THE UNESCO PROJECT ON INTERNATIONALLY SHARED AQUIFER RESOURCES MANAGEMENT (UNESCO/ISARM): OVERVIEW AND RECENT DEVELOPMENTS

A. AURELI[1] and J. GANOULIS[2]

[1] UNESCO / International Hydrological Programme (IHP), 1, rue Miollis, 75732 Paris, France

[2] UNESCO Chair and Network INWEB, Aristotle University of Thessaloniki, 54124 Thessaloniki, Greece

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ABSTRACT

UNESCO-ISARM is a multidisciplinary, international, demonstration project coordinated by UNESCO International Hydrological Programme (IHP), Paris and included in the UNESCO 2004-2007 programme. It was launched in June 2000 at the 14th Session of the Intergovernmental Council of the UNESCO-IHP and is an intergovernmental project in which all national IHP Committees are involved. The Council also decided to invite the Food and Agriculture Organisation of the United Nations (FAO), the International Association of Hydrogeologists (IAH) and the United Nations Economic Commission for Europe (UNECE) to cooperate in order to create the UNESCO-FAO-IAH-UNECE inter-agency ISARM initiative to promote studies concerning transboundary aquifer systems.

In this paper an overview of the UNESCO-ISARM initiative is given followed by a description of the project's recent developments in different parts of the world. The project uses a two-step methodological approach: first an inventory of the existing internationally shared groundwater aquifers located in a given region is developed; then, taking into consideration the results of this investigation. detailed pilot projects and specific actions are formulated.

The current situation of UNESCO-ISARM in Africa, Latin America, the Mediterranean and South Eastern Europe (SEE or the Balkans) is discussed .

1. Introduction

Transboundary aquifer systems are important sources of fresh water in many regions of the world, particularly under arid and semi-arid climatic conditions. Management of transboundary groundwater resources should be based on reliable scientific knowledge and information and avoid potential conflicts that may arise between neighbouring countries. In order to facilitate an integrated approach to transboundary groundwater resources management, UNESCO adopted the Internationally Shared Aquifer Resources Management (ISARM) initiative.

On the global scale of our planet, the importance of fresh groundwater resources is predominant. According to estimations by the US Geological Survey, 98% of the total fresh water available in the earth is stored in the ground. About 69% is stored in glaciers and permanent snow cove and practically unavailable for human use. It is interesting to note that while rivers and lakes hold only 0.3% of the total amount of fresh water available on the planet fresh groundwater represent about 30% of global fresh water, with the remainder being stored as soil moisture.This groundwater is located in depths up to 4.000 m, and half of this quantity is technically available in depths less than 800 m.

According to the latest UN World Water Development Report (WWDR, 2003) the transboundary river water flow is astmated as 42.800 Km^3, while the transboundary fresh groundwater resources offer much more important volumes of high-quality water estimated as 23.400.000 Km^3. During the last fifty years, more than 200 international treaties for transboundary watercourses have been agreed and in several river basins international water commissions are effevtively apply the principles of Integrated Water Resources Management. The same does not apply for transboundary groundwater resources, where there is a lack of international conventions as well as of bilateral agreements.

From the above considerations it can be seen that, while transboundary groundwater resources exceed by three orders of magnitute the internationally shared surface waters, a great effort still remain to be made in order to improve the existing situation and reach sustainability in transboundary groundwater resources management.

About 75% of the inhabitants of the European Union (EU) member states depend on groundwater aquifers for their water supply. Many of these aquifers are internationally shared. Public water supply requires a reliable source, which means that the quality, as well as the quantity, should be beyond all doubts in relevant areas. Both quality and quantity of the groundwater are of essential importance for the diversity of ecosystems. Lower groundwater levels and changes in groundwater quality due to man induced contamination cause loss of diversity of ecosystems and deterioration of natural reserves.

Groundwater is in danger of losing its potential functions due to the deterioration of quantity and quality. While aiming at sustainability of the use, the vital functions of groundwater reservoirs are threatened by pollution and overexploitation. This has been shown many times and for many places, as in Kohsiek et al. (eds.), 1991.

