Automation of Web-Portal Construction Processes with SQL Server for the Black Sea Ecosystem Monitoring

Gia Surguladze, Nino Topuria, Ana Gavardashvili, Tsatsa Namchevadze

Abstract—The present article discusses design and development of Information System for monitoring ecology within the Black Sea basin of Georgia. Sea parameters, river, estuary, vulnerable district, water sample, etc. were considered as the major parameters of the sea ecosystem. A conceptual schema has been developed for the Black Sea ecosystem based on object-role model. The experimental database for the Black Sea ecosystem has been constructed using Ms SQL Server, while the object-role model NORMA has been developed using graphical instrument Ms Visual Studio within the integrated environment of .NET Framework 4.5. Web portal has been designed based on Ms SharePoint Server. The server database connection with web-portal has been carried out by means of External List of Ms SharePoint Server Designer.

Keywords—Web-application, service-oriented architecture, database, object-role modelling, SharePoint, Black sea, river, estuary, ecology, monitoring system, automation of data processing.

I. INTRODUCTION

ONE of the major challenges faced at the modern stage of human development is the necessity to achieve ecological sustainability [1], [2]. Biosphere is conditionally divided into three subspheres: Aerobiosphere, Hydrosphere and Geobiosphere [1]. Within boundaries of these three environments we have the life environments of air, water and land. Earth biosphere comprises of a diversity of ecosystems. An ecosystem is a combination of live organisms and their non-live environment. The diversity of living organisms creates a complex network of interactions that determines the sustainability of a certain ecosystem.

Climate changes taking place during the past years have led to changes in certain natural processes, among which is, for instance, the increased risk frequency of flooding in river estuaries within the Black Sea basin. Estuaries of these rivers and their nearby areas often get flooded, erosion of the sea coastal line (abrasion) occurs, leading to very negative ecological outcome. In particular, we are dealing with the

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Black Sea widening its presence by taking away coastal land within boundaries of Georgia [3].

Considering the above, conducting scientific research in the area of black sea ecology and prediction of its ecological parameters is of high importance, representing one of the country's strategic directions while the protection and retainment of land areas adjacent to the Black Sea has been announced by the Georgian government to represent a high priority state direction [4]. The objectives of the field-scientific research were: to determine areas of estuaries for the major rivers within the Black Sea basin in GPS coordinates and to do the mapping (see Fig. 1), to identify temperature for sea water and air, to take sea water samples from the estuaries and vulnerable districts and to conduct laboratory research [5].

Fig. 1 GPS coordinates of the rivers within the Black Sea basin: Chorokhi and Rioni

Conducting the field research for the reason of collecting various parameters using GPS coordinates would be much convenient if data entry could take place from a computer located at a distance. This way, The External Data field type enables users to add data from external content types registered in the Business Data Connectivity (BDC) service metadata store to SharePoint lists [6]-[8].

Experts from the monitoring service take water samples from the above shown control points for analysis and once analysis is done, results are transferred to the major server of the system using mobile gadgets [7]. Fig. 2 represents a table which shows values of ecological parameters entered from those control points.

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II. Designing a Conceptual ORM Model for the Black Sea Ecological Parameters

Our objective is to design database and develop software for the Black Sea ecology computer system. At an initial stage, we need to define objects describing main parameters of the sea ecosystem in terms of syntax and semantics. System analysis has been conducted resulting in the following objects:

Sea(SeaID, Name, Length_EastWest, Length_NorthSouth, Area, Water_volume, Average_depth, Max_depth);

River(RiverID, River_Name, Catchment_pool_area, km2, Absolute_mark, m, River_length, km, Average_inclination, i, Average_height_of_basin_section, m, Average_runoff_module, L/sec.km2, Average_annual_cost m3/sec);

Estuary(EstuarID, RiverID, CoordGPSx, CoordGPSy, Area,);

Vulnerable_district(Vulnerable_districtsID,CoordGPSx, Coord-GPSy, Area, T1/T2, pH, TDS);

GPS_coordinates(CoordGPSx, CoordGPSy);

Sensitive_area(SensitiveAreasID, CoordGPSx, CoordGPSy)

District(DistrictID, Name, CoordGPSx, CoordGPSy, Area, T1/T2, pH, TDS);

Water_test_factors (WaterTestID, WaterT1, AirT2, Water_acidityPH, WaterSalinityTDS) etc.

