The ISARM/South Eastern Europe (SEE) Programme: Sharing Data and Information

J. Ganoulis[1], A. Aureli[2] and G. Stournaras[3]

(1) UNESCO Chair and Network INWEB*, Aristotle University of Thessaloniki, 54124 Thessaloniki, Greece, e-mail: iganouli@civil.auth.gr
(2) UNESCO's International Hydrological Programme, Division of Water Sciences, 1 rue Miollis, 75732 Paris, France, email: a.aureli@unesco.org
(3) Faculty of Geology and Geo-environment, University of Athens, Greece, email: stournaras@geol.uoa.gr

ABSTRACT

Approximately 90% of the territory in South Eastern European (SEE) countries lies within shared water basins and therefore the effective management of transboundary waters is of particular importance for the region. Transboundary aquifer resources are also vital sources of freshwater. 65 Transboundary Aquifers (TA) were identified in the region in an inventory developed in 2007 by the UNESCO Chair and International Network of Water/Environment Centres for the Balkans (www.inweb.gr) at the Aristotle University of Thessaloniki, in cooperation with UNESCO/IHP, as part of the UNESCO/ISARM worldwide initiative. TA in SEE, and especially those which are karstic, are highly vulnerable to pollution from different pressure factors (agriculture, industry, mining, sewage/waste disposal and tourism). In this paper, the WEB-based metadata inventory on transboundary aquifers in SEE (the Balkans) is described. This inventory is the first step towards implementing the UNESCO/ISARM (Internationally Shared Aquifer Resources Management) programme in the region. This programme uses a multidisciplinary methodological approach and is based on an effective cooperation mechanism between countries in order to reduce groundwater and ecosystem vulnerabilities and contribute to sustainable management of transboundary groundwater resources in the SEE region. Together with the Global Environmental Facility (GEF) and other partners the cooperative project DiKTAS (Dinaric Karst Transboundary Aquifer System) was formulated specifically for the Dinaric region. The project preparation phase was completed in December 2009, and the FSP (Full Size Project) is expected to effectively start in 2010.

Key words: transboundary aquifers, inventory, databases, South Eastern Europe.

1. INTRODUCTION

The existing inventory and database of internationally shared aquifers in the Balkans has been developed in two successive steps:

(1) Following the UNESCO-ISARM global initiative coordinated by UNESCO IHP, Paris, the first inventory on transboundary aquifers in SEE was prepared by INWEB and presented at the UNESCO/ISARM consultative workshop organised in Thessaloniki, Greece, in October 2004 entitled «Key Issues for Sustainable Management of Transboundary Aquifers in the Mediterranean and in South Eastern Europe (SEE) », Thessaloniki, 21-23 October 2004. In total, this assessment identified 47 transboundary aquifers but there was no clear distinction made between karst and porous aquifer types. Also the hydrogeological boundaries of all these aquifers were not determined and the location of the aquifers was just indicated using circles or ellipses. As part of the conclusions of the Thessaloniki meeting this first assessment identified priorities for future case studies, including the Dinaric karst, which was considered to be a particularly important case warranting coordinated further investigation.

(2) An improved version of the inventory resulted in cooperation with the United Nations Economic Commission for Europe (UNECE), Geneva in 2007 (INWEB, 2007). The main objective was to collect additional data with special reference to transboundary karst aquifers. This particular type of transboundary aquifer dominates South Eastern Europe (SEE) in terms of number, quantity and quality of water. Karst aquifer water resources are important not only for different human uses but also for sustaining the environment and maintaining biodiversity of ecosystems. The inventory was based largely on responses to a specially designed data collection questionnaire prepared by the UNECE/Groundwater Core Group and distributed in July 2006 to the national UNECE focal points. The information obtained was supplemented by existing information from the previous UNECE

inventory of transboundary groundwaters and from the one developed in 2004 by UNESCO/INWEB. The assessment methodology followed the DPSIR[1] framework (DIRECTIVE 2000/60/EC; DIRECTIVE 2006/118/EC; Ganoulis, 2009) to describe the pressures acting on the transboundary groundwaters resulting from human activities, the status in terms of both quantity and quality of the groundwaters, the impacts resulting from any deterioration in status, and the responses in terms of management measures that have already been introduced and applied, that need to be applied or that are currently planned. The results were presented and discussed during a regional meeting organised by UNESCO/INWEB in April 2007 in Thessaloniki entitled «Transboundary Groundwaters in South-Eastern Europe: Assessment and Future Perspectives», Thessaloniki, 23-24 April 2007.

