



Internationally Shared Aquifer Resource Management ISARM AMERICAS

DRAFT (Rev 1)

Overview and suggested Next Steps for discussion at the Montevideo Meeting 24th & 25th September 2003

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1. Introduction & background

The ISARM Americas Programme is a collaborative effort of several agencies that have come together to support and promote the sound use and management of transboundary aquifer resources. This Note has been prepared as background for the forthcoming milestone Workshop to be held in Montevideo from the 24th to 25th September 2003. The workshop is a culmination of substantial effort expended by the Organisation of American States (OAS), UNESCO-Latin America and UNESCO-Paris. It follows upon the wide circulation by the Workshop Organisers of preliminary questionnaires regarding the prevalence of transboundary aquifers in Member States. The response by Member State Focal Points to date has been overwhelming and it is expected that as a result, the Workshop will provide an excellent forum for discussion and planning the Next Steps needed for the ISARM AMERICAS Programme. In addition to setting out the background to the worldwide ISARM Programme this Note also sets out some of the strategic issues that are being addressed or will be addressed in other ISARM Programmes e.g. in Africa, Middle East, Europe and Asia. Participants to the Workshop are encouraged to provide their input to developing the Next Steps.

2. Overview of transboundary aquifers in international water

Through the mid '80's and late '90's the issues concerning the management of transboundary aquifers were hardly in the forefront of scientific and political discussion in contrast to those concerning transboundary rivers (Naff & Matson 1984, Bourne 1992, Van Dam & Wessel 1993). Much political and technical discussion, usually associated with the Middle East Region was dedicated to reduction of the potential for conflict. In fact some of the discussions then suggested that future wars might be fought over the issues of shared waters, agreed now that this is not necessarily the case. Unfortunately these discussions never took sufficient account of the fact that very large quantities of freshwater resources are held in aquifers – many of the world's largest aquifers (e.g. the Rum-Saq, the Nubian and the North Sahara Aquifer System) underlie precisely the regions where shortage, indeed absence of surface water, was the driving force for concerns on security.

It would appear that although the earliest serious concern about the significance of transboundary aquifers arose in the case of the United States-Mexico border regions as far back as 1977, it was in 1987 that the lessons and experiences from this region were somewhat generalised in the so called 'Bellagio Draft Treaty'. This document was presented to a Special Session of the Sixth Congress of the International Water Resources Association (Ottawa, May 1988) and resulted in a publication by Hayton & Utton (1989), which contains the model treaty in twenty articles. Among the preamble paragraphs of the model treaty, there is a key one that states, "Noting especially the present unsatisfactory state of protection and control of their transboundary groundwater as well as the prospects of crisis conditions in some areas because of increasing demands upon, and the decreasing quality of, those groundwaters". This sets the stage for the need for aquifer treaties. The Article II in the draft treaty recognizes the common interest and responsibility of the Parties in ensuring reasonable and equitable development and management of groundwaters in the border region, which is defined as an area approximately XX km's from each side of the mutual boundary. These two issues probably reflect the specific situation of the US-Mexico shared aquifers and cannot directly be generalized to the huge number of diverse transboundary aquifers in the World.

3. Groundwater in international water law

In recognition of the importance of transboundary waters the UN International Law Commission began work on the drafting of a convention related to it. After 27 years of work, the 1997 Convention, formally known as the 'Convention on the Law of Non Navigational Uses of International Watercourse', was adopted by the UN General Assembly. However it has still not entered into statute in 2003 because the requisite numbers of countries have not so far ratified it. In 1966 the International Law Association, a Non Governmental Organisation also recognising the importance of groundwaters developed the Helsinki Rules that were devoted to surface and groundwaters that flow to a common terminus. As these Rules did not fully address the peculiarities of groundwater flow, in 1986 the ILA also developed the Seoul Rules. The Seoul Rules demonstrate special concern with international groundwater through the provision of specific articles that relate to "hydraulic interdependence", "protection of groundwater" and "groundwater management & surface waters" the latter addresses the issue of conjunctive use. One of the difficulties of all of the above attempts to legislate on aquifers is their diverse nature and their astonishing heterogeneity, making rigid legislative classifications undesirable to hydrogeologists. Consequently hydrogeologists, generally not well versed either in international law or in politics have been notoriously reluctant to engage in this debate. As a result many significant issues in the sound management of transboundary aquifers have not received the degree of attention due to them until the start of the current Millennium (see for example Mechlem 2003).

4. IAH & UNESCO actions to promote awareness

In recognition of the gap in the debate surrounding transboundary water resources and the fact that significant aquifers of the world are of a transboundary nature, the International Association of Hydrogeologists (IAH) accepted a proposal put forward following its Nottingham Congress in 1997 to establish a Commission. The Minutes of the IAH Council meeting¹ record item 14 as follows "The President introduced a proposal initiated by S Puri (UK), following discussion in Nottingham in 1997, for an IAH Commission on the problems and issues of transboundary aquifers. It was thought that, with the present international political profile of water and the number of current political issues surrounding the sharing of water resources, insufficient attention was being given to the problem of transboundary aquifers and that work by IAH could help to focus this. Council were invited to approve the formation of this Commission under the leadership of Mr Puri and, with the help of UNESCO, to launch its work at the UNESCO sponsored meeting in Libya in November 1999". The proposal was approved unanimously and the work of the IAH Transboundary Aquifer Resource Management Commission (TARM) began with the mobilisation of scientific opinion at the Tripoli (L) Symposium (November 1999) devoted to Regional Aquifer Systems. A further impetus was given to the scope of the work of the TARM Commission following the Hague Ministerial Declaration at the 2nd World Water Forum (March 2000).

