Extension of GIS Functionality for Integration of Surface Water Bodies Assessment

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Abstract

This research is devoted to solving the main problem of representation of the assessment results of different types of surface water bodies in the geographical information system (GIS). For the development of such type of infrastructure, the problems arise in a few directions: (a) how to express the complexity, differentiation and variety of surface water bodies, (b) how to extract knowledge for qualitative assessment, and (c) how to integrate new kinds of visualisation possibilities into the GIS. The surface water bodies are of a large spectrum of types with quite dynamically changing properties. The main problem in the realisation of such type of infrastructure is in finding the right relationships between the analysed objects of water resources and visualisation of them in GIS. The main question in this research is in revealing possibilities of integration of functions of digital maps with assessment processes of water bodies. Our approach is based on the development of a deeper knowledge base for defining the required domain properties and representing them in the computer-based ontology in connection with functions of GIS working online. The ontology is used here to design data warehouses' structures, define the relationship functions for expression of the dynamic assessment results in GIS, and map required inputs in user interfaces for online decision-makers. The algorithms for the main integrating components between the Water Resource Management Information System and GIS have been developed as wrappers, while service provision scenarios enable maintenance of the information with complex features. It becomes easier to realise the decision support process by having the visualisation of the monitoring data assessment and the representation of it in the online working GIS.

Keywords

Data Warehouses (DWs), Geographical Information System (GIS), Ontology, Water Resource Management Information System (WRMIS), Assessment of Surface Water Bodies

1. Introduction

We can find scientific research works dedicated to depiction problems of the results of water pollution in geographic information systems (GIS). Some fragmentary methods have been presented in the works [1, 2] to address the application of GIS to the results of pollution assessment for groundwater usage. Some methods have been developed to describe the implementation of GIS to map the results of coastal water quality assessment in some regions using a water quality index [3, 4, 5]. The case studies are analysed by describing the results of the experience of sea regions [3, 5]. However, the results are

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quite fragmented, often examining only certain types of water bodies, only in certain regions of the Earth. The properties of pollution and water bodies are depicted in GIS rather statically.

We aim to develop a methodology to cover a wider range of assessment indicators and to develop a computer-based ontology of such a water survey area, enabling its constructions to be linked to the operational mapping of water body assessment results by developing GIS functionality. Our selected case study is based on the geographical location of water bodies in the Lithuania region. The tasks enable us to show the specifics of surface water bodies in this region. However, the methodology presented should be extended to other regions. The conceptual models being developed cover a wide range of water bodies, i.e., inland water bodies (rivers, lakes), transitional water bodies (Curonian Lagoon) and the Lithuanian coastal waters of the Baltic Sea. One of the tasks is to integrate the structure of the developed knowledge base into the GIS functions of the developed structure and provide an appropriate system to depict the specifics of such different types of water bodies to support decision-making processes.

Following such objectives, our proposed approach is intended for developing the infrastructure for a smart service provision system. The main parts for the development of the whole system infrastructure integrate the capabilities of working components of:

- interoperable data warehouses;
- the functionality of GIS;
- decision support services with the appropriate assessment of water quality of water bodies.

The assessment processes of specific water bodies have to cover the monitoring data and operational decision-making processes in the construction of an operative working online system. The retrieving, assessment and visualisation means of water bodies data are quite complex.

The maps usually are used as an intuitive way to retrieve or upload information, e.g. by selecting a location for which a user wants to receive or present information. The use of thematic maps is outstanding for presentation purposes. The implementation of digital maps for the representation of water resources has to comply with the requirements stated in the Water Framework Directive (WFD) [6] for the European Union reporting purposes. In addition, the built-in functionalities in today's GIS tools offer an advanced spatial data analysis that will be increasingly useful for planning and decision support.

For orientation purposes, some basic maps such as borderlines, municipal and county borders, roads and residential areas must be available in the system. Then all different kinds of thematic layers can be implemented for special use. The watershed layers are digitized and integrated, but the layers of land use, public density, protected areas, etc. are needed for analysis and decision-making purposes, too.

