


The UNESCO IHP's Shared Aquifer Resources Management Global Project

Alice Aureli

Abstract: Groundwater contained in aquifer systems represents the most significant as well as the safest source of drinking water. Since the late sixties UNESCO's International Hydrological Program (IHP) has devoted particular attention to these systems. The IHP is UNESCO's programme on water resources management, research, education and capacity building and is also the only intergovernmental water sciences programme within the UN system. The launching of the current phase of IHP (2008-2010), entitled: 'Water Dependencies: Systems under Stress and Societal Responses' coincides with the emergence of a profound paradigm shift in society's approach towards water. The IHP thus seeks to address links between the systems under stress and the societal responses to these stresses. In addition, with water now given high profile on the international circuit and the number of current political issues surrounding the sharing of water resources, IHP gives substantial attention to the wise sharing of transboundary aquifers. The studies conducted by the programme have demonstrated that significant quantities of groundwater resources can be found in transboundary aquifers in each of the regions of the world. In the coming years several regions will be facing severe water scarcity conditions and as a result competition for these shared resources could increase and become a source of conflict. In 2002, following the recommendation of Member States, UNESCO-IHP launched the International Shared Aquifer Resources Management project (ISARM) to conduct a worldwide inventory and assessment of these systems and to develop wise practices and guidance tools concerning their management. In this paper an overview of the UNESCO-ISARM initiative is given followed by a description of the project's results as well as recent developments.

Keywords: ISARM, transboundary aquifer, UNECE, basin boundary, IGRAC

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Riassunto: Le acque sotterranee contenute nei sistemi acquiferi rappresentano sia la più significativa che la più sicura risorsa di acqua potabile. Dalla fine degli anni sessanta il Programma Internazionale Idrologico dell'UNESCO (IHP) ha rivolto una particolare attenzione a questi sistemi. IHP è il programma dell'UNESCO che riguarda la gestione delle risorse idriche, le risorse in senso stretto, l'educazione e lo sviluppo di capacità e è anche l'unico programma intergovernativo che riguarda le scienze delle acque all'interno del sistema UN.

Il varo della fase attuale dell'IHP (2008-2010), dal nome: "Le dipendenze dall'acqua: Sistemi in condizioni di Stress e le Risposte della Società" coincide con l'emergere di un profondo cambiamento riguardo all'approccio della società nei confronti dell'acqua. L'IHP cerca così di affrontare i collegamenti tra i sistemi in condizioni di stress e le risposte sociali a queste sollecitazioni. In aggiunta, nel caso dell'acqua, attualmente, dato l'alto profilo nel circuito internazionale e le attuali questioni politiche che riguardano la condivisione delle risorse idriche, l'IHP dà una notevole attenzione ad una responsabile condivisione degli acquiferi transfrontalieri.

Gli studi condotti dal programma hanno dimostrato che significative quantità di risorse di acque sotterranee possono essere trovate negli acquiferi transfrontalieri in qualunque regione del mondo. Nei prossimi anni diverse regioni dovranno affrontare gravi condizioni di scarsità di acqua, e, come conseguenza, la competizione per queste risorse condivise potrebbe aumentare e diventare una fonte di conflitto.

Introduction

The UNESCO International Hydrological Programme (IHP) is the only intergovernmental programme of the UN system devoted entirely to water resources. Originally purely scientific in nature, the programme has since become management and policy-orientated, taking into account social, economic, institutional and cultural dimensions. The programme, tailored to the needs of Member States, is implemented in six-yearly phases. The current IHP phase (2008-2010) is entitled: 'Water Dependencies: Systems under Stress and Societal Responses' and is set to be action-orientated and policy-relevant to the benefit of governments and civil society as well as the scientific community. The launching of the new phase of the IHP coincided with the emergence of a profound paradigm shift in society's approach towards the impact of human activities on the environment and subsequently on water resources. In recent years groundwater has become a source of wealth and well-being for a society that shows an increasing need for water. Undeniably if appropriate actions are not taken in time, the deterioration of these resources could generate an unpredictable stress on our society in the years to come. Considering this, in its current phase UNESCO-IHP has intensified the study of groundwater resources on a global scale and is making a particular effort to develop guidelines for the protection and wise use of the aquifers. UNESCO-IHP prepared the *Hydrogeological Map of the*