Some transboundary groundwaters in the region had been identified and reported in earlier UNECE (1999) and INWEB (2007) inventories. However, the region of South Eastern Europe has seen major conflict and political change in the last fifteen years. Aquifers and groundwaters that for many years were located within a single country are now shared between new countries. Thus while the 1999 UNECE inventory recorded 23 transboundary aquifers in the region and INWEB reported 47 in 2004, the 2007 assessment identified 65 transboundary aquifers

The aim of the present version of the inventory was to improve the existing database in the Balkans using Google Map and Google Earth technologies, in order to make the Balkans inventory compatible with that developed in the MENA region. The new database on transboundary aquifers in the Balkans powered by Google Earth is now available on INWEB's website. The interactive map allows you to take a tour of 65 locations in different river basins in the Balkans, zoom into selected aquifer locations, and access information on aquifer properties, hydrology, hydrogeology, water uses and policy

This project also aims to provide support to a major ongoing regional GEF project called DiKTAS (Dinaric Karst Transboundary Aquifer System). The main objective of DiKTAS is to help countries establish a regional cooperation mechanism for integrated management of water and land resources. The fragmental distribution of karst aquifers across political boundaries and the differentiation between river basins and karst hydrogeological units mean that cooperation and mutual understanding are very important factors for sustainable development and environmental protection in the region.

2. OBJECTIVES AND METHODOLOGY

2.1. Geographic Scope

The Balkan Peninsula lies in South-East Europe, covers an area of around 520,000 km² and has about 45 million inhabitants (Fig.1). The "Balkan Region" is defined for the purpose of this study as the area south of the Sava River sub-basin (starting west of Ljubljana) and further downstream south of the Danube River, i.e. including the territories of Romania and the European part of Turkey. This means that the following 11 countries are involved:

- Slovenia (from the line Triest – Ljubljana eastward but south of the Sava River)
- Romania
- Croatia (the region south of the Sava River up to the Adriatic coast, but not the islands)
- Bosnia & Herzegovina (the region south of the Sava River up to the Adriatic coast)
- Serbia
- Montenegro
- Former Yugoslav Republic of Macedonia
- Albania
- Greece (only the mainland)
- Bulgaria
- Turkey (the European part of the country)

[1] DPSIR: Driving forces of environmental change (e.g. industrial production), Pressures on the environment (e.g. discharges of waste water), State of the environment (e.g. water quality in rivers and lakes), Impacts on population, economy, ecosystems (e.g. water unsuitable for drinking), Response of society (e.g. watershed protection).