The research objectives are concerned with the integration of water quality data by representing in GIS the situations by representing in rivers, lakes and other water bodies. All this complex information is possible to implement with the development by authors of the Water Resource Management Information System (WRMIS) and the implementation of the structures of the official Cadaster DB of Lithuania [7, 8, 9].

2. Related work

The validity of overall system architecture for purposes of the WRMIS in the light of the latest requirements from the European Environment Agency (EEA) is backgrounded because one of the main goals of WRMIS is environmental reporting to EEA and other European stakeholders in the general frame of ReportNet [10]. According to the goals of the 2030 Agenda for Sustainable Development [11], Lithuania undertakes to achieve its objectives and implement some activities for the reduction of pollution with wastewaters, by achieving certain quality results.

As the main objective of sustainable development activities related to pollution of water bodies, it is planned to reduce the quantities of some chemicals, which are important for the pollution of the Baltic Sea. The main tasks are to constitute up to 8970 tons of nitrogen and 1470 tons of phosphorus until the 2025 year in wastewater effluxes, following the statements announced by the Republic of Lithuania Law on Environmental Protection [12] and the HELCOM requirements [13].

The requirements for the development of the systems for assessment of surface water quality have suggested the recommendations of the project "Long term Assistance on Information and Reporting" and in the 2nd Interim Report of that project of the overall system architecture. It is needful to take into account 3 additional projects at the Lithuanian Ministry of Environment (MoE), which are relevant to WRMIS. The project “Workplace of Environmental protection inspector” for the State Inspection of Environmental Protection and this system provide the introductory infrastructure and hardware for integration of data and create the system of ComuneData, the prototype of which was developed by the Danish researchers.

Such efforts enable the creation of the right possibilities for integration of the data warehouses (DWs) of inspected data with GIS structures. The experimental case studies were obtained by using the programming components of the Geo-Kaunas system in Lithuania. The pilot versions of SQL databases were created, programmed, tested, and installed in the main towns of Lithuania (Vilnius, Kaunas, Panevėžys) where the Regional Environment Protection Departments (REPDs) of the MoE are responsible for their implementation.

Another important component is the DBs of Cadastres of surface water bodies that have the functionality of interrelation with smart GIS services. Such infrastructure requires more investigating processes and is under development. It will include databases of basins, rivers, lakes, and ponds.

The systems based on distributed data warehouses are using XML technology, and an integrative meta-data approach is also required.

Together with experience gained from other development projects and with the knowledge of the trend and development of the Internet the WRMIS is based on distributed databases and the XML technology.

It was expected that the environmental information management system should have distributed architecture and be organised as a set of web services (the generalised schema of web services) and those web services are accessible through the Internet using HTML and XML for simple browsing and data exchange, and SOAP for messaging.

In addition, at EIONET European Topic Centre on Water, there is developed WATERBASE within the Transparent Environmental Reporting System for Administrations (TERESA) project [14]. The WATERBASE is an information system offering facilities needed to collect, validate, evaluate, store and visualise water environment data, statistics, (meta) information on water quality and quantity monitoring networks and stations, making the data available at different aggregated levels, for different information users, and through different distribution channels. A reference database and data management applications are developed using MySQL DB software and XML data exchange format. The database and applications of the WATERBASE are installed on the ETC-Water EIONET server [14].

The European environmental reporting is based on the new e-EIONET standards based on MySQL database management system and XML data exchange format. The proposed overall system architecture is compatible with e-EIONET future evolvement plans.

The system of Cadastre has an interface to GIS and components of ArcView (to be able to locate objects of water bodies on digital maps and present related information from databases).

As it is concluded about the Phase II of the Report of Twinning project, there are possibilities for integration of databases (DB) with a description of the water quality of surface water bodies, like rivers, lakes, transitional and marine waters. The types of database management systems (DBMSs) differ in different applications. But different DBMSs are not a problem, because the programming of the wrappers enables their integration in the common infrastructure of smart service support with Internet connection possibilities and/or mobile connectivity.