The IAH initiative on TARM coincided with developments in the UNESCO IHP Programme. Under the VIth Phase of IHP (2002 – 2007), entitled 'Water Interactions: Systems at risk and Social Challenges'. Five themes were established – with theme 2 devoted to integrated watershed and aquifer dynamics. One of the focal areas of this theme was devoted to international river basins and aquifers. The rationale for developing this focal area was stated as, "*The basin scale is appropriate for comparing water resources (precipitation, groundwater, surface water) and water use or water demand (domestic, industrial, agricultural). It is the natural scale for hydrological processes but it is also a relevant approach for landscape and land use mapping because of the topographically-driven organization of the watershed. The evaluation of water resources at the basin scale needs to combine data from various sources. However, the problem is more complicated for the water demand which is often evaluated at administrative scales. Mechanisms that govern water demand are not well outlined and relevant parameters are yet to be suggested.*" Taking note of the rationale of this focal area and recognizing the wider value of transboundary aquifers, the Scientific Panel established by UNESCO concluded that a major international initiative was justified.

5. Establishment of the ISARM Programme

Additional preparatory work by UNESCO & IAH, through consultation and partnership with other agencies such as FAO, ESCWA and UN ECE, resulted in the preparation of a project whose logical framework is shown in Annex I. The activities

¹ NOTES OF THE MEETING OF IAH COUNCIL HELD AT THE XXIX CONGRESS OF IAH IN BRATISLAVA, SLOVAK REPUBLIC ON 5 SEPTEMBER 1999 BEGINNING AT 11.00 HRS.

carried out resulted in the submission of a Resolution to the 14th Session of the Inter Governmental Council of IHP (June 2000), by the Representatives of the Government of Argentina as follows:

Recognizing	that transboundary aquifer systems are an important source of fresh water in some regions of the world, particularly under arid and semi-arid climatic conditions,
Also recognizing	that due to a lack of reliable scientific knowledge and information conflicts may arise,
Recalling	that at the fifth UNESCO/WMO International Conference on Hydrology (Geneva 1999) concern was raised on the lack of monitoring and assessment of the key aquifer resources,
Noting	that the Tripoli Statement of November 1999 and the Ministerial Declaration of The Hague (March 2000) drew attention to the problems of managing shared water resources,
Endorses	the recommendations of the experts meeting organised by UNESCO and IAH in co-operation with FAO and UN/ECE (UNESCO, Paris 27-28 March 2000),
Decides	to launch an inter-agency initiative to promote studies in regard to transboundary aquifers (TARM) ,
Requests	the Director-General of UNESCO to take necessary actions to conclude a Memorandum of Understanding with UN/ECE and FAO,
Invites	Member States to facilitate regional co-operation and provide their support to this initiative,
Encourages	UN Agencies to provide their support and funding institutions to contribute financially to this initiative.

The above Resolution was adopted by a vote of 143 countries in favour, authorizing the UNESCO IHP Programme component that was renamed Internationally Shared Aquifer Resource Management (ISARM). The Council also decided to endorse the UNESCO-FAO-IAH-UNECE inter-agency initiative to promote studies in regard to transboundary aquifer systems.

6 Accelerating global interest in ISARM

Between the 14th and the 15th Sessions of the Inter Governmental Council (June 2002), work activities of the ISARM/TARM Programme accelerated considerably and are listed in brief:

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.

An International Workshop was 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. (Proceedings of the Conference are in press)

A proposal for the study of the lullemeden aquifer was prepared and submitted to GEF for financing through the support of UNEP. (GEF approval was confirmed in July 2003)

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, with the aim of launching the inventory of transboundary aquifer systems in Latin America.

-XXII Brazilian Congress on Groundwater organized in Florianópolis from 10 to September 13, 2002 requested the participation of ISARM experts

The IAH Congress at Mar de Plata (October 2002) established the ISARM Americas Programme with the OAS as the lead agency, working with the UNESCO IHP Programme.

ISARM Arab States

A project proposal on the "Sustainable Management and Protection of Internationally Shared Groundwater Resources in ISARM-Americas, Overview & suggested 'next steps' for discussion at Montevideo Workshop

the Mediterranean Regions" was 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 setting out the key components of the ISARM Programme and establishing the expert network for the region.

The above abbreviated summary of the establishment of ISARM sets the stage for the OAS-UNESCO supported programme for Americas.

7. Significance of transboundary aquifers

A Framework Document (Puri 2001, Ed) on ISARM sets out the full outline of the principal issues concerning transboundary aquifers. The purpose of the Framework Document is to summarise the current understanding of transboundary aquifers, demonstrate their significance in water resource management and to highlight the fact that as yet there is very little international experience in the approaches needed for their shared management. Unlike transboundary surface water and river basins, transboundary aquifers are not well known to policy makers. Present International Law does not adequately address the issues concerning 3-dimensional spatial flow of ground waters and has limited application in conditions where impacts from neighbouring countries can be subtle to develop, because groundwater movement is slow compared to surface waters (see e.g. Yamada 2003). Scientific correlation of the hydrogeology of such aquifers is often deficient and issues related to shared, sustainable production remain blurred because of poorly developed institutions and a lack of capacity and awareness. The ISARM Programme seeks to address these issues.