One very important problem of deterioration of groundwater quality is the increasing pollution from diffuse sources, like agricultural activities, groundwater nitrification and salinisation near the coastal areas and in many cases near the soil surface. As a consequence of the latter situation, desertification has occurred of millions of hectares of irrigated land around the world. For example in Australia, it has been recognised (Tickell and Humphrys,1984) that a rise in the groundwater table is one of the main causes of waterlogging and salinity increases near the top layer of the soil. As groundwater moves upward, salinity is increased by dissolving of salts in the soil. The rising of the groundwater table arises from the effect of intensive actual irrigation combined with the disruption of the natural equilibrium between plants, soil and groundwaters. In fact, intensive removal in the past of deep-rooted vegetation, has reduced the natural drainage capacity of basins and destroyed the natural equilibrium between groundwater recharge and drainage. When the water table rises to a depth less than two meters below soil surface, salt concentrations are further increased by evaporation and damage to vegetation and soils is then likely.

The protection of groundwater resources may be based on different methodologies involving either empirical or sophisticated methods. Various traditional strategies for groundwater protection range from the construction of groundwater vulnerability maps and the definition of protection perimeters around pumping wells, to the use of sophisticated optimisation multi-criterion decision-making techniques under risk conditions. A very characteristic example is the definition of adequate waste disposal sites in relation to the risk of groundwater contamination.

In this paper, the UNESCO-ISARM programme is presented, focussing on the recent development of an inventory describing the geological, hydro geological and institutional status of existing transboundary aquifers in the Balkans or South Eastern Europe (SEE).

2. Transboundary geohydrological issues

Interstate borders may cross aquifers without recognising hydrological and hydrogeological processes that may take place in different ways from each side of the

border. As shown schematically in Fig. 1 taken from UNESCO/ISARM Framework Document, 2001, water recharge contributing to transboundary flow may occur in one country and as a consequence deep aquifer may discharge to the neighbouring country. The groundwater flow may be to the opposite direction in local shallow groundwater aquifers near the border.

In internationally shared rivers and lakes a large progress was made on how to determine what type of water resources problems are or will likely be posed for bilateral or multilateral interstate solutions. A large number of international agreements for solving various types of interstate surface water resources problems are available for reference and act as precedents.

The situation is quite different in the case of transboundary groundwater resources. Difficulties arise in scientific and technical matters (groundwater monitoring, data interpretation, modelling), the lack of political willness for cooperation and the weakness of the institutions involved. Major difficulties in designing groundwater development plans is that groundwater flow and groundwater quality are subject to several types of uncertainties much more important than in surface hydrology. These are related to the high variability in space and time of the hydrogeological, chemical and biological processes. The principal challenge is to set up a cooperativce framework in which institutions involved from both sides could work together effectively.