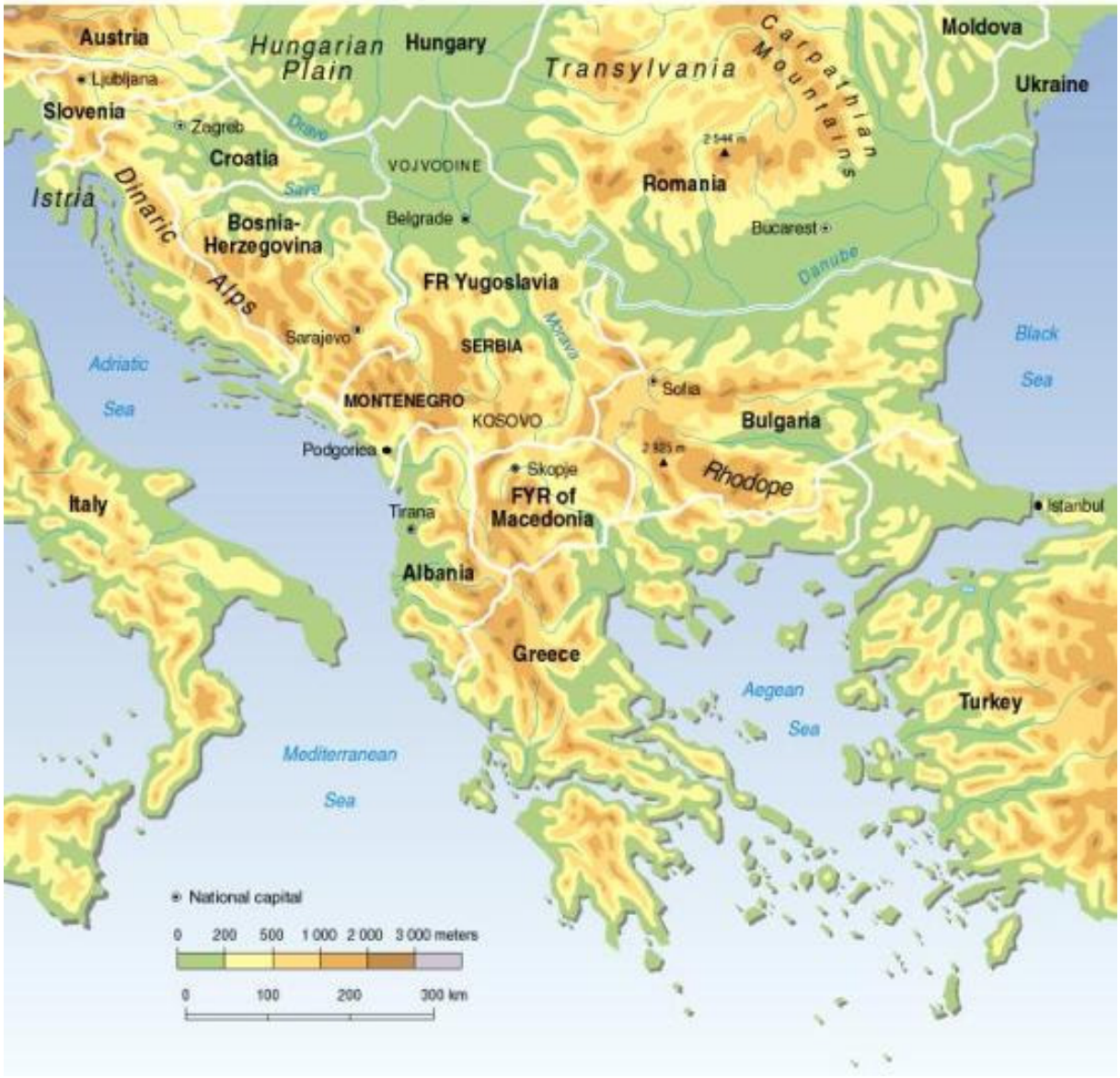

Figure 1. Topographical and political map of the Balkan region.

2.2. Methodology

The methodology of interactive maps, which can be dynamically changed, was used for the revised assessment. An interactive map may contain a single GIS dataset (e.g. satellite imagery, networks of rivers or roads or land cover) or a collection of several GIS datasets. Map services allow users to access GIS data directly over the web just like any other local data set. This makes the sharing of GIS data easier and much more flexible. Nowadays, map service technology has been dramatically improved by the development of Earth browsers such as Google Earth and Google Maps, which can make the presentation of interactive maps very attractive and user-friendly.

INWEB's interactive map for transboundary aquifers in SEE is a Google Map based application combined with GIS technology. By clicking on the arrows and symbols, this map allows users to pan (move) up/down/left/right and to zoom in/out on a political map of the Balkan region, which shows all transboundary aquifers marked with their approximate hydrogeological boundaries. The areas in green refer to karst aquifers, and those in indigo to alluvial/sedimentary aquifers (see Fig. 2).