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World (WHYMAP) to better define the characteristics of the world's groundwater resources on a global scale (Fig. 1) and has also initiated a worldwide inventory of transboundary aquifers. IHP has also successfully contributed to the formulation of strategies for the protection and sustainable management of shared groundwater resources. There is a noticeable lack of international norms on the use and management of transboundary aquifers. IHP has provided technical and scientific advice to the UN International Law Commission (UNILC) in the preparation of the draft articles of a new UN international legal instrument. Significant quantities of groundwater resources can be found in transboundary aquifers in each of the regions of the world. In view of the importance that these systems represent for human development and the natural environment, through such a tool, UNESCO-IHP is able to provide support to countries to improve cooperation and encourage the inclusion of specific provision for transboundary aquifers management within national policy making.

The ISARM global endeavor

The International Shared Aquifer Resources Management project (ISARM) was launched by the International Hydrological Programme of UNESCO in June 2000. Prior to this no global estimation for transboundary aquifers was available. During its 14th Session (23–25 June 2000), the Intergovernmental Council of UNESCO-IHP sought to respond to this knowledge gap by adopting a resolution to launch ISARM, a worldwide inventory and assessment of transboundary aquifers (UNESCO-HP IC Resolution XIV-12), im-

plemented in cooperation with a wide number of organizations. The main partner of the project is the International Association of Hydrogeologists (IAH). Other partners include the UN Food and Agriculture Organisation (FAO), UN Economic Commission for Europe (UNECE), International Network of Water-Environment Centres for the Balkans (INWEB), International Groundwater Resources Assessment Centre (IGRAC), UN Economic and Social Commission for West Asia (UNESCWA), GEF (Global Environment Facility), Organisation of American States (OAS), and the African Ministers Council on Water (AMCOW). This programme has launched a number of global and regional initiatives, designed to delineate and analyze transboundary aquifers and aquifer systems and encourage riparian states to work cooperatively toward mutually beneficial and sustainable shared groundwater resources management.

The sustainable and equitable use of groundwater resources contained in transboundary aquifers requires a full understanding of the characteristics of aquifers (geology and hydrogeology) as well as the clear definition of the related environmental, socio-economic, institutional and legal aspects. On a global scale the sustainable development of transboundary aquifers seems to be hampered by weak social and institutional capacity, as well as poor legal and policy frameworks. This is even further amplified by contrasting levels of knowledge, capacities and institutional frameworks on either side of many international boundaries. While there are good examples of how such issues have been dealt with in the management of international rivers, until 2000 there was no equivalent body of knowledge for the management of shared aquifers.

