Legal Aspects of Groundwater Management: An Overview

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1 Introduction

Many countries still lack coherent policies, strategies, legislation and institutional arrangements for the management of groundwater resources. However, the inclusion of groundwater-specific provisions in recently enacted water legislation – or the adoption of groundwater-specific legislation – suggests that efforts are being made towards achieving the goal of a more sustainable development, use and management of these resources. The manner in which the legislation and companion institutional arrangements are shaped depends on a series of factors, including water availability, value systems, socio-economic development priorities and political agendas, the prevailing legal system and traditions, hydrology, hydrogeology and climate.

International groundwater law is far less developed than domestic groundwater management legislation. A survey of international state practice and literature on the subject reveals that most of the existing water treaties relate to surface water resources, groundwater being dealt with incidentally, either because it comes within the meaning of ‘frontier waters’, or because it is part of a specific river basin. Very few international legal instruments of a groundwater-specific nature are in place, and not all of them contain adequate provisions in respect of transboundary groundwater resources management.

When groundwater resources are concerned, the following should be taken into consideration:

- all aquifers are characterized by a flow component and a storage reserve;
- groundwater moves slowly from an area of natural recharge to aquifer discharge areas, and in the time employed the flow – and the discharge - may be influenced as a result of human activities;
- a number of important aquifer systems, especially in arid regions, receive negligible contemporary recharge. Hence, they are storage-dominated and become subject to depletion if measures to control groundwater abstraction are not taken (GW-MATE 2002-2004, Briefing Note 4);
- it is essential to identify the linkages between aquifer recharge and land use, as urban and agricultural development and other activities may radically modify recharge rates (Foster 1999);
- highly dispersed groundwater abstraction patterns may have significant aggregate impacts, with adverse effects showing at a considerable distance, such as in the case of overpumping by many well owners causing the lowering of the water pressure, thus allowing the intrusion of saline water. Hence, it might be difficult to apportion responsibility (Foster 1999);
- aquifers play an important role in mitigating drought conditions through their reserves (Hayton & Utton 1989);
- aquifers are more vulnerable to pollution than surface water; groundwater moves slowly and self-purification is extremely limited. Pollution may have long-lasting if not irreversible effects (Foster 1999);
because of the complexity of groundwater flow and the time lag between the occurrence of pollution and when the effects are felt, it is technically difficult to prove liability for groundwater pollution.

In view of the above, special policies, strategies and legal regimes must be contemplated and adequate institutional mechanisms for implementation must be established. Unfortunately, this is not always the case.

What follows is a brief review of the characteristics of national legal and institutional frameworks for groundwater management, and of international water law developments on the subject.

2 Domestic groundwater law

When studying and developing rules of groundwater law in a transboundary context it is important to pay attention to the manner in which the law deals with groundwater management issues at the national level. On the one hand, domestic practice may generate principles applicable at the international level. On the other hand, by assessing the national legal and institutional frameworks it is possible to anticipate the chance of international legal rules to be implemented at the national level prior to proposing these rules to the authorities competent for adoption.

2.1 Existing legal frameworks

At the outset national legislation tended to consider groundwater as the property of the owner of the overlying land, or as the subject of an exclusive use right by the landowner in accordance with principles inherited from Roman law (Caponera 1992; Burchi & Nanni 2003). Due to increasing stress on groundwater as a result of growing demands and deteriorating water quality, this situation has undergone substantial changes in recent years. Legislation has been widely enacted to vest all water resources in the state, or to recognize the state’s superior right to the use, flow, control and management of water resources.

A corollary of these changes is that the landowner, who formerly owned the water or had an exclusive use right to its use, has been turned into a groundwater user who must apply for a water right – a permit, authorization, concession or the like - to the (ground)water administration. In turn, the administration may exercise greater power to control groundwater resources and introduce measures limiting water use rights and activities having a negative impact on groundwater – quantity- or quality-wise - when the specific conditions of an aquifer so warrant (Caponera 1992; Caponera & Alhéritière 2003). Since constitutions protect private ownership and subject its taking to compensation, in a number of instances this legislation has been challenged before the courts, but claims have been consistently rejected on the grounds that groundwater use and management are to be regulated in the broader public interest (Caponera 1992; Burchi & Nanni 2003).

The provisions to be found in national legislation generally apply both to surface water and to groundwater, and tend to cover the following, amongst other things (Burchi & Nanni 2003; GW-MATE 2002-2004, Briefing Note 4):

- the permit system, through which a given amount of water at a given location is allocated to a person and on the basis of which the water is put to (beneficial) use for a specific purpose;
- protection measures, including wastewater discharge permits;
- economic mechanisms, such as water charges and pollution fees, and economic incentives in support of water use efficiency;
- sanctions for non-compliance.