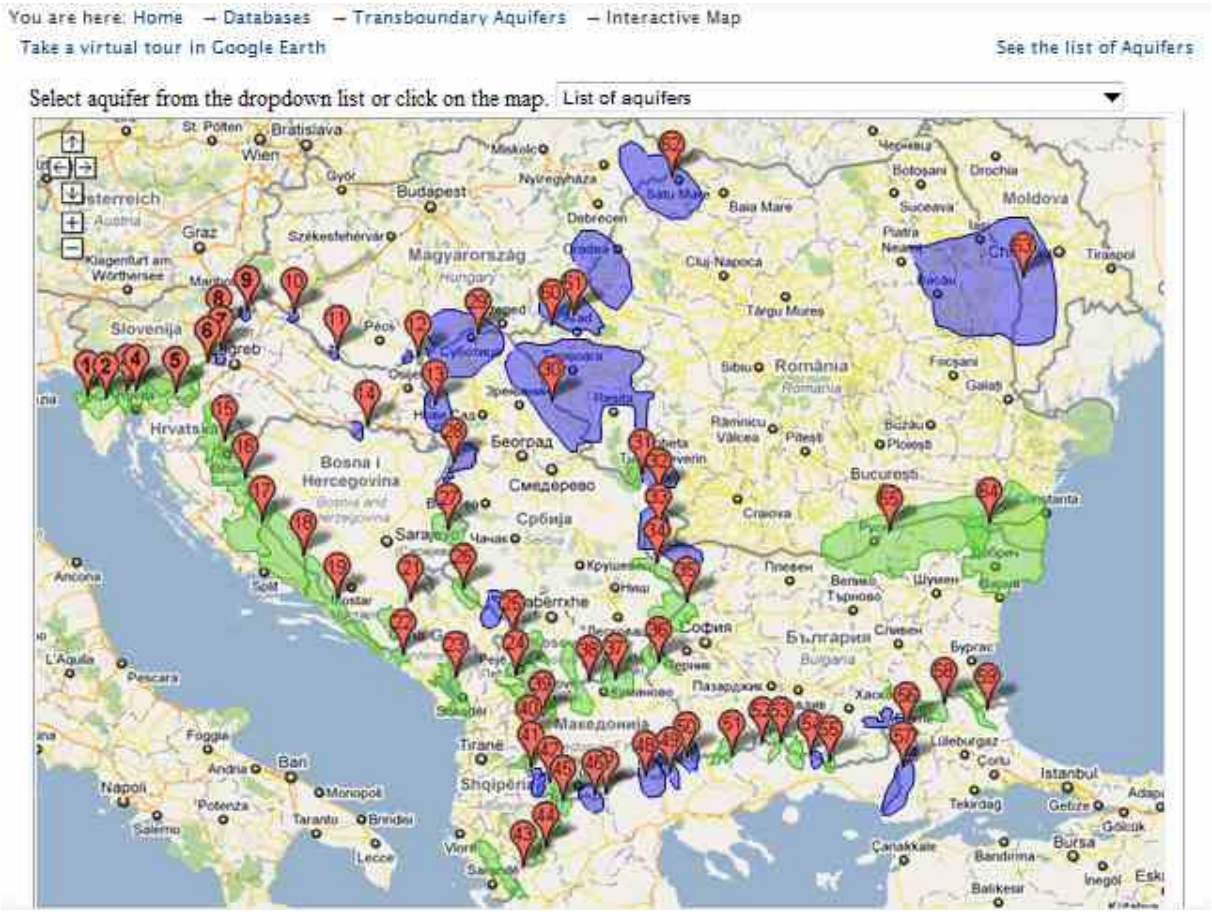

Figure 2. Interactive map of transboundary aquifers in SEE.

INWEB's interactive map offers users the following options:

Take a virtual tour in Google Earth:

This activates the «transboundary aquifers.kmz» which is a Google Earth KML file. KML files (a file format used to display geographic data in an Earth browser) use a tag-based structure with nested elements and attributes and are based on the XML standard. Google Earth then presents a tour of the 65 different transboundary aquifers in the Balkans. By clicking one of these aquifers Google Earth zooms in to the selected location.

See the list of Aquifers:

This opens the complete list of the 65 transboundary aquifers in SEE in a new window.

Select aquifer from the dropdown list or click on the map:

The map on the screen is a political map of the Balkans with all the transboundary aquifers marked with their approximate hydrogeological limits. Those in green refer to karst aquifers, and those in indigo to alluvial/sedimentary aquifers. The "tear drop" marker shows the reference number of each aquifer. There are two options to obtain further information on the aquifer:

- By clicking on the tear drop
- By selecting the aquifer name from the drop down list

Both these options open a balloon with the aquifer's name, the type of aquifer and the names of the countries to which the aquifer belongs and three interactive links as follows:

- Summary information (opens a new window with information on aquifer properties, hydrology, hydrogeology, water uses and policy)
- Descriptive information (open a new window with more information)
- See the aquifer in Google Earth (activates Google Earth and zooms in automatically to this aquifer). The user has the option either to open this KML file or to save it to disk, and then by clicking on the blue symbol next to the aquifer name can open a new window with information on aquifer properties, hydrology, hydrogeology, water uses and policy (as above).

3. TRANSBOUNDARY AQUIFERS CHARACTERISTICS

3.1. Groundwater Use

Transboundary groundwater resources play a significant role in the SEE region. The physical environment of the region – the geology, topography and major catchments – is such as to promote the occurrence of productive aquifers. These aquifers are of two distinctive main types – the limestones of the karstic type area of the Dinaric coast and its mountainous hinterland, and the thick alluvial sedimentary sequences of the Danube basin, mainly those associated with the Danube River itself and its tributaries. In some locations the alluvial sediments overlie and are in hydraulic contact with the limestones or comprise relatively thin aquifers in river or lake sediments overlying ancient metamorphic rocks.

The geographical distinction between the two main aquifer types and the fact that much of the national borders of several of the countries of the region are traversed by transboundary groundwaters can be clearly seen in the map in Fig. 2.