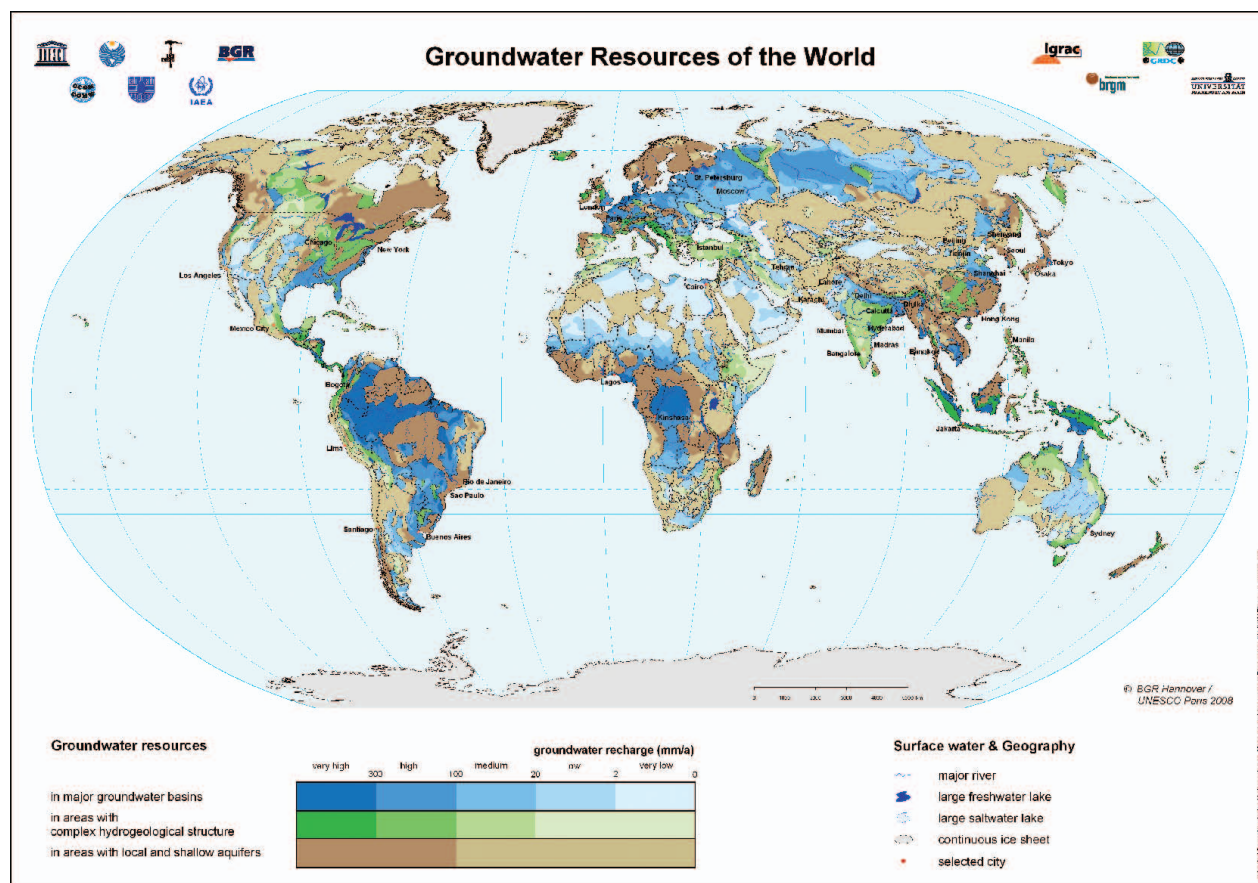


Fig. 1: Hydrogeological map of the world.

UNESCO's ISARM programme includes five focal areas related to the management of transboundary aquifers:

- Hydrogeology
- Legislation
- Socio-economy
- Institutions
- Environment

Hydrogeological characteristics

Formulating adequate guidelines for the management of groundwater quantity and quality is a complex scientific exercise and this is further complicated when dealing with transboundary aquifers. Aquifer boundaries do not often coincide with international river basin boundaries. Very few international political boundaries follow natural physical features of an aquifer, and water resources can cross them unchecked. It is necessary therefore to carefully evaluate the transfer of groundwater flows from one side of the boundary to another (Figure 2). Nevertheless, difficulties frequently arise due to the lack of groundwater monitoring and data. In hydrogeological terms, these crossing resources can only be estimated through effective observation and in situ measurements of selected hydraulic parameters. It is essential to study the characteristics of the entire aquifer or aquifer system (this includes all aquifers that are hydraulically interconnected), directly by lateral contact or indirectly through vertical contact or through fractures and low permeability formations (aquitards). In many cases it is necessary to evaluate the interactions

between surface and groundwaters on both sides of an international border. As shown in Figure 2, groundwater overpumping on one side of the border may lower the water level of a shared surface lake or river or accelerate the sea water intrusion in a coastal zone on the other.