Database was designed using an object-role modeling instrument and its principles [7], [8]. As an instrument we used Natural ORM Architect (NORMA) package which is compatible with integrated system of Visual Studio.NET Framework [9].

Fig. 2 Table with sea ecological parameters
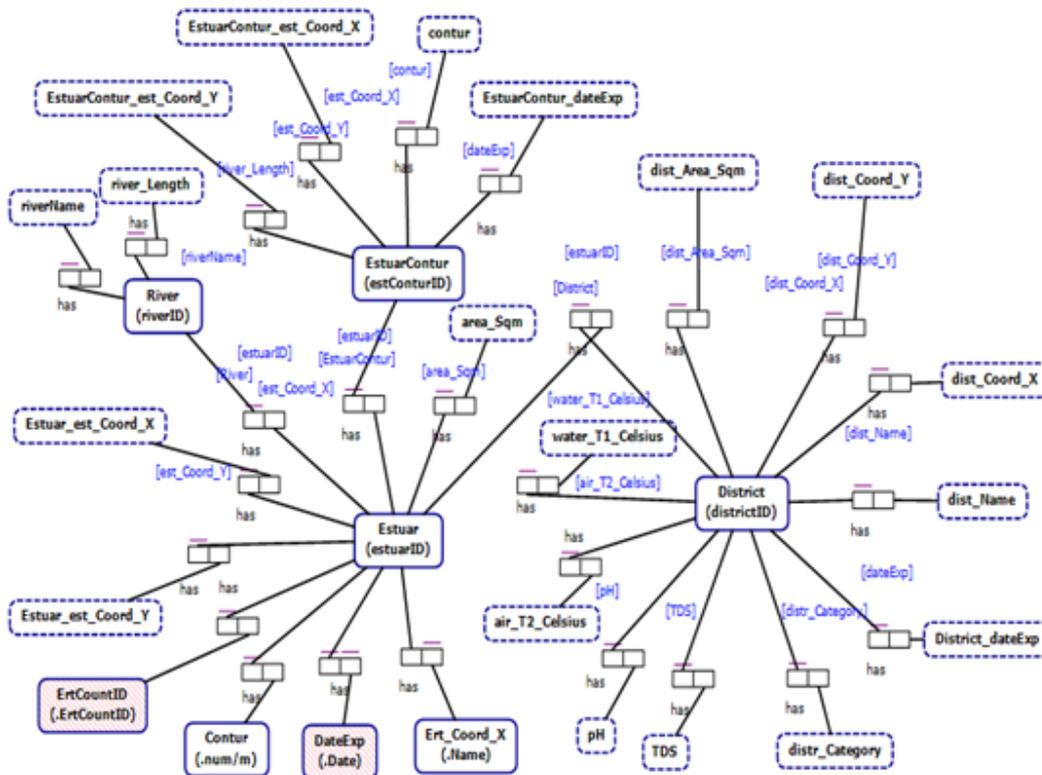
Fig. 3 Fragment of ORM Schema of Black Sea Ecology Monitoring System

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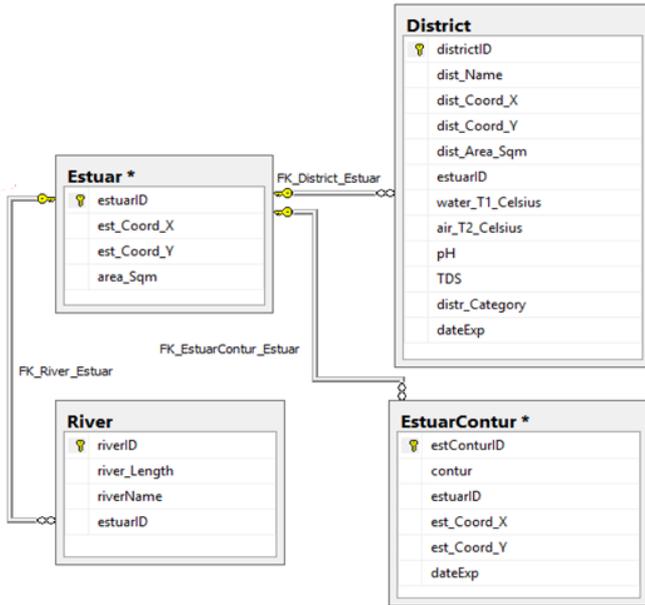International Journal of Environmental and Ecological Engineering
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Fig. 4 ERM- Conceptual Model