Transboundary karstic groundwater aquifers were reported to provide 60 to 80 per cent of total water usage in their respective areas, and for some of the Dinaric karstic aquifers of Bosnia, Serbia, Croatia, Montenegro and Albania this figure was as much as 90 or even 100 per cent.

Compared to surface waters, alluvial aquifers exhibit a greater range of use varying from only 15 per cent for some, and up to 70 per cent for the important Banat, Backa and Srem alluvial aquifers along the River Danube in Serbia, Croatia and Hungary.

3.2. Main pressures

The majority of transboundary aquifers, except for those located in remote, sparsely populated areas, are very vulnerable to anthropogenic pollutants emitted from both point and non-point sources. Karstic aquifers, with their lack of soil cover and rapid flow paths leaving little time for attenuation, are almost invariably classified as highly vulnerable. Alluvial aquifers are also likely to be considered as vulnerable, unless they contain a high proportion of clay-rich material to reduce their permeability, are overlain by a protective confining layer of clays and/or the water table is relatively deep. The transboundary groundwaters of the SEE region are likely, therefore, to be highly vulnerable to pollution if the pressure factors outlined below produce significant loadings of mobile and persistent pollutants.

In general, both alluvial and karstic aquifers have reported groundwater quality problems. Of the questionnaires received, only two specifically reported that there were no groundwater quality issues at all.

Agricultural activities provide some of the major pressures on freshwater systems in SEE in terms of both quantity and quality. Some 70% of overall water use is for agriculture and severe problems can result when this heavy usage depends on groundwater abstractions. Moreover, intensive cultivation, both with and without irrigation, uses heavy applications of fertilisers and pesticides. Intensive cultivation and animal production can produce increased levels of nutrients and pesticides in groundwaters, due to infiltrating surface run-off from agricultural land, leaching from the soil through the unsaturated zone and sometimes from return waters from irrigation channels.

Overall, industrial pressure factors for transboundary groundwaters in the region appear to be quite limited. Tourism and recreational activities, especially in summer, create a huge demand for drinking water and water for recreational activities.

4. CONCLUSIONS

The importance of shared groundwater resources in the Mediterranean and Balkan regions becomes most apparent when plans to combat water scarcity and to adapt to climate change are needed and when there is increased pressure for economic development and water related activities on either side of the border (Margat, 2004; MEDITERRANEAN GROUNDWATER REPORT, 2007). Transboundary groundwater protection plans and sustainable management of shared groundwater resources in the Balkan region should be based on strong cooperation between countries involved, and joint projects should be developed. Of primary importance are:

- development of common monitoring systems
- sharing of data
- establishment of multi-lateral and multi-disciplinary aquifer commissions
- development of common research projects with harmonised methodology

For karst transboundary aquifers, which are very important in the region, the main difficulties are related to the following:

- karst aquifers are heterogeneous with anisotropic surface and underground formations; and have well developed, complex, deep and unknown underground karst conduits, fissures, joints and cracks
- a strong interaction exists between the circulation of surface water and groundwater; and between inflow (ponors) and outflow (karst springs)
- there are significant and rapid variations in groundwater level
- the influence of man-made structures (e.g dams and reservoirs) and human activities.

Future case studies in the region, like DiKTAS should aim to:

- Develop regional groundwater governance in order to ensure effective management of transboundary groundwater resources, taking into account environmental risks associated with various water pollutants and risks from potential conflicts over sharing transboundary aquifer resources.

REFERENCES

Ganoulis, J. (2009): *Risk Analysis of Water Pollution,* Wiley-VCH, Weinheim, 311 pp. (Second Edition).

DIRECTIVE (2000/60/EC): European Parliament and the Council of 23 October 2000 establishing a framework for community action in the field of water policy. Off. J. Eur. Communities. L 327, 22.12.2000.

DIRECTIVE (2006/118/EC): European Parliament and the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration.

INWEB (2007): Inventories of Transboundary Groundwater Aquifers, UNESCO Chair and Network INWEB, Thessaloniki, Greece. http://www.inweb.gr

Margat, J. (2004): Blue Plan. "L'eau des Mediterraneens: situation et perspectives". UNEP MAP Technical Report Studies, 158, Athens. (www.unepmap.org)

MEDITERRANEAN GROUNDWATER REPORT (2007): Joint Mediterranean EUWI/WFD process, Mediterranean Groundwater Working Group. http://www.semide.net/topics/groundwater/

UNECE (2000): *Inventory of Transboundary Groundwaters*. Lelystad, UNECE Task Force on Monitoring and Assessment, under the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki 1992). ISBN 9036953154.