Accurate and reliable information is crucial to facilitate co-operation among aquifer stakeholders. All stakeholders should have easy access to reliable data on abstractions, water quality, and aquifer water levels. Through such an approach it should be possible to establish mutually accepted rules, adopted by all parties, based on a conceptual model definition of the aquifer system and principles of equivalence of impacts of abstraction.

An important contribution to the monitoring of these systems was conducted by UN Economic Commission for Europe (UNECE), which has developed guidelines for the monitoring of such aquifers (UNECE, 2000). These 'Guidelines on Monitoring and Assessment of Transboundary Groundwaters' were prepared by the UNECE Working Group on Monitoring and 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). The guidelines were endorsed by the Parties to the Conventions during their second meeting in The Hague, Netherlands, 23–25 March, 2000. These have since been translated into Spanish by UNESCO and adapted to different regional settings in other continents.

Legal aspects

Despite the increasing importance of groundwater for human development and environmental cycles there is a regrettable lack of political consideration for these resources. Many countries do not have legal instruments to regulate and monitor the use of national groundwater resources and furthermore very few bilateral agreements exist to regulate management of transboundary groundwater. Cooperation between countries is of primary importance in order to understand problems, to agree about the underlying causes and to try to develop reliable solutions. Europe is the one region of the world that is better equipped to do this however with regional legal settings on transboundary water resources, including shared aquifers systems. Both the UNECE Convention on the Protection and Use of the Transboundary Watercourses and International Lakes concluded in 1992 and the European Union Water Framework Directive of 2000 (expanded in 2006 to the daughter directive dealing with groundwater resources) provide the member countries with recommendations and a set of rules and regulations on the use and management of these systems in which the environmental protection regulations are particularly strict. Many other regions of the world do not have the same institutional capacity.

Whilst provisions on groundwater can be found in many binding and non-binding legal instruments mainly addressing surface water resources, there is the need to deal comprehensively with transboundary aquifer systems by taking into consideration their specific characteristics. A comprehensive institutional response to acknowledged transboundary aquifer management problems has not yet emerged. There are no institutions that compare to such bodies as the Rhine Commission or the Chad Basin Commission. Multilateral finance agencies have barely begun to include groundwater in basin-wide projects. Shared groundwater tends to be considered as part of a river basin commission mandate however, groundwater cannot be subject to the same type of controls that govern flows in shared watercourses.

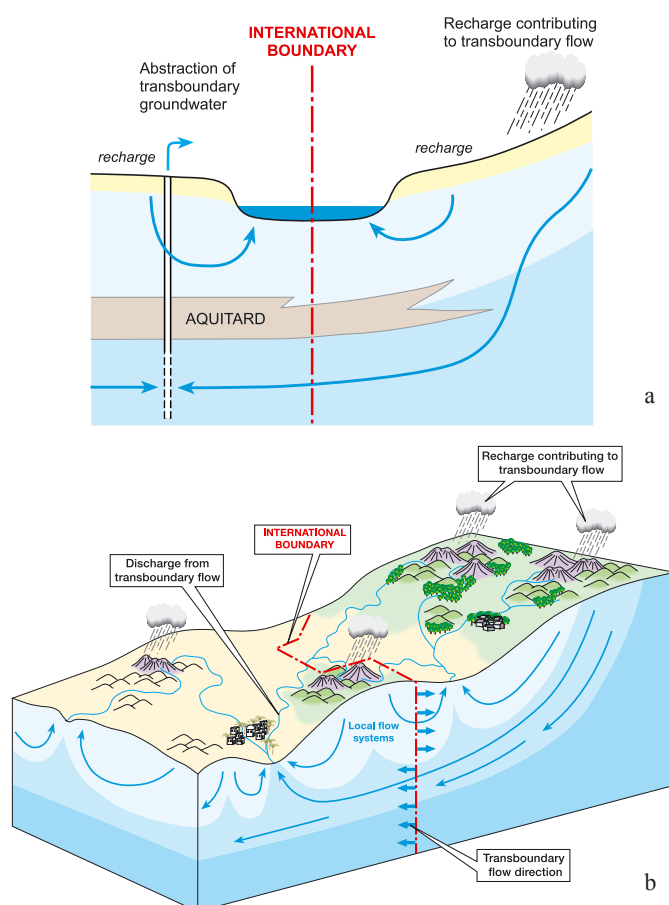


Fig. 2a, b: Interaction between surface and groundwater flows near an international boundary (UNESCO/ISARM, 2001).