In addition to the above, the legislation may contain groundwater-specific provisions that take into consideration the close relationship between groundwater and land use, the difficulties that may arise when defining minimum protection requirements and the need to improve the groundwater-related knowledge base by facilitating the collection of data. These provisions relate in particular to:

- the licencing of drilling contractors, aiming at ensuring that professional drillers are qualified and that they provide data to the administration;
- the inventory of existing wells under given circumstances – sometimes limited to certain locations or to wells showing specified characteristics - which may take place based on the information provided to the administration by the well owners;
- the metering of wells, which serves the dual purpose of quantifying the amount of water extracted from a well and verifying compliance with the conditions attached to groundwater use permits;
- the duty of users pumping groundwater from a well on the basis of a permit to report the amount of water pumped in a given period of time (normally one year) to the water administration;
- land surface zoning through the formal designation of control, protection or management areas, districts and the like, with prohibitions or restrictions as to groundwater abstraction or activities with adverse impact on groundwater (Caponera & Alhéritière 2003). This measure may be introduced for a number of reasons, including the risk of aquifer depletion due to the intensive use of groundwater (Burchi & Nanni 2003) and the risk of pollution of aquifer recharge areas, particularly from diffused sources (GW-MATE 2002-2004, Briefing Note 8; Foster et alia 2002);
- the protection of public drinking water sources through designated protection areas or perimeters which are placed under the responsibility of the water administration – but may be managed by a public water utility under contract or concession (Foster et alia 2002);
- the assessment of environmental impact (EIA), particularly in industrialized countries; and
- the artificial recharge of aquifers, for which the legislation may require that certain conditions as to the qualifications of the operators in the sector and to water quality are met (Nanni, Burchi, Mechlem & Stephan 2005).

In a number of countries recently enacted legislation places emphasis on water resources planning as a tool for integrating resource development and management, including pollution control measures, into a formal instrument which is binding on both the water administration and the water users. Planning normally refers to water resources as such, but there is a trend towards considering the aquifer or sub-aquifer, like the river basin or sub-basin, as the unit for the development of plans (Burchi & Nanni 2003).

There may be different types of plans, ranging from management plans proper, such as in the case of France and Spain, to contingency or emergency plans introducing measures which would not be applicable otherwise. In Uruguay, for instance, a master plan for the national portion of the Guaraní Aquifer System was adopted in 2000 to empower the government to grant groundwater abstraction permits under terms and conditions that are more stringent than those attached to water use permits elsewhere (Burchi & Nanni 2003). The 1980 Groundwater Management Code of Arizona envisages the formulation of groundwater management plans for designated Active Management Areas (AMA), providing for measures limiting groundwater abstraction and banning new irrigation
development. AMAs are critical overdraft areas corresponding to specified groundwater basins or sub-basins (Arizona Department of Water Resources, www.water.az.gov).

A situation which deserves to be mentioned is that of non-renewable groundwater resources, i.e., ‘fossil groundwater’ which originated as recharge in past climatic regimes and which is only weakly or negligibly replenished under current conditions (GW-MATE 2002-2004, Briefing Note 2). Planning in this case must reflect the policy choice between aquifer depletion (‘mining’) through orderly utilization of the reserves over a given period of time, or aquifer recovery. If the recharge is negligible and there are no alternatives to the utilization of the resources, aquifer recovery or the maintenance of a ‘sustained yield’ might be unrealistic. Thus, the policy choice will be depletion. In this case the depletion plan must contemplate an ‘exit’ strategy, i.e., indicate possible development options for the day in which the groundwater will no longer be available including, possibly, the identification of the replacement water resources (GW-MATE 2002-2004, Briefing Note 11).

National groundwater legislation normally does not set any requirements as to how to behave in the specific case of non-renewable groundwater resources. Since non-renewable aquifers are storage-dominated and therefore should not be dealt with in the same way as rivers, provisions should be made through regulations for given hydrogeological units to provide guidance in the depletion (or recovery) plan implementation process. The regulations should be supported by administrative and technical guidelines (Nanni, Burchi, Mechlem & Stephan 2005; GW-MATE 2002-2004, Briefing Note 11).

It will be essential in the case of non-renewable groundwater resources to empower the water administration to designate special critical areas coinciding with hydrogeological units and to develop the relevant groundwater management plans. There is no golden rule as to how groundwater abstraction rights within critical areas should be dealt with. All will depend on the groundwater reserves available in storage, on the allowable decline rate which is calculated over a given period of time and on the strategic management goal for each hydrogeological unit. While certain groundwater uses might have to be limited, modified or prohibited tout court, others will be allowed to continue, perhaps subject to certain requirements such as the duty of the user to submit a conservation plan. Whatever the situation, it is advisable to limit the duration of groundwater abstraction rights – to, say, five years - so as to facilitate the periodical review of these rights and their adjustment to changes, as needed (Nanni, Burchi, Mechlem & Stephan 2005).