3. An approach for integrating GIS functions with surface water bodies assessment

The main requirement of the provided approach is that the map can be used for the presentation of surface water assessment results and provided on the portal. When a user uploads a map to the system, the user should be able to grant rights to other users to the specific map. The maps of GIS can be downloaded, or users can even be granted rights to edit and upload a map.

Our approach is based on the introduction of new additional structures to usual GIS software, by naming them - “Map Hotel”. The structure of “Map Hotel” means that GIS enables the additional function for adding and making the different layers of representation of the different features of water bodies. In the "Map Hotel" the maps are stored in the same format as geographical dispositions of the surface water bodies, but with the functionality to represent the different layers of visualisation of assessed data. The maps can be easily used by the applications and procedures for uploading and downloading maps. Such functions can be provided. Rights for using and editing the maps should be implemented to secure that only the owners of the maps can edit and manage them.

Maintenance of the thematic maps should be possible on the de-central level. Therefore if a user downloads a map for updating/editing, the map should be marked as "checked out" and specific information should be given to other users who want to download or use the same map. This can prevent that analysis is done on outdated maps and it can eliminate redundant work on the maps.

There are no problems with selecting a common projection for the map used in WRMIS because all maps in Lithuania are used as a common national projection. The system should be able to handle maps on a different scale, but it is recommended that maps be produced on at least the scale of 1:50.000.

The GIS tools such as ArcView and MapInfo are used. ArcView is based on the open format ESRI shape file (.shp), while MapInfo uses its own protected format. MapInfo can produce shape files. Hence the use of shape file format as a standard is suggested, but the decision on standard file format should await the decision on GIS software.

The data in GIS tables should generally be limited to the attributes needed for the presentation of maps and information that is generated through the digitizing process. Where data from the database(s) is needed for presentation it should be retrieved from the database(s). All points, e.g. water abstraction wells, point sources and sampling stations should be mapped via coordinates stored in the databases and not digitized by hand.

The Water Framework Directive (WFD) sets out some requirements for maps which can be included in the reporting. The maps are needed as a minimum for the analysis and reporting data about:

- River Basin Districts;
- River Basins;
- Water bodies;
- Protected areas.

These layers are based on the relevant layers in the official digital map of Lithuania on a scale of 1:50.000. This makes it easy to update themes as new maps are released. For more clear information representation, further, we plan to include:

- Protected areas;
- Monitoring stations;
- Pressures (points).

A map of river basin districts is produced from the map of digitized river basins by joining the main river basins in each river basin district.

One map type represents the hydrological boundaries of the major river basins in Lithuania. Further sub-basins should be added if necessary for the analysis and administration.

The river basins and sub-basins should be digitized and based on the maps from authorities of the EU country. The main scale of such maps is 1:100.000. Objects are scanned and assigned to the geographic coordinates and structure of GIS. Where these maps are lacking or have shortcomings, the details can be added by using the maps in scale 1:25.000 on paper or be defined based on other existing cartographic material.

The river basins are mapped with such accuracy that there are no overlaps or areas outside the river basins. The table will include a unique ID and the name of the river sub-basin. It should also include the name of the main river basin and the river basin district, but these columns should be filled in by query and not by hand. If a code for river basins exists in the Cadastre of rivers system it should also be included.

4. The scope of functionality and peculiarities of WRMIS

The WRMIS helps in implementing the requirements of the Water Framework Directive (WRD) and provides the framework for the protection of inland, transitional, coastal and ground waters. The main functions of WRMIS are:

- To prevent further deterioration, to protect and enhance the status of aquatic ecosystems;
- To promote sustainable water use based on the long-term protection of available water resources;
- To enhance the protection and improvement of the aquatic environment;
- To ensure the progressive reduction of pollution of groundwater.

To streamline environmental data flows using WRMIS, the idea of a core MDIAR process[2] is used for monitoring data supply; primary data recording; information (integrated data); assessments (analysis); and reports.

Monitoring data of environmental quality is gathered for the following main purposes:

- To inform local and national policy-makers and the general public so that they can take appropriate action where necessary;
- To check the requirements for compliance with EU legislation and other international legislation and conventions;
- As a contribution to the assessment of the state of the environment at the local and national levels, and in the European (international) context.