While competition for the visible transboundary surface waters (rivers, lakes etc...) is already evident across the continents, competition for groundwater resources has only just begun. UNESCO-IHP is cooperating with the countries sharing groundwater resources to better define the challenges related to the management of these resources. Education and cooperation is at the root of our changing approach to the peaceful management of transboundary aquifer systems. Cooperation between countries has to be improved and water-related conflicts prevented. The UNESCO-IHP ISARM programme, in coordination with other UN agencies, is today looking to set up educational tools and incorporate clear mechanisms for conflict prevention as a prerequisite for effective long-term transboundary aquifers management.

As mentioned earlier, despite the importance of transboundary aquifers and the increasing dependency on them for water resources, they have, until recently, received little attention in international law. While regulations for transboundary surface waters are quite well developed, this is still not the case for transboundary groundwaters. Yet, in 2002, the UN International Law Commission (UNILC) in charge of the codification and progressive development of international law added the topic of Shared Natural Resources to its programme, dividing it into three sub-topics: transboundary groundwaters, oil and gas. The UNILC Special Rapporteur, Ambassador Chusei Yamada, decided to adopt a step-by-step approach, choosing to commence with the first topic, 'transboundary groundwaters'. Upon his invitation, UNESCO-IHP was given the opportunity to cooperate with the UNILC to provide scientific and technical advice on issues related to transboundary aquifers. UNESCO coordinated the contributions of international experts, as well as international, regional and national institutions. The experts invited reiterated the need for the formulation of a flexible and open international legal instrument that would contribute to raising awareness, provide scientific criteria and increase the possibility of transboundary groundwater governance being included on the agendas of the Member States, encouraging them to negotiate regional agreements.

In August 2008, following their submission to the United Nations General Assembly (UNGA), the draft articles on the law of transboundary aquifers were adopted at second reading. The governments concerned considered the subject to be of major importance and as a result the Resolution on the Law of Transboundary Aquifers (A/RES/63/124) was adopted by the UNGA in December 2008. This event marks an important step forward in the development of international law. The UNGA draft annexed the articles on the law of transboundary aquifers to the resolution, and commended them to the attention of governments. With a view to examining, *inter alia*, the question of the form that might be given to the draft articles, the UNGA included an item entitled 'The law of transboundary aquifers' in the provisional agenda of its 66th Session. While the resolution is non-binding, it does constitute a step forward in the progress of international water law on transboundary aquifers and represents a reference for Member States, as well as for water experts and managers offering guidance in reaching agreements on the sharing of transboundary aquifers. It encourages the Member States concerned to make appropriate bilateral or regional arrangements for the proper management of their transboundary aquifers, taking into account the provisions of the annexed draft articles.

ISARM Inventory

Since the launch of ISARM, UNESCO-IHP and its partners have carried out a number of regional activities related to transboundary aquifers, including the preparation of an inventory of around 273 transboundary aquifers (2002-2009). This number is comparable to that of the international water basins inventory (Wolf, 2002), and is set to increase in future years through ISARM's on-going investigations in particular in Asia and Africa. One of the essential steps in the preparation of the inventories was the need for some degree of standardisation to enable comparisons and distinctions to be made across regions. While not prescriptive, such standardisation is often difficult to achieve given the diversity of aquifer types.