The significance of transboundary aquifers as a key resource has been further emphasised through the recent publication of the World Hydrogeological Map (IAH 2003), from which the South American Continent has been extracted, shown in Figure 1. Complete analysis of the number of aquifers that are transboundary has not been completed to date – however by analogy to the 261 transboundary rivers basins of the world, it is clear that a similar number, if not greater aquifers are shared by nations. Almost 40% of the world population lives in one or another transboundary water resources region... In Europe alone 90 have been identified (Almassy 1999). A further confirmation of the wide distribution of transboundary aquifers can be gauged by the knowledge that there is a significant predominance of accessible freshwater from aquifers (over 90%) than from other sources. Groundwater is the water resource of critical importance for poverty alleviation, as it can be provided cheaply and usually nearest to the point of demand.

Aquifers systems, due to their partial isolation from surface impacts, on the whole contain excellent quality water. In many countries these systems have been fully evaluated and extensively used for municipal and other demands. Such resources represent a substantial hidden global capital that still needs prudent management. Competition for visible transboundary surface waters, based on available international law and hydraulic engineering is evident in all continents. However the hidden nature of transboundary groundwater and lack of legal frameworks invites misunderstandings by many policy makers. Not surprisingly therefore, transboundary aquifer management is still in its infancy, since its evaluation is difficult, suffering from a lack of institutional will and finance to collect the necessary information. Although there are fairly reliable estimates of the resources of rivers shared by two or more countries, no such estimates exist for transboundary aquifers (World Bank 2000). One of the drivers of the ISARM Programme is to support cooperation among countries to develop their scientific knowledge and to eliminate potential for conflict, particularly where conceptual differences might create tensions. ISARM aims to contribute to the improvement of the scientific knowledge on internationally shared aquifers and their risk based management, providing a framework for regional and scientific cooperation. It aims to educate, inform and provide inputs for policies and decision making, based on good technical and scientific understanding.

8. Regional Initiatives: the UN ECE environmental conventions

A regional initiative in the management and monitoring of transboundary aquifers arose from the significant developments achieved by the UN Economic Commission for Europe (UN ECE) through the promotion and adoption of the guidelines and recommendations relating to Europe's environment. With the geopolitical changes that took place in Europe between 1990 and 1995, the membership of the ECE increased from 34 to 55 countries. The environmental legacies of past ISARM-Americas, Overview & suggested 'next steps' for discussion at Montevideo Workshop

inactions in the Former Soviet Union and East Europe were the driving forces behind the interest of States to improve their environment. As much of the environmental issues closely related to transboundary waters, a Convention on Protection and Use of Transboundary Water Courses and Inland Lakes was signed in 1992 and has been in force since October 1996. Arising out of these concerns the ECE also issued guidelines on water quality monitoring and assessment of transboundary rivers in 1996. Again the focus of attention was on surface waters until the year 2000, when following an agreed work plan, monitoring guidelines related to groundwaters were also prepared. In the course of this work a pioneering inventory of European transboundary aquifers was completed (Almassy & Buzas 1999), forming volumes 1 of 4, which also include "Problem oriented approach and the use of indicators", "Application of Models", and "State of the art on Monitoring and Assessment of groundwaters". These four volumes provide a good basis to extend the lessons learnt to other regions in the World. Consequently other Economic Commissions notably ESCWA and ECA are developing their regional approaches to transboundary aquifers.

9. Transboundary aquifers and social development

There is a linkage between water resources of transboundary aquifers and social development. All recent international fora devoted to water resources e.g. the WSSD in Johannesburg, the World Water Forum in Kyoto and the Dushanbe Fresh Water Forum, have stressed that human survival may be at stake if sound management of water resources is not given priority. Thus the contribution of transboundary aquifers to society and its security must be seen in the context of their contribution to the environment, human, natural and the built environment.

In this context 'aquifers and rivers' need to be considered as a unitary system – the dry season baseflow of many rivers is provided from transboundary aquifers. Large numbers of poor people in Africa, South America, and Asia, rely directly on transboundary water resources for their subsistence. The 'water poor' in the transboundary aquifers context are those impacted by:

- Persistent threat to their natural livelihood base by severe drought or flood;
- Dependence of livelihood on cultivation of food or gathering of natural products of transboundary waters;
- Excess pumping resulting in greater drawdowns, and increased costs to the poor in terms of power;
- Contamination of transboundary water resources, and inability to afford to use, or have no access to, an alternative source;
- Vulnerable people who spend several hours a day collecting potable water, and whose security, education, productivity, and nutritional status is thereby put at risk;
- Those living in areas with high levels of water-associated disease (bilharzias, guinea-worm, malaria, trachoma, cholera, typhoid, etc.) without means of protection;

To date social assessment for poverty alleviation in the context of transboundary water resources are rare. The inter relationship between integrated water resource management (IWRM) and poverty has not generally been recognised, as might be noted from the lack of reference to 'water-poverty' in many PRSP's².

10. Programmes related to ISARM

Several programmes associated with ISARM have started and an important initiative has been taken by the Government of Libya, which has proposed the establishment of a Regional Centre for Africa, under the auspices of UNESCO & WMO. This proposal was adopted by the IHP Inter Governmental Council at its 15th Session.