The integrated analysis of the state of the environment (and subsequent needed actions) should be based upon a set of policy-relevant key indicators and organised using a general DPSIR assessment framework [15].

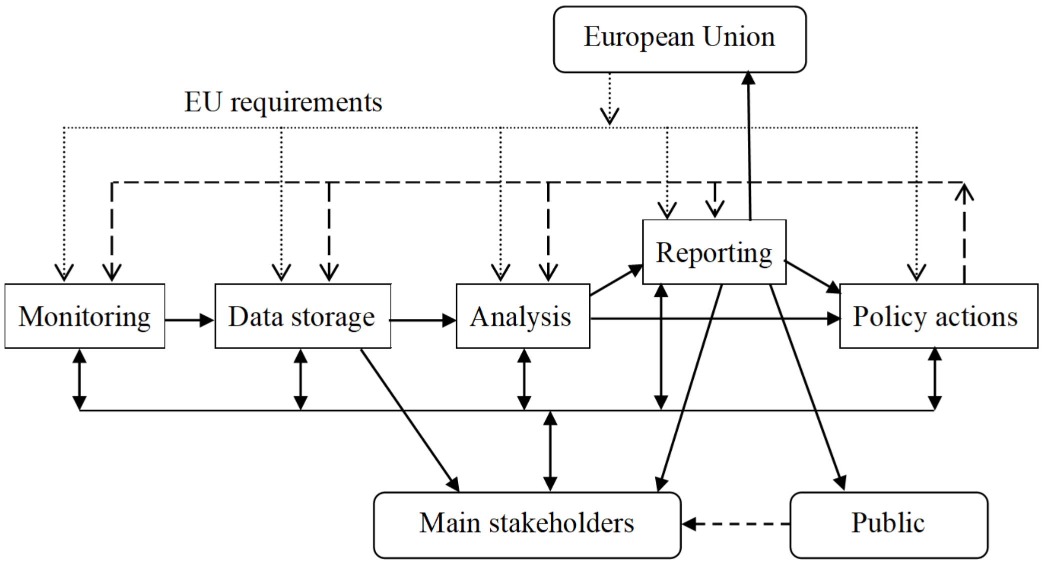

Figure 1: The model of data flows between the main processes and actors of the environmental protection cycle

The framework assumes cause-effect relationships between interacting components of social, economic, and environmental systems, which are:

- Driving forces of environmental change (e.g. industrial production),
- Pressures on the environment (e.g. discharges of wastewater),
- State of the environment (e.g. water quality in rivers and lakes),
- Impacts on population, economy, ecosystems (e.g. water unsuitable for drinking),

The model of main processes and data flows supported by WRMIS is presented in Fig. 1; here the dotted lines indicate the impact of EU requirements, solid lines show the data and information flows, and the dash lines indicate the influence of (1) policy actions on the processes and (2) the public on main stakeholders.

The hierarchy of main WRMIS functions is dependent on the warehousing of information that includes:

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[2] The monitoring/data/information/assessment/reporting (MDIAR): the flow of data and information from national monitoring to European reporting.

- Integrated storage of water monitoring data (as high priority function);
- Storage of environmental reports (as moderate priority);
- Centralised storage of water management legal and draft documents (low priority function for WRMIS because of availability of CIRCA and storage of legal documents on the Ministry of Environment of Lithuania (MoE) Internet site).

The integrated storage of water monitoring data contains:

- Object's inventory in metadata catalogue (dictionary);
- Browsing, entering/modifying/deleting, querying, importing/exporting, validation of data items in WRMIS databases by allowed users (according to the list of access rights indicated in the directory of institutions, persons and roles);
- GIS-based interface and data visualisation (basic; with extension possibilities in the future);
- Metadata maintenance (viewing, entering/modifying/deleting metadata items);
- Quality assessment of monitored data (according to environmental protection requirements stated in EU and Lithuanian laws);
- Integrated data analysis from different perspectives;
- Data retrieval for reporting and presentation purposes.