ISARM of the Americas

The regional initiative for the American hemisphere, (Fig. 3) the ISARM-Americas Programme jointly coordinated by the UNESCO-IHP and the Department of Sustainable Development of the Organization of American States (DSD/OAS), is a successful example of collaboration. Indeed it has been suggested that the methodology employed for the region should be replicated in other regions. The Programme is implemented at a country level by National Focal Points designated both by the IHP National Committees and by the Focal Points of the Integrated Water Resources National (IWRN). Since the start of the activities in 2003, the Programme has established a network of National Coordinators, which represents almost all the countries in the American hemisphere. Through the first phase, the ISARM of the Americas project collected data con-

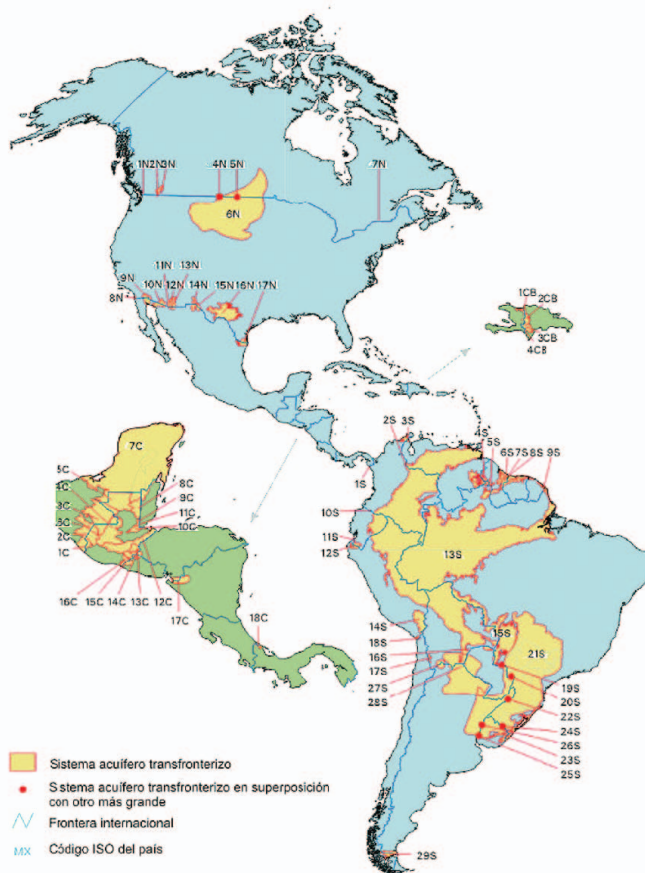


Fig. 3: Transboundary aquifers in the Americas

cerning the hydrogeological characteristics of major transboundary aquifers and their usage. A total of 73 transboundary aquifers were identified: 30 located in South America, 18 in Central America, 21 in North America and 4 in the Caribbean. Evaluations demonstrated that some of the most important aquifers in South America are transboundary systems. The second phase assessed the institutional and legal frameworks of transboundary aquifers in the region, while the third phase focused on the sustainable socio-economic and environmental aspects of transboundary aquifers for which results should be published in 2010. The close cooperation between country representatives has allowed for the preparation of the first comprehensive continental assessment of transboundary aquifers with the result of providing valuable tools to decision-makers of the region for the improvement of understanding and management of these resources. Indeed, the cooperative and participative process undertaken under the ISARM Americas project was critical to its success.

The most well known example of a transboundary system in the region is the Guarani aquifer which underlies portions of Argentina, Brazil, Paraguay and Uruguay and represents not only one of the largest aquifer system of the world but also the most important aquifer system of the southern portion of the South-American continent. It is associated with a set of predominantly sandy sedimentary rocks of the Paraná Basin (Brazil and Paraguay), the Chaco-Paranaense Basin (Argentina) and the Northern Basin (Uruguay). The aquifer system units were previously known in each country under different names: Misiones in Argentina and Paraguay, Botucatu and Pirambóia in Brazil, and Tacuarembó in Uruguay. The current name was chosen in honor of the Guarani, an indigenous people who inhabited the area overlying the aquifer. In the 2003, the Global Environmental Facility (GEF) launched a project that was a pioneering initiative in world terms which demonstrated the benefits of cooperation between countries. Such close cooperation has given rise to a better understanding of the aquifer and its behavior. Moreover the effective integration and cooperation at technical and diplomatic levels provided the necessary safeguards to ensure the coordinated management of the system and as well as generating a framework for regional cooperation.