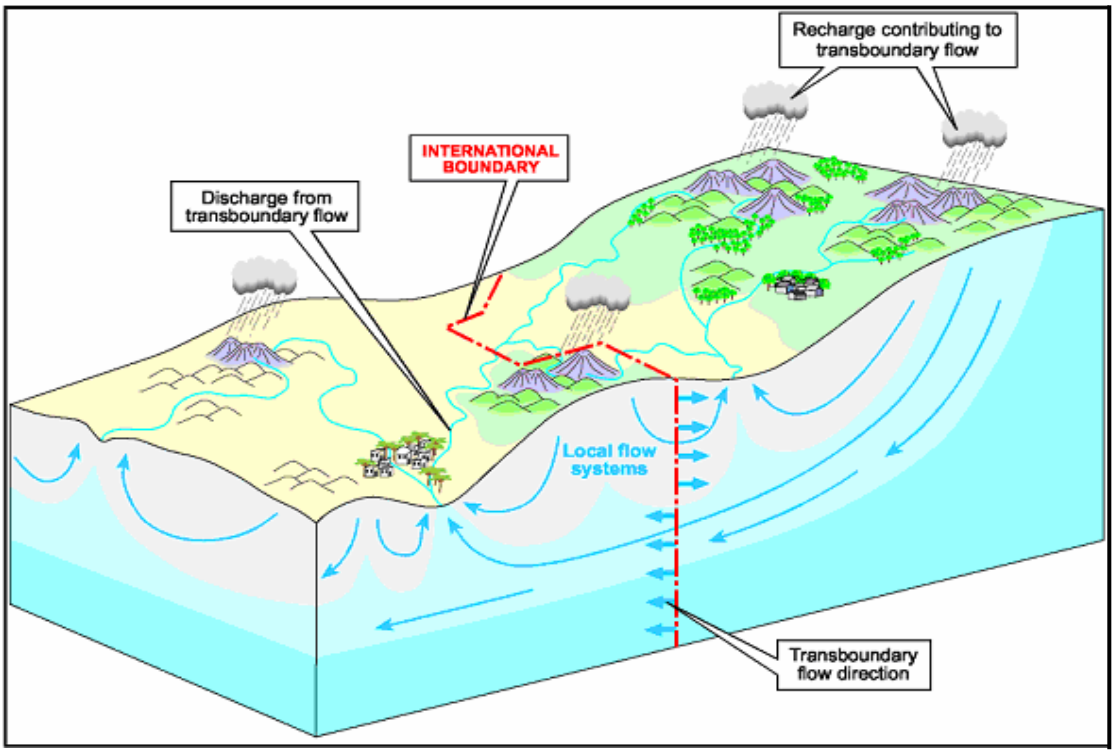

Figure 1 Schematic representation of hydrological and hydrogeological processes in transboundary areas (UNESCO/ISARM, 2001).

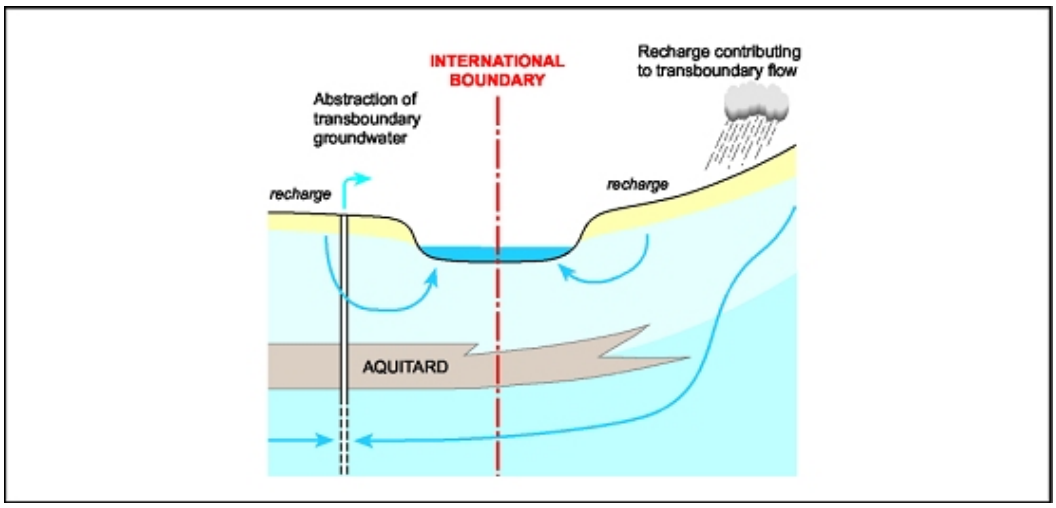

Figure 2 Interaction between surface and groundwater flows near an interstate boundary (UNESCO/ISARM, 2001).

In many real situaions interactions between surface and groundwaters from both sides of the international bunder may create international disputes. As shown in Figures 2 and 3 groundwater overpumping in one side of the boundary may lower the water level of a shared surface lake or river (Fig,2) or accelerate the sea water introsion in a coastal zone located in the other country.