The storage of environmental reports is retrieved from the previously described DWs.

The centralised storage of water management legal and draft documents enables:

- Ensuring computerized information flows through the circle of water management (high priority function);
- Central portal of environmental information of water sector for usage inside MoE and (to some needed extent) for public (high priority function);
- Support for water resources management-related group collaboration (low priority function, because of availability of CIRCA and other discussion group services).

Enabling the infrastructure for integrating distributed information sources, which are available on different platforms with different software is important. Interoperability of related components is realised by using standardized means of the Internet (Web CORBA client technology) and by efforts to the creation of the common conceptual structure of DWs and the application ontological layer of the overall system.

Interoperability requirements concern the development of interrelations of data types, classification of provided data and creation of meta-models by including:

- general data;
- classification data;
- coordinates (and distance from the mouth);
- morph metrical data (for lakes and ponds only);
- islands and affluent rivers (for lakes and ponds only);
- address (for lakes and ponds only);
- flow characteristics (for rivers only);
- lengths of affluent rivers in a basin, areas of basins (for rivers only);
- hydrological data (hydrometrical measurement and hydrological observation);
- water consumption;
- main characteristics of shore protection belts and zone characteristics, and potential points of pollution;
- characterisation of basin soil usage, and potential points of pollution;
- basin geological characterisation;
- main data on hydro-technical constructions;
- water quality analysis data;
- data on water flora and fauna (fish, crustaceans, etc.);
- biological quality analysis data (for rivers and ponds only).

The main purpose of WRMIS is to integrate data on water flow, water quality, wastewater, and catchments into a unified environmental information system, integrating present databases. Such integration can be done in two ways:

- Realising centralised data storage for all water quality data in the Oracle database;

- Implementing the mentioned distributed architecture of web services with standardized HTML, XML and SOAP-based data exchange capabilities.

Having in mind the requirements of the Project Document, the abovementioned European requirements, and the context of other relevant projects in Lithuania, the architecture of web services integrating distributed databases of environmental water quality data is more appropriate for WRMIS. The WRMIS applications are realised using the Rapid Application Development platform Delphi[3] version 6 (which includes a next-generation web application design framework WebSnap[4]). WRMIS is realised using CORBA[5] - Common Object Request Broker architecture and SQL-based databases.

5. Knowledge base integration with maps for displaying data about water bodies

All surface water bodies are classified in the knowledge base and include lakes, rivers, coastal waters and transitional waters. Such structures should be mapped using attribute tables of the same structure. The same structure might also be applicable to groundwater. The maps of surface water bodies must contain the name of the water body, a unique ID for the water body (fragment), space for the EU code (ID) under development and a Lithuanian hydrological code where such codes exist.

It is expected that only the amendment of attribute tables is required for the development of the GIS layer of lakes. Rivers will be edited to have correct attributes and to be coherent, i.e., to allow water to flow from the spring through lakes to the sea.

Coastal water means surface water on the landward side of a line, every point of which is at a distance of one nautical mile on the seaward side from the nearest point of the baseline from which the breadth of territorial waters is measured, extending where appropriate up to the outer limit of transitional waters.

The following river basins (RB) are mapped:

- RB of small tributaries to the Baltic Sea;
- Bartuva RB;
- Venta RB;
- Mūša-Nemunėlis RB with sub-basins Mūša and Nemunėlis;
- Dysna (Dauguva) RB;
- Nemunas RB (sub-basins: Minija, Jūra, Dubysa, Nevėžis, Merkys, Šešupė, Nemunas small tributaries and Neris (sub-basins Žeimena and Švetoji)).

The only transitional water in Lithuania is the Curonian Lagoon. As an example of the visualisation of assessment data of the Curonian Lagoon area is represented in the GIS displaying window (Fig. 2).

Describing the groundwater, all occurrences of groundwater should be mapped to facilitate the characterisation and analysis of groundwater. The mapping should include information on borders and hydraulic connections from aquifers to ground or surface water.

The digitizing of protected areas could benefit the reporting to all authorities and EU Commission. Maps of the protected area should contain information on the attributes of the legal act under which the area is protected. There should also be an identifier to search the database for information on species, site type and requirements.