ISARM Africa

In Africa groundwater represents a strategic source of freshwater with some of the regions in the continent depending entirely or almost entirely on groundwater. In Southern Africa, in particular, groundwater is likely to be the key resource needed to improve the water supply coverage of many areas (Fig. 4). Despite the aquifer resources in Africa being to a large extent transboundary and shared between two or more countries, there is a scarcity of regional hydrogeological information and gaps in the understanding of the role of groundwater. A total of 40 transboundary aquifers have been noted to date. ISARM activities are still ongoing and aim at establishing sub regional inventories and networks of experts. Close cooperation is being established with the African Minister Council on Water (AMCOW), which will further improve collaboration on this project.

ISARM Western and South East Europe

The inventory of Western and Eastern Europe transboundary aquifers has been carried out in cooperation with the 'Convention on the Protection and Use of Transboundary Watercourses and International Lakes' (Helsinki 1992), whose Secretariat is located within the UNECE. The UNECE activity aims to inform, guide and stim-

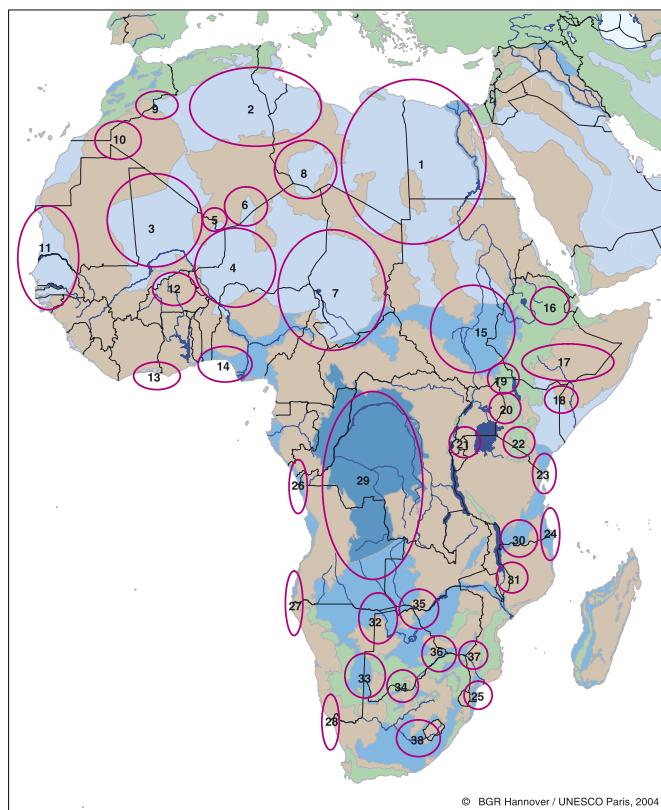


Fig. 4: Transboundary aquifers in Africa

ulate further action by Parties and non-Parties to the Convention, river basin organizations, international organizations and relevant non-governmental organizations (Fig. 5, 6).

The ISARM activities in South East Europe began in March 2004 with consultations between UNECE, UNESCO-IHP, UNESCO Chair/INWEB and the Global Water Partnership Mediterranean (GWP-MED) Secretariat in Athens, the aim of which was to coordinate two separate ongoing activities concerning internationally shared surface and groundwaters. One of the advantages of the coordinated action was that both studies could be prepared by the same team of national experts, most of whom are members of UNESCO Chair/INWEB. ISARM-South EST Europe covers Greece, Albania, Bulgaria, FYR of Macedonia, Romania, Slove-



