Basic.NET and ASP.NET. The users will be able to access the application remotely through any modern web browser provided that they have access to the Internet. All the products (in the form of thematic maps) will be available to them for viewing and (for the formation of SQL queries). The telemetric data, in particular, will be directly fed into the system and their values will be renewed in an hourly basis.

8. Partners Communication

8.1. Web Content Management System

Content Management System, or CMS, is a set of processes and technologies that support the evolutionary life cycle of digital information. This digital information is often referred to as content or, to be precise, digital content. Digital content may take the form of text, such as documents, multimedia files, such as audio or video files, or any other file type which follows a content lifecycle which requires management.

The digital content lifecycle consists of six primary phases: create, update, publish, translate, archive and retire. For example, an instance of digital content is created by one or more authors. Over time that content may be edited. One or more individuals may provide some editorial oversight thereby approving the content for publication. Publishing may take many forms. Publishing may be the act of pushing content out to others, or simply granting digital access rights to certain content to a particular person or group of persons. Later that content may be superseded by another form of content and thus retired or removed from use.

A content management system is a set of automated processes that may support the following features:

- Import and creation of documents and multimedia material
- Identification of all key users and their roles
- The ability to assign roles and responsibilities to different instances of content categories or types.
- Definition of workflow tasks often coupled with messaging so that content managers are alerted to changes in content.
- The ability to track and manage multiple versions of a single instance of content.
- The ability to publish the content to a repository to support access to the content. Increasingly, the repository is an inherent part of the system, and incorporates enterprise search and retrieval.

Functional Characteristics

- Each user will be identified by the system through a login page.
- The users will be able to access the system through a graphical user interface that should be accessible through a typical web browser.
- The users of the system will be able to publish documents.

- The users will be able to acquire documents that have been published by the other partners.
- The users will be able to exchange images (i.e. maps) through the system.
- The users will be able to exchange ideas, know-how, innovations and best practices through the system.
- The administrators of the Web-interface system will be able to create and manage user accounts and specify the access limitations for each group of users.

8.2. Web IMS

Internet Map Server (IMS) provide maps through the Internet usually as images. One standard specification for such a server is the OGC Web Map Service.

An OGC Web Map Service (WMS) produces maps of spatially referenced data dynamically from geographic information. This international standard defines a "map" to be a portrayal of geographic information as a digital image file suitable for display on a computer screen. A map is not the data itself. WMS-produced maps are generally rendered in a pictorial format such as PNG, GIF or JPEG, or occasionally as vector-based graphical elements in Scalable Vector Graphics (SVG) or Web Computer Graphics Metafile (WebCGM) formats. This is in contrast to a Web Feature Service (WFS), which returns actual vector data, and a Web Coverage Service (WCS), which returns actual raster data.

This International Standard defines three operations:

1. returns service-level metadata
2. returns a map with well-defined geographic and dimensional parameters
3. returns information about particular features shown on a map (optional)

Web Map Service operations can be invoked using a standard web browser by submitting requests in the form of Uniform Resource Locators (URLs). The content of such URLs depends on which operation is requested. In particular, when requesting a map the URL indicates what information is to be shown on the map, what portion of the earth is to be mapped, the desired coordinate reference system, and the output image width and height. When two or more maps are produced with the same geographic parameters and output size, the results can be accurately overlaid to produce a composite map. The use of image formats that support transparent backgrounds (e.g., GIF or PNG) allows underlying maps to be visible. Furthermore, individual maps can be requested from different servers. The Web Map Service thus enables the creation of a network of distributed map servers from which clients can build customized maps.

A Web Map Service is usually not invoked directly. More often, it is invoked by a client application that provides the user with interactive controls. This client application may or may not be web-based.

Functional Characteristics

- Application accessible through the Internet
- Application accessible through a common web browser. No additional software installation will be required.
- Application able to manipulate geographical data in the ArcGIS platform format.
- Application able to provide a basic map display and basic tools such as zoom in, zoom out, full extent etc.
- The users will be able to choose which map to display and which layers of information to display.
- The users will be able to retrieve information about specific features and layers on the map.
- The users will be able to search for specific features in the map.
- Only users with permission will be able to change and update information on the system.

Software Requirements

- ArcGIS Server
- Visual Studio.NET
- Microsoft IIS Server

Hardware Requirements

- Web Server: A PC with ArcGIS Server and Microsoft IIS Server installed and a reliable and fast Internet connection.

9. Deliverables

The deliverables of the monitoring program are divided into two main categories.

A. Integrated multilevel data analysis

- Orthorectified satellite images
- Spatial information derived from the integration of data
- Trend analyses of telemetric data time series

B. Development of environmental indicators

- Spatiotemporal and biophysical indicators which describe pressures on wetlands, and state of wetland ecosystem

It has to be mention that the final outcomes of the monitoring will include a core set of deliverables uniform for every site plus additional site specific monitoring outputs depending on the particularities of each site.