If requirements for management and protection could be limited to a list of 10-15 different cases, this would allow these issues to be included in the analysis.

It is expected to obtain the GIS layer of protected areas from the State Protected Areas Service. The conceptual schema of GIS layers is presented in Fig. 3.

[3] https://www.embarcadero.com/products/delphi/features/fast-development-single-code-base
[4] https://www.delphipower.xyz/guide_8/websnap.html
[5] https://www.ibm.com/docs/en/integration-bus/9.0.0?topic=corba-common-object-request-broker-architecture

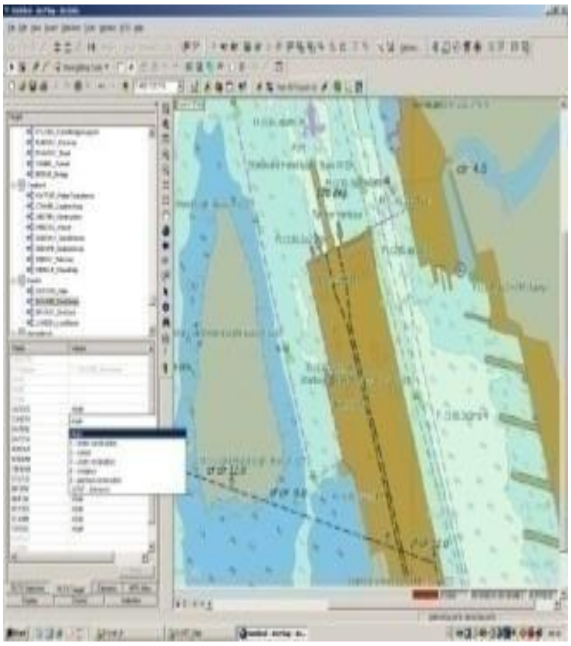

Figure 2: Illustration of map structure for the representation of marine water body

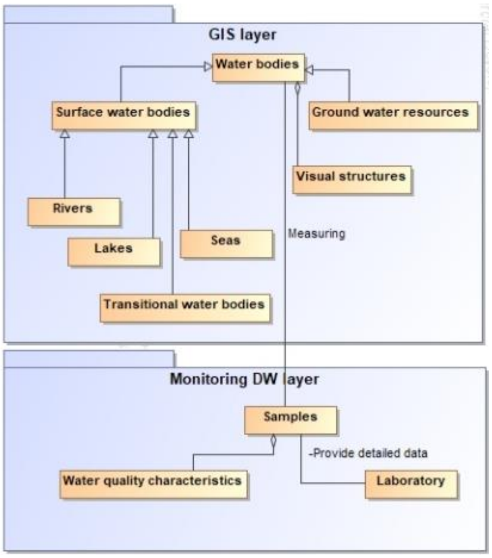

Figure 3: UML Class diagram of Water bodies of the GIS layer and their association with the Monitoring layer

6. Ontology development by the semantical description of data structures

The structures for the development of DBs are based on the specifications, which can handle all surface water data gathered according to the WFD. Structures for the meta-database are holding information on the databases and the GIS layers. They are represented by the following databases and data sets that could be managed by WRMIS and integrated with GIS:

- Baltic Sea and Curonian Lagoon water quality databases (Marine Research Centre, MoE),
- Cadastre of surface water bodies (Water Division, MoE),
- Surface water quality database VanMon (Joint Research Centre, MoE),
- Water consumption and emissions database (Joint Research Centre, MoE),
- Groundwater databases (Lithuanian Geological Survey),
- Meteorological database Hymer (Lithuanian Hydrometeorological Service).

The sequence of those databases corresponds to the priority of inclusion in WRMIS. The databases of the Marine Research Centre are of the highest priority to be integrated into WRMIS. The priority of Groundwater databases is not so high because their data is available through GIS-based tools on Internet, already, and their extension is the least problematic (if compared with data sets of other Lithuanian water quality databases).