Noting	i) that water scarcity in most countries implies a serious threat to sustainable and balanced socio-economic growth, ii) the increasing dependence on groundwater resources and in particular the development of
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² PRSP – Poverty Reduction Strategy Papers
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	shared groundwater resources, which require more emphasis on their study and assessment,
Acknowledging	that for more than three decades Libya has been very active in cooperating with neighbouring countries for establishing joint management regulations with the assistance from international organizations and at present all shared aquifers in Libya are being subject of management through joint commissions, bilateral and multilateral committees and joint regional study projects,
Noting with satisfaction	that Libya proposes to create and to host in Tripoli an International Centre for the Management of Shared Groundwater Resources under the auspices of UNESCO with the aim of: i) coordinating with IGRAC, ii) assisting countries to implement joint management through the strengthening of their respective institutions, building capacities, raising awareness, encouraging investment and supportive legal frameworks, iii) conducting inventories of shared aquifers following the guidelines of the ISARM framework document, iv) preparing policy guidelines for sound and sustainable development of shared aquifers,
Requests	UNESCO's assistance in preparing the documentation to be submitted to the governing bodies of UNESCO towards the implementation of this Centre according to 21 C/36 Section B(ii),
Invites	Member States and in particular the existing UNESCO networks which address groundwater issues, especially at the regional level, to lend active support to the proposed Centre.

11. Case Studies Programmed

A number of Case Studies have been programmed under the ISARM Programme. These are activated through the participation of national expert teams working together to formulate the concepts, develop technical proposals and submit them for financing to appropriate agencies. The current list of potential case studies includes the following, though the list is not yet comprehensive.

Proposed case Study under ISARM	Comments	Timetable
Management of Hydrogeological Risks in the Mediterranean Wetlands	project proposal in preparation	End 2003
Management of Hydrological Risk in the Chad Aquifer System (Cameroon, Libya, Niger, Nigeria, Chad, Sudan)	Requested by the Lake Chad Commission	End 2003
Kalahari Aquifer System (Botswana, Namibia, Angola & Zaire)	Draft MSP has been prepared by SADC and submitted	
Managing Hydrogeological Risk in the lullemeden Aquifer System (Algeria, Mali, Niger, Nigeria)		approved 2003
Management of the Rum-Saq Aquifer System (Jordan, Saudi Arabia)		by 2005
Management of the Chuy Aquifer (Uruguay, Brazil)	to be prepared during meeting with OAS in Peru - suggest medium priority	mid 2004
Joint Management of the Nubian Aquifer System (Egypt Libya, Sudan, Chad)	Overlaps with IAEA proposal - we should combine both	Late 2003
Management and Risk evaluation of the Great Oriental		2005

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Erg Aquifer System (Algeria, Tunisia)			
Al-Kabeer Al-Janoubi System (Lebanon, Syria)		low priority	end 2005
Regional Assessment and Strategy of Development for the Management of the Shared Aquifers in Latin America - several offers on the table		To discuss with OAS, high priority	aim for 2003 & 2004
European aquifers - Basin of the river Bug - Poland, Belarus, Ukraine - ECE		Intergovernmental MoU awaited	end of 2003
Joint Management of shared Awash Valley sedimentary aquifer resources (Ethiopia, Djibouti)			mid 2004
Joint Management of shared West African Coastal Aquifer Resources (Benin, Ghana, Ivory Coast, Togo)			2005
Joint management of aquifer resources shared between Kenya and Somalia. (Kenya, Somalia)			2004
Regional assessment of transboundary aquifer systems (a) In the African Region (b) In the Near East and North Africa Region (c) In the South Asia Region (d) In the Far East Region (e) In the Latin American Region		awaiting evaluation	2004

12. The development of the ISARM Toolkit

The experience gained from ISARM activities in several regions confirms that there remains a lack of experience in the management of transboundary aquifers, which is in contrast to surface resources. The reviews and analyses conducted by ISARM Experts have also demonstrated that the considerably more complicated nature of aquifers, compared to surface waters, requires a multi disciplinary approach. It has been concluded therefore that there would be considerable value in developing a multi disciplinary 'toolkit' that might consolidate the best practices, guidance and information on transboundary resource management. The multi disciplinary toolkit might form the basis of a management approach that could apply in most transboundary aquifers. A flow chart representing the parallel approach to development of the toolkit is shown in Figure 2 (Puri 2003).

While it is too early for a detailed design of such a toolkit in advance of the completion of the ISARM case studies, it would be worthwhile to set out its main components, as follows:

Toolkit package	Main components
Scientific	Guidance for the development of reliable conceptual models
Legal	Guidance on legal frameworks for negotiation of agreements
Institutional	Guidance on responsibility and powers of institutions engaged in joint management
Socio-economic	Guidance on the current and forecast needs for population, industry, agriculture & environment
Environmental	Guidance on development of an EIA, covering biodiversity, climate change, ethical use

Each package within the toolkit would ensure consistency and equivalence, as relevant to any given transboundary aquifer system. It would enable the 'joint - owners' of the resources to achieve a common platform for each of the focus areas of transboundary aquifers.