A very characteristic case of groundwater-surface water interdependencies can be found in the South Balkans, in the region of the Dojiran lake, internationally shared between Greece and the Former Yugoslav Republic of Macedonia (FYROM). In the last decade, during a multiple years draught period, extensive pumping from the Greek side for irrigation may contributed in lowering the lake's water level substantially.

In all these situations cooperation berween countries is of primary importance in order to undersamd the problems, to agree about the underlying causes and to try to develop reliable soltions

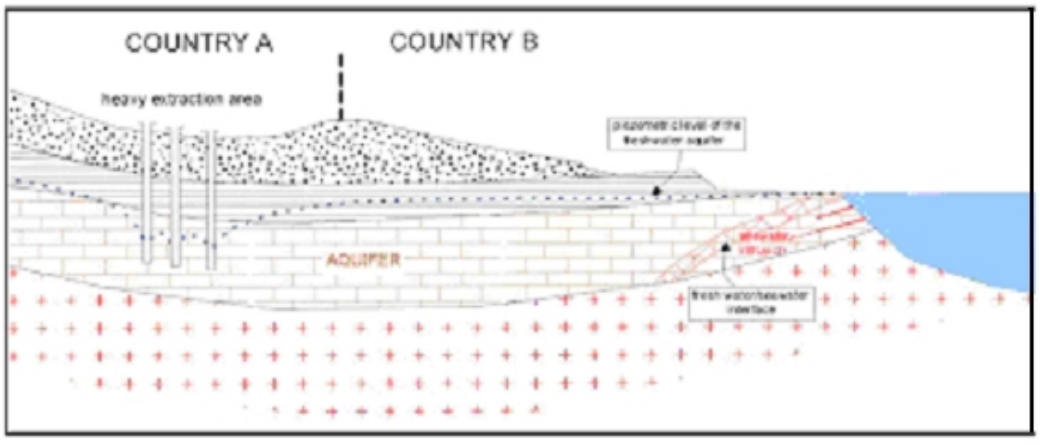

Figure 3 Groundwater salinisation in country B due to overpumping in country A (UNESCO/ISARM, 2001).

3. ISARM's methodology for transboundary aquifer management

The UNESCO/ISARM Programme has identified five key focus areas that require attention for sound management of transboundary aquifer water resources. These include the following topics:

- scientific-hydrogeological approaches,
- legal, aspects
- socio-economic issues,
- institutional considerations, and
- environmental protection.

Scientific-hydrogeological approaches

The management of groundwater quantity and quality is a complicated multidisciplinary scientific field requiring good cooperation between various disciplines, such as:

- *Hydrogeology*: geophysical and geological prospecting, drilling techniques, mapping
- *Groundwater hydrodynamics:* quantitative aspects of flows, mathematical modelling, calibration, and prediction scenarios
- *Groundwater management*: systems analysis, optimization techniques, risk analysis and multiobjective decision methods
- *Hydrochemistry* : chemical composition of the soil and water
- *Hydrobiology* : biological properties of groundwater systems

Modern tools for groundwater development use extensively information technologies, computer software, development of data
bases and remote sensing.

Legal issues

Only three agreements deal with groundwater supply (the 1910 convention between Great Britain and the Sultan of Abdali, and the 1994 Jordan-Israel peace treaty and the Palestinian-Israeli accords (Oslo II)). Treaties that focus on pollution usually mention groundwater, but do not quantitatively address the issue.

The complexities of groundwater law have been described by more than a few authors (see, for example, Hayton 1982 and Utton (1982)). Overpumping can destroy cropland through salinity problems, either by seawater intrusion or evaporation-deposition, and therefore allocating too much water (or one party's overpumping) can decimate future freshwater supplies. The Bellagio Draft Treaty, developed in 1989, attempts to provide a legal framework for groundwater negotiations. The treaty describes principles based on mutual respect, good neighborliness, and reciprocity, which requires joint management of shared aquifers (Hayton and Utton 1989). While the Draft recognizes that obtaining groundwater data can prove difficult and expensive, and its acceptance relies on cooperative and reciprocal negotiations, it does provide a useful framework for future groundwater diplomacy.

The Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki, 1992) includes important provisions on the monitoring and assessment of transboundary waters, the effectiveness of measures taken to prevent, control and reduce transboundary impact, and the exchange of information on water and effluent monitoring. Other relevant aspects deal with the harmonisation of rules for setting up and operating monitoring programmes, which includes measurement systems and devices, analytical techniques, data processing and evaluation techniques. Further needs for monitoring arise, because the Conventions aims to protect ecosystems, which may be closely connected with groundwaters and the protection of sources of drinking-water supply.

Monitoring and assessment are also part of the 1999 Protocol on Water and Health to the Convention on the Protection and Use of Transboundary Watercourses and International Lakes.

This Protocol contains provisions regarding the establishment of joint or co-ordinated systems for surveillance and early-warning systems to identify outbrakes or incidents of water related diseases or significant threats of such outbrakes or incidents (including those resulting from water pollution or extreme weather). It also foresees the development of integrated information systems and databases, the exchange of information and the sharing technical and legal knowledge and experience.

Socio-economic aspects

It is widely accepted today that protection of the environment and economic development are not separate challenges. Development cannot subsist on a deteriorating environmental resource base and the environment cannot be protected and enhanced when growth plans consistently fail to consider the costs of environmental destruction. Nowadays it is clear that most environmental problems arise as 'negative externalities' of an economic system that takes for granted - and thus undervalues - many aspects of the environment. The integration of environmental and economic issues is a key requirement in the concept of sustainability, not only for the protection of the environment, but also for the promotion of long-term economic development, especially in water sensitive areas.

This ISARM Framework Document is a preliminary overview of each focus area. No doubt there will be other issues, specific to regional conditions e.g. aquifers in arid zones with limited recharge or those in temperate regions with more reliable recharge. These are to be incorporated and developed through detailed case studies, involving multidisciplinary regional working groups.
A project logical framework of the ISARM Programme is shown at the end of this Document (Appendix II). A preliminary questionnaire is also included for completion by interested parties (Appendix III). During the course of this Programme an inventory of transboundary aquifers is to be compiled. Responses to the preliminary questionnaire may form the basis for such an inventory.

Institutional aspects

Environmental issues

4. Overview of ISARM's programme

A framework document presenting the different social, economical, legal and environmental aspects of ISARM has been published in November 2001.
Co-operation has been strengthened with UN Economic and Social Commissions, in particular with the UN Economic Commission for Europe (UNECE), and UN Economic and Social Commission for Western Asia (UNESCWA). UNECE has finalized the inventory of the European transboundary aquifers and prepared recommendations for the management of these systems. UNECE and UNESCO IHP will cooperate to implement these recommendations.

An important contribution to the improvement of knowledge has been made by the UNECE, which has developed guidelines for monitoring of such aquifers (UNECE, 2000). These 'Guidelines on Monitoring and Assessment of Transboundary Groundwaters' were prepared by the ECE Working Group on Monitoring an Assessment and adopted as part of the 1996–1999 work plan under the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki, 1992). These Guidelines were endorsed by the Parties to the Conventions at their second meting (The Hague, Netherlands, 23–25 March 2000).
c) The international conference on "Hydrological Challenges in Transboundary Water Resources Management" was organized in Koblenz, Germany, 25-27 September 2001 by the IHP/OHP National Committee of Germany under the auspices of WMO and UNESCO.
Since 2002 UNESCO has initiated the Inventory of the African, Balkans (workshop information to be requested to Mr Jacques Ganulis Chairman of the UNESCO INWEB Chair) and the Americas transboundary aquifers. A Letter of Agreement has been signed with the OAS last September 2004 (attached herewith) and a letter of agreement was signed with the UNESCWA for the compilation of the transboudary aquifers of the Americas (for more information on the ISARM RE ISARM.ems ;of the Americas you can contact Ms Maria Donoso at the UNESCO Office in Montevideo) and of Western Asia. We will start the inventory of Asia in 2005.
Moreover UNESCO IHP has established an international experts group to provide scientific support on issues related to hydrogeology to the Special Rapporteur of the UNILC in the preparation of a new legal instrument on Transboundary Groundwaters. We also cooperate with the UNECE's groundwater group concerning the European aquifers.