Fig. 5: Transboundary aquifers in south east Europe

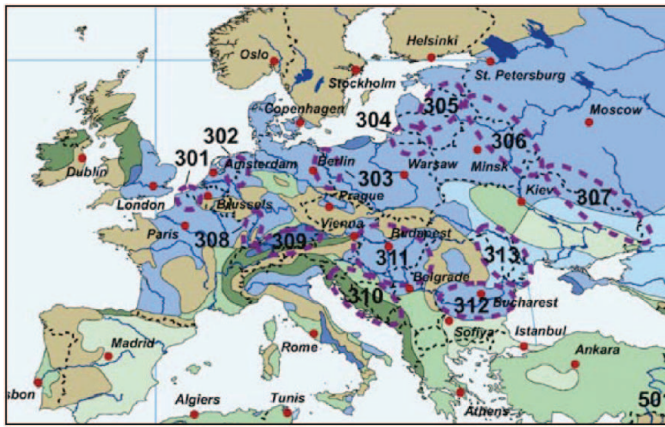


Fig. 5: Transboundary aquifers in western Europe.

nia, Croatia, Serbia, Bosnia and Herzegovina and Turkey. 40 transboundary aquifers have already been noted and detailed studies are still ongoing.

ISARM Asia

UNESCO-IHP, in collaboration with the Geological Survey of China, has undertaken the inventory of transboundary aquifers in the region. An initial volume containing the preliminary results of the inventory with special emphasis on China has been published. Twelve transboundary aquifer systems have been identified and appear in the map (Fig. 7). A second volume will be published in 2010.

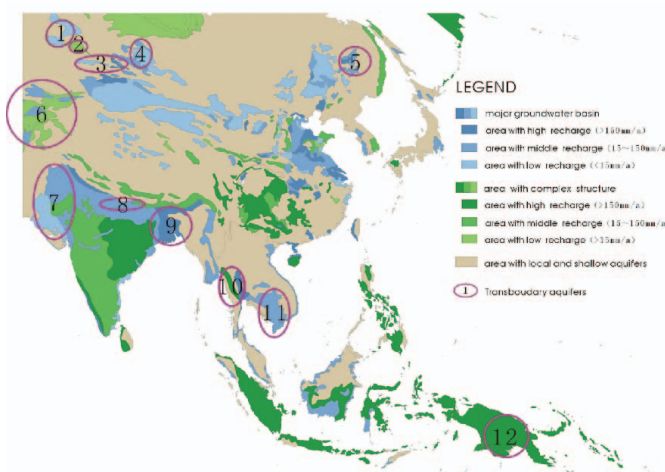


Fig. 7: Transboundary aquifers in Asia

Conclusions

The UNESCO ISARM project is the first worldwide attempt to undertake an inventory of transboundary aquifers in all continents and to set up criteria for the sustainable management of these systems. It aims at facilitating cooperation amongst countries sharing these aquifers. Legal and institutional components have been successfully introduced to provide sound recommendations for coordinated actions and planning. The project wishes to support the countries to promote the joint management of internationally shared aquifer resources through the setting up of joint institutions, common monitoring networks, information and data sharing as well as a common vision for their sustainable development. Regional partnerships and

networks involving decision makers, different scientific disciplines, and stakeholders are important driving forces behind the promotion of innovative approaches and the development of effective action plans. UNESCO's global ISARM project has collected a complete set of data on the transboundary aquifers of the planet, formulated methodological approaches and demonstrated how multidisciplinary can contribute to sustainable transboundary aquifers management. A milestone in the sustainable management of transboundary aquifers was set in December 2008 when the UN General Assembly, considering the importance for humankind of life-supporting groundwater resources in all regions of the world, adopted the Resolution on the Law of Transboundary Aquifers, (A/RES/63/124), including the set of draft articles containing technical and scientific recommendations as an annex. The resolution encourages Member States sharing an aquifer to consider these recommendations, and to make appropriate bilateral or regional arrangements for the proper management of their transboundary aquifers. In adopting the resolution, the UNGA affirmed the importance of international cooperation in this field and emphasized the need to take into account the particular situation of developing countries.

More details and useful links can be found in ISARM website, hosted by IGRAC, <<http://www.isarm.net>>.

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