Conceptual model (ORM- Object-Relational Mapping) or a schema is a unity of main terminology found in the problem area and related links among them, describing business processes and rules of the given research area. In theory, it jointly used categorical approach (grammar rules of a language) and math logic (algebra).

Using the NORMA instrument interface, knowledge from users related to objects to be designed is transferred to the system in the descriptive, textual form of objects, their attributes and predicates (binary, … n). Later on, NORMA system itself provides us with an integrated conceptual model which is shown in Fig. 3. To illustrate, we have described four objects: River, estuary, estuarCountur and district. Connections among these objects are constructed using "has", "is", "works", etc. predicates. Predicates are facts, for instance:

f1: River has RiverName;
f2: River has RiverLength;
f3: River has Estuar;
f4: Estuar has River;
. . .
f15: District has Category;
f16: District_Category is Normal or Sensitive or Vulnerable and so on.

Object "District" has a parameter "district_category" which represents a value from a set {normal, sensitive, vulnerable} determined by values of its ecological parameters. It is possible that results might contain inaccuracies, correction of which is possible easily under network modification regime by the user itself any time before the final conceptual model is designed (shown on Fig. 4 with realistic tables and database attributes). Fig. 4 shows the relationships between the tables of database (ERM - Entity Relationship Model). Fig. 5 represents the tables in SQL Server.
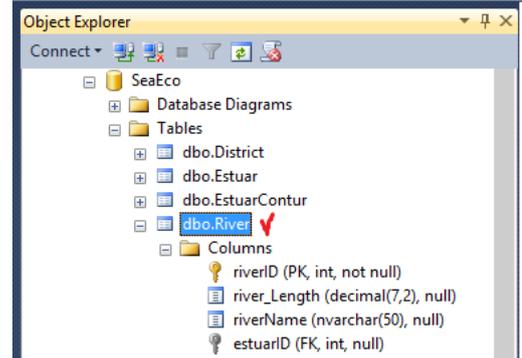

Fig. 5 The tables in SQL Server

After building the Black Sea Ecological System database on MsSQL Server, an administrator interface was developed enabling data in tables and testing. The administrator interface was developed on the basis of programming language C# and ADO.NET driver (Fig. 6).

Here, it is possible, for example, to get information from the Database River.dbo table in the DataGridView table and then perform DataShow, Update and Exit operations with appropriate buttons. The user interface model is given in Fig. 6 and software codes for Keys are in 1-Listing.
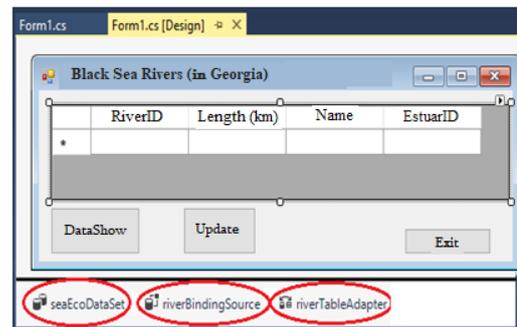

Fig. 6 User Interface with Functional Buttons

```
//- Listing1: Datashow, Update, Delete for DataGridView_SQL--
using System;
using System.Collections.Generic;
using System.ComponentModel;
using System.Data;
using System.Drawing;
using System.Linq;
using System.Text;
using System.Threading.Tasks;
using System.Windows.Forms;
using System.Data.SqlClient;
namespace WinFormSQL_DGV
{
  public partial class Form1 : Form
  { // declaration of global variables ----
    SqlDataAdapter sda;
    SqlCommandBuilder scb;
    DataTable dt;
    public Form1() {InitializeComponent(); }
    // Data Show----
private      void      button1_Click(object      sender,
```