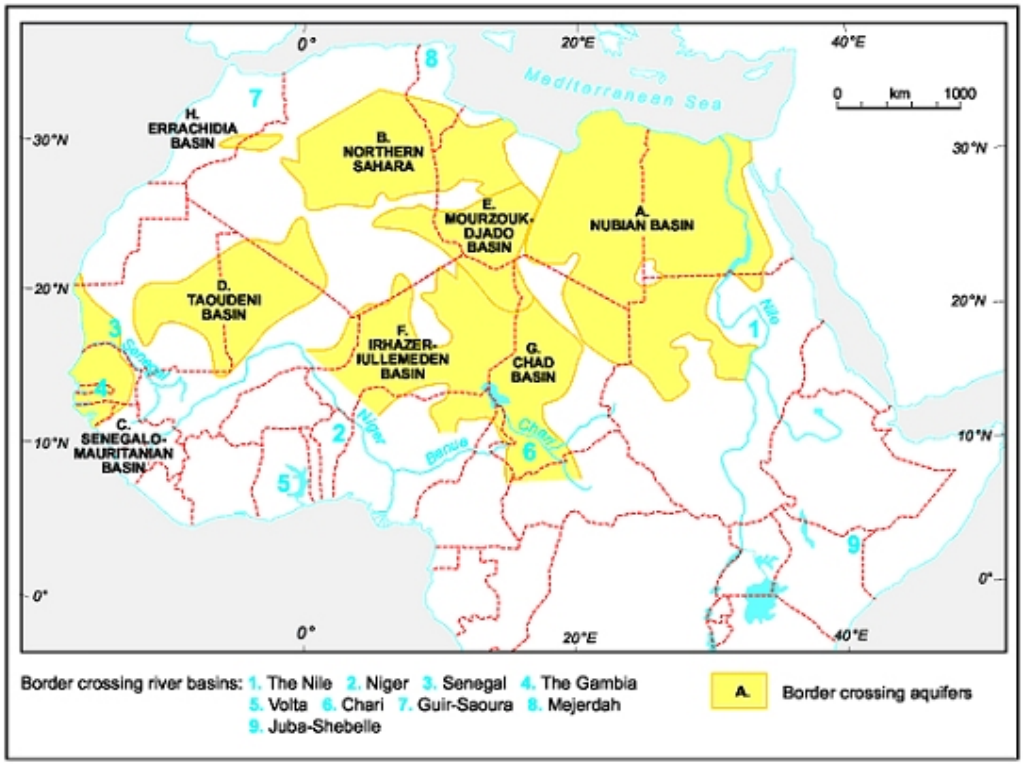

Figure 2 Interaction between surface and groundwater flows near an interstate boundary (UNESCO/ISARM, 2001).

follow-up of the IHP Council's Resolution several regional activities have been initiated:

a) ISARM Africa

- A workshop was organized in cooperation with IAH in Cape Town, South Africa, 20 November – 1 December 2000, with the aim of setting up a network in the SADC countries for enhancing the study and assessment of the Southern African regional aquifers.
- A Project proposal for the study and management of the Iullemeden Aquifer (Mali, Niger, Nigeria) is currently under preparation for submission to GEF.
- An International Workshop will be organized, 2-4 June 2002, in Tripoli, by the General Water Authority of Libya with the aims to improve the existing knowledge on African Shared Aquifer Systems and to prepare an inventory of case studies.

b) ISARM Latin America

- A seminar has been organized by the National Committee of Argentina for IHP and the University of Santa Fe (Argentina), 29-31 August 2001, on the transboundary aquifer systems in Latin America, particular focus was given to the Guarani Aquifer.
- XXII Brazilian Congress on Groundwater that will be organized in Florianópolis from 10 to 13 September, 2002.
- International Symposium on Transboundary Water Management will be organized in Monterey Mexico 18-22 November 2002.
- Close cooperation has been established with the Organization of American States.