13. Next Steps in the ISARM-Americas programme

The workshop to be held in Montevideo between the 24th and 25th September 2003 are aimed at developing the 'next steps' for ISARM-Americas. The following sets out some of the key points that will provide the background. During the ISARM-Americas, Overview & suggested 'next steps' for discussion at Montevideo Workshop

course of the workshop the regional experts will contribute to the discussion and formulate the regional needs.

(i) *Review of developments*

In Latin America and North America there is considerable existing expertise and data base of hydrogeological, hydrological and water resources information. One of the fundamental sources of information will be the Hydrogeological Map of South America (da Franca & Mente 1996) at the scale of 1:5000000. Although this scale is only appropriate for macro level assessment, clearly more detailed national information will also be needed. Considerable progress has been made through the circulation of a preliminary questionnaire to all national focal points that have been established through the cooperation between UNESCO & OAS. Some early summaries of the data collected are presented in Table 1.

Table 1: Preliminary information collected through the questionnaire survey conducted by the ISARM America group (UNESCO & OAS)

Argentina	<ul style="list-style-type: none"> • Bolivia, Paraguay; Noroeste Argentino. Incluye el Norte de la provincia de SANTIAGO DEL ESTERO, Este de las provincias de TUCUMÁN, SALTA y JUJUY, las provincias de CHACO y FORMOSA, Sudeste de BOLIVIA y Sur de PARAGUAY. • Abarca en el subsuelo un área que se relaciona parcialmente con las cuencas de los ríos BERMEJO Y PILCOMAYO. • Su geometría aún debe ser definida. • GUARANI: NO SE CORRESPONDE CON CUENCA HIDROGRÁFICA. Provincias DE Entre Ríos (comprobado). Sin comprobar Corrientes, Misiones, Formosa, Santa Fe. FALTA definición del límite oeste del sistema.
Belize	
Bolivia	
Brazil	
Canadá	
Chile	<p>Bolivia; 21° 30' S 68° 11' W, cuenca del Salar de Ascotán A = 1455 km² (Total), 1.231 km² (en Chile); l = 80 km, P = 85,5 mm Q = 800 l/s Provincia del Loa.</p> <p>Peru; 18° 16' S 70° 03' W, cuenca de la Quebrada de La Concordia A = 700 km² (en Chile); l = 70 km, P = 1.1 mm Q = 150 l/s Provincia de Arica.</p> <p>Bolivia; 21° 12' S 68° 15' W, Cuenca correspondiente a la Depresión cerrada del Salar de Bolivia; Chiguana A = 4.250 km² (total) y 320 km² (en Chile); l = sobre 90 km, P = 101 mm. Q = 300 l/s Provincia del Loa.</p>
Colômbia	
Costa Rica	
Ecuador	<p>Colombia; 00° 37' N a 00° 50'N y 7° 37' W a 77° 55'W, cuenca del Río Carchi, A = 296 km², P = 1138 mm; Q = 5.5 m³/s. Provincia Carchi-Cantón Tulcán.</p>
El Salvador	
Guatemala	<ul style="list-style-type: none"> • Mexico, Belize; Cuencas ríos San Pedro y Hondo de 14,335 y 2931 km²., ver en mapa área 1 Ubicado en el norte del país en el Departamento de Peten

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	<ul style="list-style-type: none"> • Cuenca río Usumacinta de 2638 km²., ver en mapa área 3. Ubicado en el norte del país en el Departamento de Peten • Cuencas ríos Chixoy y Xalcbal de 12,150 y 1,366 km²., ver en mapa área 4. Ubicado en el norte del país en los Departamentos de Peten, Alta Verapaz, Quiché y Huehuetenango. • Cuencas ríos Selegua y Cuilco de 1,535 y 2,366 km²., ver en mapa área 5. Ubicado en el Departamento de Huehuetenango. • Cuencas ríos Coatán y Suchiate de 270 y 1,054 km²., ver en mapa área 6. Ubicado en el Departamento de San Marcos en el occidente del país. • Cuenca río Suchiate de 1,054 km²., ver en mapa área 7. Ubicado en el Departamento de San Marcos • Cuenca río Paz de 1,732 km²., ver en mapa área 8. Ubicado en el Departamento de Jutiapa al suroriente del país • Cuencas ríos Paz, Ostua, Olopa de 1,732, 2,243 y 310 km²., ver en mapa área 9. Ubicado en Departamentos de Jutiapa, Jalapa y Chiquimula del oriente del país. • Cuenca río Motagua de 12,670 km²., ver en mapa área 10. Ubicado en el oriente del país en el Departamento de Izabal • Cuenca río Motagua de 12,670 km²., ver en mapa área 11. Ubicado en el Departamento de Izabal y Zacapa
Guyana	Surinam; the coastal basin, 110000 km ²
Haiti	
Honduras	
México	USA; several, locations to be described
Nicaragua	
Panamá	Costa Rica; Cuenca Binacional del Río Sixaola, Provincia de Bocas del Toro, Distrito de Changuinola, Corregimiento de Guabito.
Paraguay	
Peru	
República Dominicana –	<p>Haiti;</p> <ul style="list-style-type: none"> • 19° N 71° 45' W, cuenca del Río Artibonito, A = 9504 km², l = 134 km, P = 1,250 mm; en 4,143 km² Q = 42 m³/s. Provincias Elías Piña y San Juan de la Maguana. • 19° 35' N 71° 45' W, cuenca del Río Masacre, A = 793 km², l = 62 km, P = 1,500 mm; en 162 km² Q = 3.8 m³/s. Provincia Dajabón. • 18° 05' N 71° 45' W, cuenca del Río Pedernales, A = 362 km², l = 48 km, P = 1,000 mm; en 298 km² Q = 1.6 m³/s. Provincia Pedernales.
Suriname	
Uruguay	
USA	