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```
                    EventArgs e)
{
  SqlConnection     con     =    new     SqlConnection("Data
        Source=GTU-205A-08;Initial          Catalog=SeaEco;
        Integrated Security=True");
  sda    =    new    SqlDataAdapter(@"SELECT    riverID,
        river_Length,    riverName,    estuarID
        from River", con);
  dt = new DataTable();
  sda.Fill(dt);
  dataGridView1.DataSource = dt;
}
  // Update ----
  private     void     button2_Click(object     sender,
        EventArgs e)
  {
   scb = new SqlCommandBuilder(sda);
   sda.Update(dt);
  }
      private     void     button3_Click(object     sender,
                    EventArgs e)
      { Close(); }
  }
}
```


Fig. 7 Database Connected to the Server

Fig. 8 Data Transfer (System Entry) Process

III. DEVELOPING WEB-SERVICE FOR BLACK SEA RIVER ESTUARY MONITORING SYSTEM

Web portal has been developed on the basis of Ms SharePoint Server which provides flexible possibilities of using cooperation and group services. In particular, it is possible to quickly create web-based services for groupwork [10].
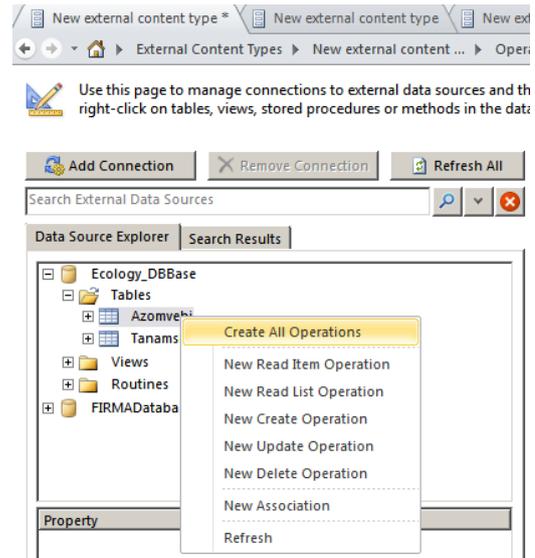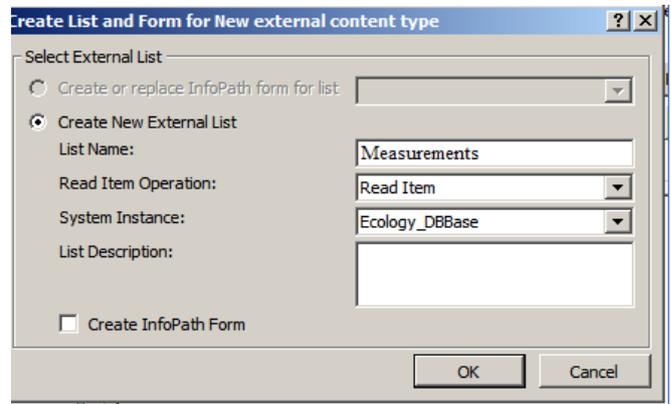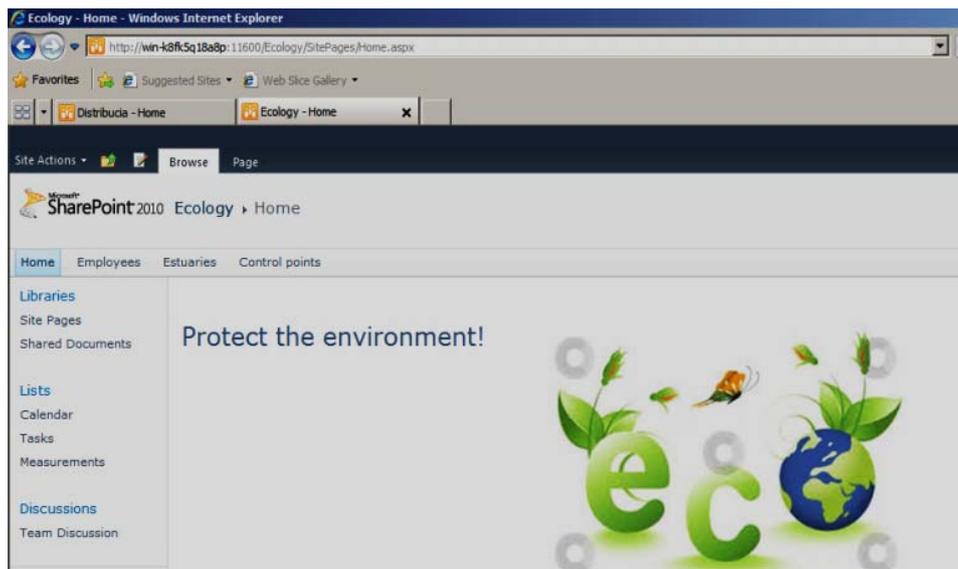

Fig. 9 Data Transfer (System Entry) Process

At next stage, it is necessary to connect MsSQL Server database with the web portal. To solve this, we used

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Sharepoint Designer. Fig. 5 shows connection of the database with External List of the portal. Figs. 7 and 8 present the process of creating the External List which has already been connected with the database. Fig. 9 presents the home page of organization's web portal. Thus, taking various measurements according to GPS coordinates can be carried out from a remote computer or mobile phone. Efficient data entry right at

the point of research does not require the use and maintenance of a paper register. Values are depicted on the corporate web portal at the moment of entry in the remotely located SQL Server database.

Fig. 10 presents table with measurement values taken at control points as shown on organization's web portal

Fig. 10 Measurement values taken at control points

IV. CONCLUSION

The constructed experimental monitoring system is capable of identifying new vulnerable districts of the coastal line with respective areas according to GPS coordinates [11], [12]. The system was developed using dynamic forms of Ms SharePoint Server, BDC and Infopath. Thus, all will allow us to conduct complex assessment of current ecology problems for the Black Sea and correspondingly, further plan the necessary security measures for the coastal line and nearby areas Helpful Hints