c) ISARM Mediterranean Project

A project proposal on the "Sustainable Management and Protection of Internationally Shared Groundwater Resources in the Mediterranean Regions" has been prepared by UNECE-ESCWA-ECA and UNESCO for submission to the EU's Euro-Med Water Programme. Within this framework ESCWA has commissioned a desk survey of the Shared Aquifers within the Mediterranean region.

A seminar was organized in co-operation with UNESCWA in Beirut from 27-28 February 2002.

d) ISARM South East Europe (SEE)

The Venice Office has established contacts with Croatian IHP National Committee in order to organize 27-29 June 2002 a Working Group Meeting with the aim of discussing and drafting a project proposal covering SEE countries. Funding for this meeting (25,000 US$) is provided by the Venice Office. This SEE-project has to be seen as a sub-component of the Mediterranean one leaded by UNESCWA. It is foreseen that this proposal will be submitted to the Donor's Conference organized by UNESCO later this year in the favour of re-building scientific cooperation in the specific SEE region.

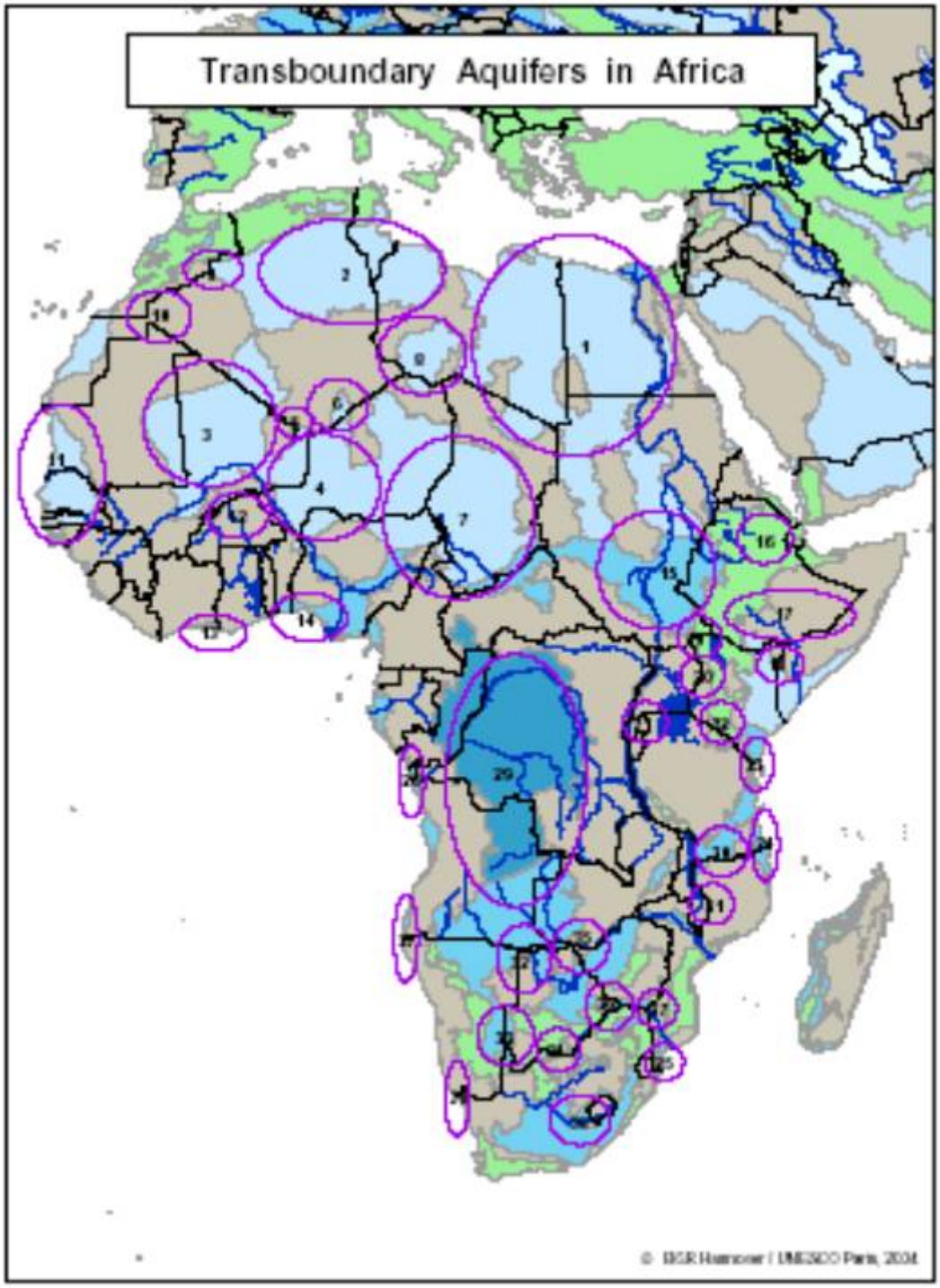

Figure 2 Interaction between surface and groundwater flows near an interstate boundary (UNESCO/ISARM, 2001).

No	Name of shared aquifers	Countries involved
1	Dragonja	Slovenia & Croatia
2	Kupa	Slovenia & Croatia
3	Kupa	Croatia & Bosnia Herzegovina
4	Una	Croatia & Bosnia Herzegovina
5	Cetina	Croatia & Bosnia Herzegovina
6	Neretva	Croatia & Bosnia Herzegovina
7,8	Sava	Croatia, Bosnia Herzegovina & Serbia Montenegro
9	Backa & Banat	Croatia, Hungary & Serbia Montenegro