Finally, since groundwater management measures may entail limitations to the rights and interests of groundwater users their introduction and adoption may encounter a certain resistance. Therefore they might become difficult to implement. For this reason, there is a trend towards enabling groundwater users and stakeholders at various levels to participate, and have a say, in decision-making concerning such measures and, in particular, in the resource planning process (Burchi & Nanni 2003; GW-MATE 2002-2004, Briefing Note 6).

It might be useful to mention the agreements and other arrangements concluded among member states of federations. Although national, these instruments are of particular interest because domestic groundwater law is generally more developed than international law (Barberis 1987). However, few of them deal with groundwater. In the United States of America, the Delaware River Basin Compact (1961), concerning the states of Delaware, New Jersey, New York and Pennsylvania, empowers the Commission established by it to regulate and control surface water and groundwater withdrawals. Thus, the Commission has developed policies to conserve and protect aquifers, their capacity for storage and their recharge area, and to protect groundwater quality. The Susquehanna River Basin Compact (New York, Maryland and Pennsylvania) contains similar provisions (Utton 1981). Also of interest is the situation with regard to Great Artesian Basin (GAB)
2.2 The institutional framework

Fragmentation of groundwater management functions is too often present at the national (government) level. Groundwater data are normally collected and processed by different agencies, while water quality is handled separately from quantity aspects. By the same token, the administration of groundwater use is often the prerogative of several institutions. This situation hinders the development of an adequate understanding of groundwater systems, of their use and protection needs, which is the basis for planning groundwater conservation and protection measures (Nanni & Foster 2005).

The ideal solution for addressing the above would be to place the entire range of functions relevant to groundwater in the hands of a single ministry or authority. This, however, is not always possible. In spite of the existence of a 'water resources' institution in a number of countries, many ministries and government agencies usually have an interest in groundwater development and use. Therefore, legislation provides in some cases for the participation of these stakeholders in groundwater resources planning and management through interministerial coordination mechanisms, such as a council, commission or committee. In Tunisia, for instance, a Water Committee provides advice on all matters relating to policies and plans. In Algeria, a similar mechanism was created in 1996.

Not all groundwater management issues may be handled at the national government level. Depending on the size of a country, there may be intermediate levels of administration (GW-MATE 2002-2004, Briefing Note 4). Groundwater management may be entrusted to the decentralized branches of a national water ministry or authority, such as in the case of Libya, or to basin agencies where they exist. In Algeria, a specific basin agency deals with the portion of the North-Western Sahara Aquifer System located in Algerian territory. In the case of intermediate levels of administration, it is important to establish institutional mechanisms for the coordination of activities of the decentralized institutions relating to the same aquifer.

An optimum solution relates to the establishment of aquifer management institutions. The participation of stakeholders and users in groundwater management is indispensable for the successful implementation of planning determinations and management measures. Its importance has been recognized, and many countries are beginning to provide, through their legislation, for the establishment of Aquifer Management Organizations (AMORs). AMORs may comprise representatives of central government agencies, water users and other stakeholders, and of the local authorities. They may perform an advisory role with regard to aquifer management planning and the measures required to address the negative impacts of development on the condition of an aquifer, including measures entailing a limitation to individual water rights. Further, they may be called upon to monitor the implementation of an aquifer management plan (GW-MATE 2002-2004, Briefing Note 6).

It is important that the local authorities have a say in groundwater management when AMORs are established. It is also essential, for groundwater management to be successful, that user representatives participate, through their groupings or associations, in any decision that might affect their interests. This has been acknowledged by the legislation of some countries, which has provided for user representation in AMORs.
AMORS have been established in a number of countries, including Spain, Mexico and some of the western states of the United States of America. A remarkable example of this type of organization is offered by the Australian states sharing the Great Artesian Basin (GAB), namely Queensland, New South Wales, South Australia and Northern Territory. Each of these states has established an advisory committee for its respective portion of the GAB, which represents all stakeholders and provides advice to the water administration on the granting of groundwater abstraction licences. At the GAB level there is a GAB Consultative Council comprising representatives of the Commonwealth, the states, the users and various associations of stakeholders. In the year 2000, the Council has adopted the GAB Strategic Management Plan, which sets guidelines for groundwater management at the Commonwealth and state level. The formulation of the Plan has followed a quite complex consultation process involving groundwater users and stakeholders at all levels. Quite recently, the states concerned have enacted water legislation enabling them to manage groundwater resources - and water resources in general - more efficiently, through improved permit systems and institutional mechanisms favouring user participation in decisions relating to the development, use and protection of water resources. The GAB Council is in charge of monitoring the implementation of the Plan at the basin level and of facilitating the exchange of information among basin states, amongst other things.