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Gia Surguladze - Doctor of Technical Sciences. Full Member of International Academy of Informatization of UN (since 1994). Professor of Georgian Technical University. Head of the Academic Department of Software Engineering of the Faculty of Informatics and Control Systems. Author of 15 monographs, 55 guides and more than 200 scientific works of data relational bases, programming hybrid technologies, simulation of business processes (with Colored Petri Networks), SE with UML/Agile, BigData- and Ecosystems and other fields. Contribution: In the present work, he has worked out the concept of multi-media bases of the ecological monitoring system of the Black Sea, system infrastructure and has solved the interfacial functions for the base modification.

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Ana Gavardashvili - Academic Doctor (defended the thesis in July, 2017, Supervisor: Professor Gia Surguladze). Within the framework of the Rustaveli Foundation Grant (#DO/159/4-130/14) "Research of Ecological Parameters of Black Sea, Based on Multimedia Bases" with financial support). Senior Researcher of the Ecocenter for Environmental Protection. Contribution: Maintaining field work (as an expert) in Black Sea control points, information about the results of analysis of sea water sampling was given to the database server. The results of her research were personally mentioned by her at the International Conferences of Paris and Amsterdam (2016-2017yy.)

Tsatsa Namchevadze - Academic Doctor of Engineering Sciences, Associate Professor of the Department of Computer Technology of the Faculty of Exact and Natural Sciences of Akaki Tsereteli State University of Kutaisi. She works in the direction of database systems, in particular, with the issues, dealing with the optimization of the queries of relational bases. She is the author of several books. She has scientific works and is a participant of several international conferences. Contribution: In the present article, she has studied the efficiency of the structure of the system database (in terms of achieving fast responses to the requirements) and she conducted an analysis for its improvement, regarding the increase of informational records in the base.