10	Srem, Macva & Posavo-Tamnava	Croatia, Bosnia Herzegovina & Serbia Montenegro
11,13	West Serbia	Bosnia Herzegovina, Serbia Montenegro & Former Yugoslav Republic of Macedonia
12	SW Serbia	Bosnia Herzegovina ,Serbia Montenegro ,Albania &Former Yugoslav Republic of Macedonia
14,20	Central Serbia	Serbia Montenegro, Former Yugoslav Republic of Macedonia & Romania
15	Zemen	Serbia Montenegro & Bulgaria
16,17,18	Gaver-Nesla, Znepole, Tran	Serbia Montenegro & Bulgaria
19	East Serbia	Serbia Montenegro, Bulgaria & Romania
21	Upper Pannonian/Lower Pleistocene	Serbia Montenegro & Romania
22	Middle Sarmatian/Pontian GWB	Romania & Moldova
23,24	Sarmatian, Upper Jurassic/Lower Cretaceous GWB	Bulgaria & Romania
25	Vjosa/Pogoni	Albania & Greece
26	Mourgana	Albania & Greece
27	Prespes	Albania, Greece & Former Yugoslav Republic of Macedonia
28	Galicica	Albania & Greece
29	Pelagonija/Florina catchment	Former Yugoslav Republic of Macedonia & Greece
30	Gevgelija	Former Yugoslav Republic of Macedonia & Greece
31	Lake Dojran	Former Yugoslav Republic of Macedonia & Greece
32	Sandansky-Petrich	Bulgaria, Greece & Former Yugoslav Republic of Macedonia
33	Gotze Delchev/Agistro-Orvilos	Bulgaria & Greece
34,35	Nastan-Trigrad, Smolyan	Bulgaria & Greece
36,37	Rudozem, Erma Reka	Bulgaria & Greece
38	Svilengrad/Orestiada/Edirne Aluvion	Bulgaria, Greece & Turkey
39	Meric/Evros Aluvion	Turkey & Greece

Figure 2 Interaction between surface and groundwater flows near an interstate boundary (UNESCO/ISARM, 2001).

5. Conclusions

6. References

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