Venezuela	Colombia; Estados: Táchira, Venezuela Norte de Santander, Colombia. Cuenca del río Táchira, frontera entre Venezuela y Colombia. Del lado venezolano entre 7° 45 y 8° 00 Norte y 72°20 y 72°30 Este
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(ii) *Features relevant to the American Region*

While in pure hydrogeological terms the definition of aquifers and their characteristics are no different from those of any other parts of the world, there are features in resource development that are specific to the region. In North America the technical development of the aquifers is well advanced including their identification, description and management. On the other hand in many regions of South America, development is related to the economy and the national GDP. The range of GDP's across the region is very wide; the human development indicators reflect to a large extent this disparity. In such a region, a single uniform approach to the development of transboundary aquifers will not apply. Therefore the socio-economic and institutional issues will to a large extent drive the identification, description and development strategy. The challenge will consist of ensuring harmonised development of these issues so that the sharing countries benefit from the resources in their aquifers.

(iii) *Phased development of the Programme*

The ISARM Americas programme of work should be phased in several stages. While the scope of work of each stage will require discussion and agreement, some suggestions can be made, as follows:

Stage I: Inventory and preliminary documentation. A good start has been made already with the circulation of the questionnaire. This should be completed as far as possible during stage I of the programme. Further elements of this will include development of criteria that will define the degree of significance of the aquifer system. The methodology should be based on a system of weighted scores, with the weightings applied in the context of each country participating in the programme. Some possible criteria, listed in no particular order of importance, to consider include:

- Available water resources vs. population served, including industrial, agricultural & other demands
- Contribution from the aquifer discharge to base flows and support to aquatic or other bio diversity
- Contribution of aquifer water resource to poverty alleviation
- Cost benefit of development in terms of contribution to economic development

Sub criteria based on the above can be developed as appropriate.

Stage II: Detailed Analysis and Development: once the transboundary aquifers have been prioritised in some manner, as suggested above a more detailed evaluation should be conducted. The Stage II of the ISARM programme suggests a multi disciplinary approach for the detailed analysis of transboundary aquifers. A flow chart representing this is shown in Figure 2 for general guidance. The hydrogeological analysis that is needed for the management of transboundary aquifers should run in parallel and close relationship with the socio-economic, legal and institutional analyses. Unless these components of the activities are closely linked, the inter relationships may not be fully established and the final outcome may be weak. One of the objectives of this Stage of development is to evaluate the extent to which inter regional harmonisation is needed. In certain regions where the shared aquifer underlies communities with different cultural, linguistic and ethnic origins, there could be a substantial variation in the legal and institutional regimes. Work will be required to ensure that these different regimes have common base lines for moving towards compatibility. Stage II does not seek to change national approaches, rather to seek synergies and equivalences.

Stage III: Implementation, Operation & management & monitoring: The sequence of activities in this Stage should be considered in the long term. There are many reasons for this, not least that seeking finances and stakeholder support is ISARM-Americas, Overview & suggested 'next steps' for discussion at Montevideo Workshop

generally a process that must not be hurried. Apart from this, a fundamental reason for this Stage to extend to the long term is that aquifers respond much more slowly than surface water systems. Consequently the management of transboundary aquifers and monitoring are closely linked and have to be viewed in that perspective.

(iv) The need for Case Study based approach

The immense diversity of aquifer 'types' and their configurations suggests that no one uniform approach is likely to apply to all transboundary aquifers. It is clear therefore that Case Studies under different conditions will be needed. As was stated above case studies in different parts of the world have been proposed and are expected to be conducted, with each making a contribution to the 'package' of approaches that can then be transposed. In the case of ISARM-Americas a similar approach is recommended. Case studies should be so selected that each makes a contribution to the overall understanding to the management of transboundary aquifers. While the hydrogeological drivers for the full understanding will be important, more important will be the socio-economics, i.e. the users of the resources, including the demands placed on the aquifers for a sustainable environment, especially where aquifer discharge maintains important habitats.

(v) Strategy for the selection of Case Studies

The suggestions made in this section are subject to discussion and refinement during the Workshops to be held in Montevideo for the ISARM-Americas programme. In advance of the Workshop, some ideas can be formulated to help with the discussion:

In selection of Case Studies the factors that may be used to identify priority transboundary aquifers will include aspects such as:

Persistent transboundary aquifer resource management problems including:

- Poor prediction of aquifer yields on one or either side of the national boundary
- High variability in transboundary aquifer properties and therefore high uncertainties
- Presence of unutilised or under-utilised groundwater resources on or other side of the national boundary
- Conflicting demands for the transboundary aquifer resource – such as between irrigation and industrial uses
- Significant environmental concerns arising from current water management practices
- High likelihood that current transboundary aquifer management practices are depleting the resource, either through over-exploitation or by pollution.