The WRMIS is prepared to deal with the quality data of surface water (i.e., rivers, lakes, transitional waters and coastal waters) for the classification of ecological status. The structure of such data is as follows:

I. Biological elements:
  a. Composition, abundance and biomass of phytoplankton (for lakes, transitional waters and coastal waters);
  b. Composition and abundance of aquatic flora;
  c. Composition and abundance of benthic invertebrate fauna;
  d. Composition, abundance and age structure of fish fauna.

II. Hydro-morphological elements supporting the biological elements:
  e. Hydrological regime (for rivers and lakes only):
    (1) Quantity and dynamics of water flow,
    (2) Residence time (for lakes only),
    (3) Connection to groundwater bodies;
  f. River continuity (for rivers only);
  g. Morphological conditions:
    (1) Depth variation,
    (2) River width variation (for rivers only),
    (3) Quantity of the bed (for lakes and transitional waters only),
    (4) Structure and substrate of the bed,
    (5) Structure of the riparian zone (for rivers) / the lake shore (for lakes) / the intertidal zone (for transitional waters and coastal waters);
  h. Tidal regime (for transitional waters and coastal waters only):
    (1) Freshwater flow (for transitional waters) / direction of dominant currents (for coastal waters),
    (2) Wave exposure.

III. Chemical and physicochemical elements supporting the biological elements:
  i. General:
    (1) Transparency (for lakes, transitional waters and coastal waters only),
    (2) Thermal conditions,
    (3) Oxygenation conditions,
    (4) Salinity,
    (5) Acidification status (for rivers and lakes only),
    (6) Nutrient conditions;
  j. Specific Pollutants:
    (1) Pollution by all priority substances identified as being discharged into the body of water,
    (2) Pollution by other substances identified as being discharged in significant quantities into the body of water.

The quality elements applicable to artificial and heavily modified surface water bodies shall be those applicable to whichever of the four natural surface water categories (i.e., rivers, lakes, transitional waters and coastal waters) above most closely resembles the heavily modified or artificial water body concerned.

The integration of functional components of GIS within WRMIS is presented in Fig. 4.

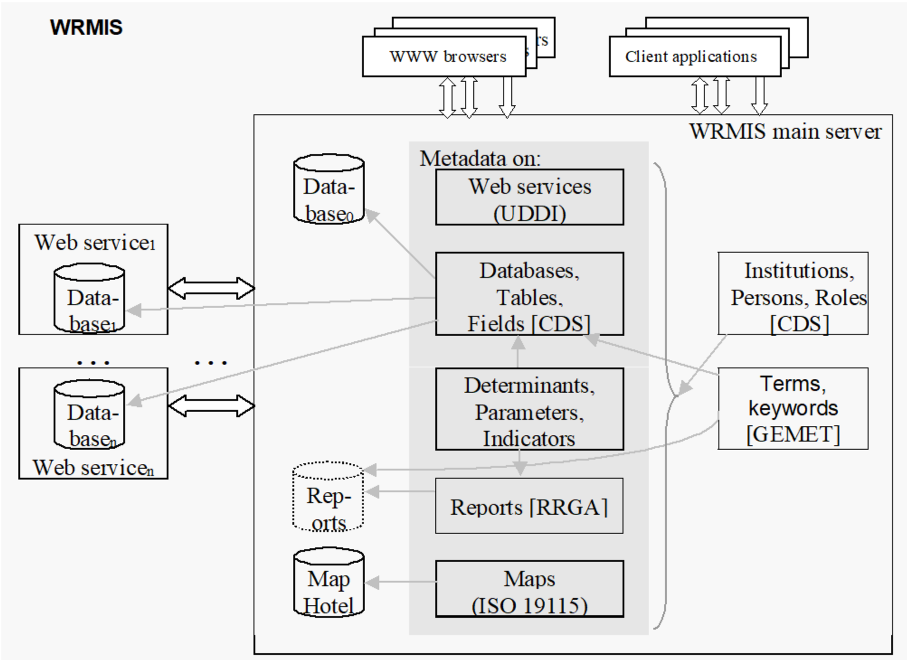

Figure 4: The scheme of integration of functional components of GIS within WRMIS

Prospective WRMIS information bases are:

- Registry of WRMIS for Web services (in UDDI[6] format);
- Directory of institutions, persons and roles (for user authentication, security services, getting contact information; to be based on CDS or – alternatively – on LDAP[7] and DSML[8]).