There could be several other criteria applied in selecting the case studies, some of which could be focused on ensuring the study is not unnecessarily over-complicated. The characteristics that will make a transboundary aquifer suitable as a case study could include:

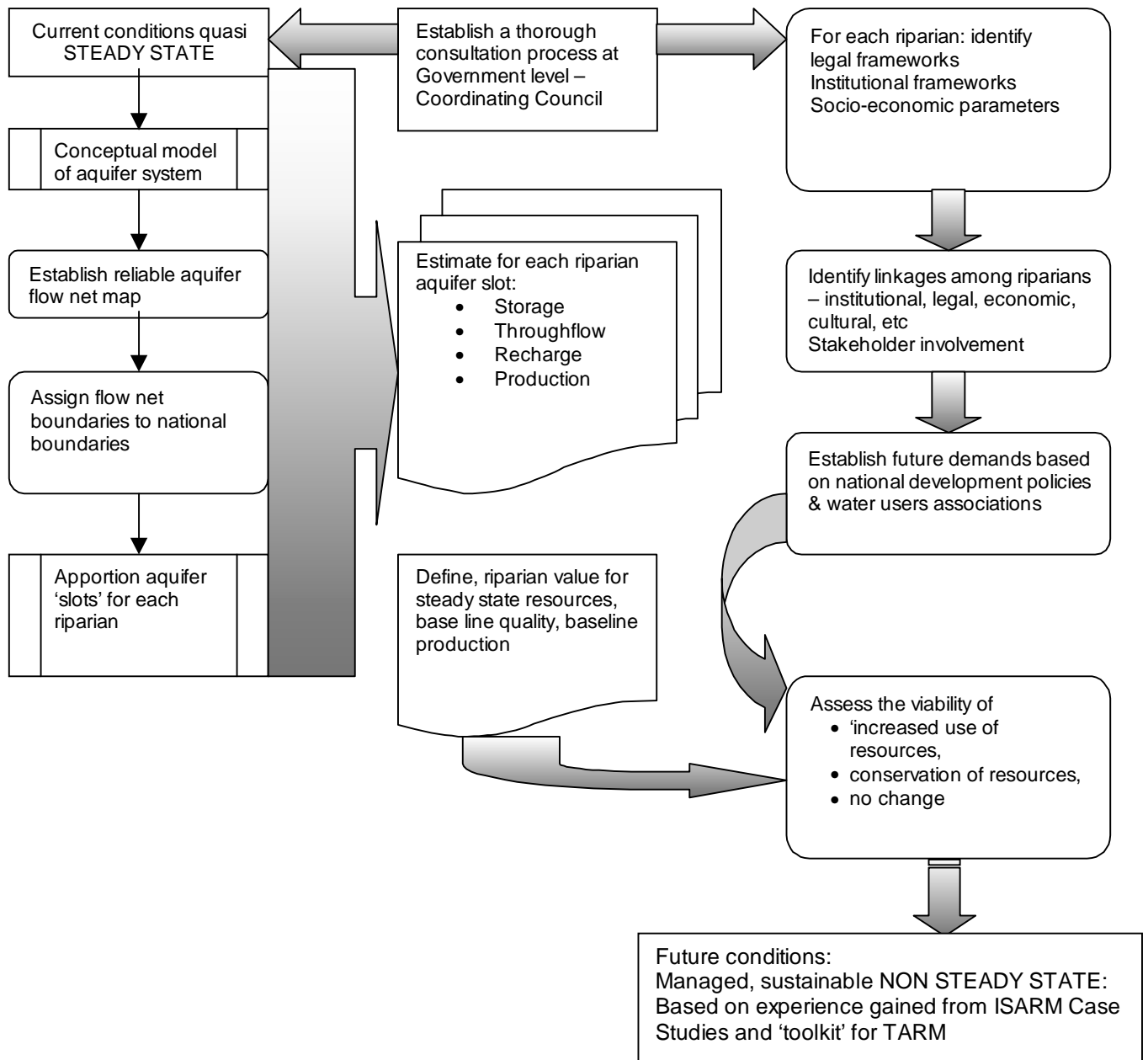
- The aquifer well defined and is hydrologically distinct – ideally without major inter-basin transfer arrangements
- Strong national and local support can be developed for the case study aims
- Good history of surface and groundwater hydrometric data collection in at least some of the key sites.
- Broadly comparable socio-economic situation. (If, for example, there is significant industrialization on one side, this could complicate analysis including demand forecasts. As a consequence the details of dealing with such changes may be given greater prominence than the overall approach to improving the transboundary aquifer resource management.)
- Ideally only one international boundary crossing the aquifer system, as bilateral evaluations are thought to be more effective at least during the case study stage.

(vi) Scope of Case Studies and their contribution to World wide experience

The ISARM Programme is currently developing a definition of the scope that the case studies might include and this is shown in Annex II. While the case studies are expected to focus on the five key issues of concern, the outcome of the case study should provide guidance for their sustainable management. Some of the issues raised in the part of the case study will require high level of liaison with governments, stakeholders and international agencies.

Figure 1: Hydrogeological Map of the World

Figure 2: Suggested development strategy for the ISARM toolkit



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Logical Framework of the ISARM programme

Wider Objectives

- To contribute to the multifaceted efforts in global cooperation through providing for the planet's needs in sustainable environments, economy, social and political security, based on integrated water resource management, including internationally shared aquifers.

Specific Project Objectives

- To establish a network of multidisciplinary experts for identification and definition of internationally shared aquifers
- To promote scientific, legal, socio-economic, institutional and environmental assessment of internationally shared aquifer resources
- To identify several Case Study internationally shared aquifers and support experts teams of multidisciplinary experts to conduct detailed projects
- To learn, from Case Studies, the issues relevant to good management of internationally shared aquifer resources
- To raise the awareness of policy and decision makers of the significant and importance of transboundary aquifer resources, forming a critical component of the world freshwater resources
- To disseminate the lessons learnt from Case Studies and encourage policy and decision makers to incorporate appropriate internationally shared aquifer management
- To promote cooperation among nations that share internationally shared aquifers, through making available scientific tools, water resource management options and methodologies that apply to such aquifers

Tasks & Activities

Short term (One year: August 2001)

- Preparation and wide distribution of an illustrated *framework document* promoting the concept of cooperation for optimal and sustainable management of internationally shared aquifers
- Dissemination of existing information on internationally shared aquifers, including the scientific, legal and other arrangements in FAO and other databases
- Launch of the framework document at the IHP/OHP Conference entitled 'Hydrological Challenges in Internationally shared Water Resources Management' Sept 2001, Koblenz
- Circulate and process a questionnaire to identify the significant internationally shared aquifers of the world
- Cooperation with UN Economic Commissions in particular with UNECE for the implementation of the guidelines on monitoring and assessment of transboundary groundwaters and the setting up of training and exchange of information with the other regions

Medium term (Two years: March 2003)

- Preparation of detailed Case Studies of selected internationally shared aquifers
- Report progress at the IAH-ALHSUD Congress on "Groundwater and human development", 21-25 October 2002 Mar del Plata, Argentina.
- Preparation of a bibliography and database of internationally shared aquifers
- Contributions for the improvement of standard monitoring procedures
- Contributions for the preparation of maps considering potential risk and groundwater vulnerability
- Organisation of several regional consultations, to ensure consensus and participation at regional level and to disseminate and debate the results of the Case Studies

Long term (six years: March 2005)

- Preparation of a "ISARM toolkit",
- Capacity building and advisory assistance to Member States based on the implementation of the toolkit,

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facilitated by regional workshops

- Holding a final conference to evaluate the products and the experience of their use.

Programme Outputs

- *Illustrated framework document* on the issues involved in the sustainable management of internationally shared aquifer resources.
- Case Study reports from ISARM projects in Latin America, Africa, Europe and Asia
- Bibliography and data of internationally shared aquifers
- Development of a 'ISARM toolkit' comprising technical guidelines, examples of legal and institutional frameworks and a database of findings of the Case Studies

ISARM Case study Outline (DRAFT)

EXECUTIVE SUMMARY – max 5 pages

Introduction

- Name (scientific, international, local), definition and general features of the aquifer system and its sub-systems, (location map)
- Countries and sub-regions & populations sharing the aquifer system,
- Regional, sub-regional and national importance of the aquifer system(s) – based on national volume of groundwater use, for municipal / irrigation uses
- Cross-border issues and risks for multidisciplinary management (identify the u/s and d/w riparians, flow directions)

Scientific-hydrogeological issues

- Hydrogeological identification and recognition of the transboundary aquifer systems (simplified hydrogeological map, key cross section along the main transboundary flow line(s))
- Spatial delimitation, distribution of parameters
- Groundwater hydraulics, actual and potential international implications
- groundwater flow patterns (detailed information)
- piezometric surface
- water quality: pollution, salinity and land and water salinization (tabulated trends in water levels, water quality)
- Other implications
- Summary of transboundary aquifer management issues (historic and future changes in flows / levels/quality, etc)
- Actual and planned uses. Modern in- and outflows, recharge and captive zones,
- Limited contemporary recharge and fossil reserves – impact of climate change, if known
- General and specific management needs and opportunities (i.e. licensing, control on production – levels, etc.)

Legal aspects

- The need for legal agreements
- Existing rules of governance - groundwater in water law in each riparian, compare & contrast
- Rules and principles that apply
- Identified gaps in existing legal regime for transboundary aquifers
- Initiatives and opportunities for international cooperation

Socio-economic aspects

- Population served by the aquifer system – poverty profile – contribution of aquifer water to livelihoods – water quality-health issues – population at risk – integration (social, economic allocation – economic development-poverty)
- The state of groundwater development
- Driving forces
- Nature of competition
- Governance issues
- Contribution of groundwater to local economy – what proportion of income is based on groundwater use

Institutional issues

- Domestic and international management
- Institutional analysis – national-regional-local; what agencies are involved, how do they inter act?
- Political and legal aspects and dimensions

Environmental issues

- Sustainable development of transboundary aquifer resources – estimate of 'life of resource' on current & future production rates
- Biodiversity
- Climate change - link to section on 'recharge'
- Poverty alleviation, water and health – based on info provided in the socio-economic section
- Conflict prevention
- Ethical development of transboundary aquifers
- Non-traditional or specific uses: CO2 sequestration, disposal of waste, thermal ASR

Guidance for sustainable management of the transboundary aquifer

- Inter-government cooperation and communication
- Joint aquifer resource monitoring strategy
- Joint (or parallel) development-management institutions
- Joint water user associations
- Etc.

APPENDICES

Tabulated data

Aquifer features

Population statistics

Economic indicators