The catalogue of available data resources – databases, tables and fields are included by using the CDS tool and ETC-CDS Core Data Model, or – alternatively – in GELOS format, which includes commonly used metadata elements from existing metadata standards/schemes such as the Government Information Locator Service (GILS)[9], Dublin Core[10], EEA Catalogue of Data Sources[11].

The description of water sector environmental databases will be prepared in correspondence to a minimal standard of environmental data collection and storage.

Thesaurus of terms (i.e., GEMET, for indexing of entries in the Catalogue of data resources) and reports (if they will be included in WRMIS) are presented as well.

Databases with Water sector environmental data (i.e., $Database_0$, $Database_1$, …, $Database_n$) are included. The Dictionary of definitions of data – determinants, parameters, and indicators are specified by ISO/IEC 11179[12] and are presented using XML schema[13] language.

The Registry of what should be reported and reporting obligations is based on RRGA database content.

The Registry of maps is represented in GML[14] format, following ISO 19115 compliant. The Map Hotel is constructed from the storage of maps and is described in the registry of maps.

The model of WRMIS metadata is stored in Registry of Web services, Catalogue of data resources, Dictionary of data definitions, Registry of maps (and possibly Registry of reports, too).

GIS layers integrated with the WRMIS have administrative borders (Country, Regional, County, and Municipality) and information is provided about:

- Rivers;

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[6] http://www.oasis-open.org/cover/uddi.html
[7] http://www.ietf.org/rfc/rfc2251.txt
[8] http://xml.coverpages.org/dsml.html, http://www.oasis-open.org/committees/dsml/docs/DSMLv2.doc
[9] http://www.gils.net/
[10] http://dublincore.org/
[11] https://sdi.eea.europa.eu/catalogue/srv/api/sources
[12] https://metadata-standards.org/11179/
[13] http://xml.coverpages.org/schemas.html
[14] http://xml.coverpages.org/ni2001-02-28-c.html

- Lakes and ponds;
- Protected areas;
- Contaminated areas;
- Towns and settlements;
- Roads and railways;
- Elevation.

Data are captured by the sources. Data providers – the staff in the regional departments and enterprises need special tools for data entry, validation and reporting. Results shall be available on request. The users need search engines and information that can be accessed by use of an Internet browser. The application is scalable and open both regarding input data and system data. The database structures and applications can handle additional data such as new sampling sites and new parameters in the monitoring program. The data structures are prepared for data exchange with other sectors.

Data security and user rights are in priority. Some data are considered sensitive for the participants; therefore a high level of data security must be established by the use of differential user rights. Each user or group of users must be granted different rights to the system. A login procedure shall handle the specific user's rights and accessibility to the information. Additional the system could make use of SSL (Secure Socket Layer). Data shall be validated before entering the database. At least the input shall be typed checked e.g. where numbers are expected the users shall be prompted if illegal data are typed in. Where ever possible lookup tables shall be used to secure data integrity, and eliminate as many errors as possible.

7. Conclusions

For solving the representational problems of complex and dynamic assessment data of surface water bodies into the GIS, a new approach for the integration of GIS functionality with the WRMIS system is developed. The development of such type of infrastructure has some difficulties in expressing the complexity, differentiation and variety of water bodies. The new approach is needful for extracting the requirements of quite qualitative assessment. The proposed solutions present the methodology how to integrate functionalities of a new kind of visualisation in GIS with existing data structures.

The proposed approach includes a description of the overall system infrastructure. The proposal of the additional functionality of GIS is based on the structure of "Map Hotel". This solution of including "Map Hotel" enables us to integrate different layers of visualisation of assessing results about the water quality of surface water bodies.

The solution of integrating the new functionality of GIS with the operative working decision support system enables to visualise and assess the surface water monitoring data, which can be provided for decision-making.

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