3 The international dimension

3.1 International groundwater law

Like surface water, groundwater does not know man-made boundaries. However, while rich in respect of shared surface water resources, international law has tended to pay scant attention to transboundary groundwater, mostly due to lack of awareness and full understanding of the characteristics and behaviour of this ‘invisible’ resource. Since groundwater has rarely been the subject of disputes in the past, most of the existing water treaties deal with it marginally, focus being placed on surface water resources (Caponera & Alhéritière 2003; Barberis 1987). In substance, they make no difference between surface water and groundwater. Inter alia, reference to groundwater may be found in:

- the Convention on the Law of Non-Navigational Uses of International Watercourses (UN Watercourses Convention), adopted by the General Assembly of the United Nations on 25 May 1997 based on the work of the International Law Commission (ILC). Groundwater is covered in its provisions only in so far as it is related to surface water and forms a ‘system’ with it. The shortcomings of the Convention will be summarized in the next section of this paper;
- for the United Nations Economic Commission for Europe (UNECE) region, the 1992 Convention on the Protection and Use of Transboundary Rivers and International Lakes (UNECE Water Convention). It covers both surface water and groundwater and contains provisions geared to the protection of transboundary water resources and the reduction of transboundary impact, in line with developments in the ECE region. The UNECE Protocol on Water and Health, 1999, calls for the development of resource management plans, including plans for transboundary aquifers;
- the 2000 Revised SADC Protocol (also regional), which is modelled on the UN Watercourses Convention, hence presents the same shortcomings;
- river basin-specific treaties such as the Convention and Statute of the Lake Chad Basin, which was signed by Cameroon, Chad, Niger and Nigeria on 22 May 1964, the 1994 Danube Protection Convention, the 1998 Convention on the Protection of the Rhine and the 2002 Sava River Basin Framework Agreement. The scope of these international legal instruments extends to groundwater.
Several bilateral treaties mostly concluded before 1970 and concerning boundary waters in general. Some of these make reference to local situations involving the utilization of wells or springs located in the border area, such as in the case of the Agreement concluded by Egypt and Italy on 6 December 1925 to set the boundary between Cyrenaïc and Egypt, which contains provisions on the utilization of the Ramla Well. Others, mainly concluded between Eastern European states, relate in general to ‘water economy’ questions (Barberis 1987).

Treaties taking into consideration the possible adverse effects of surface water resources development on groundwater, and vice-versa. This is the case of the Treaty between the Grand Duchy of Luxembourg and the Land Rheinland Pfalz in Germany of 25 April 1950, concerning the construction of a hydropower plant on the Sauer. The relationship between surface water and groundwater is also recognized in the Procès-Verbal between Greece and Yugoslavia of 31 March 1956, relating to the water levels of Lake Dojran (Utton 1981).

The Agreement (Arrangement) between the Canton of Geneva (Switzerland) and the Préfet of Haute-Savoie (France) relating to the protection, utilization and recharge of the Franco-Swiss Geneva Aquifer is perhaps the only example of international legal instrument dealing specifically and in a comprehensive manner with groundwater resources management as such. The Agreement, which was signed on 9 June 1977 and is in force since January 1978, provides for the creation of a joint Commission to facilitate cooperation in the monitoring of water levels, water abstraction and water quality, to prepare annual water utilization programmes and to advise on groundwater protection measures, amongst other things. Further, the Agreement contains provisions as to the respective rights and obligations of the two parties in relation to the artificial recharge of the aquifer. The Commission keeps an inventory of groundwater abstraction works located in the two states and, since these works are equipped with meters, is in a position to know how much water is taken by each user (Barberis 1987).

The high level of cooperation reflected in the Geneva Aquifer Agreement, which culminates in the establishment of an institutional mechanism for groundwater management, is an exception. There are other examples of cross-border cooperation on groundwater matters, but on a much smaller scale. One of them relates to the interim Agreement on a permanent and definitive solution of the salinity problem of the Colorado River, which was concluded by the United States and Mexico in 1973 (Minute No. 242 under the Treaty between the United States of America and Mexico relating to the utilization of the waters of the Colorado and Tijuana rivers, and of the Rio Grande from Fort Quitnam, Texas, to the Gulf of Mexico, signed at Washington on 3 February 1944). Pending the conclusion of an agreement on transboundary groundwater – which was never arrived at - the two states decided to introduce restrictions to groundwater pumping for a strip of land along extending five miles on both sides of the Arizona-Sonora border, and undertook to consult each other before engaging in any new resource development having adverse effects across the boundary (Caponera & Alhéritière 2003; Barberis 1987; UNESCO 2001). It is interesting to note that Minute No. 242 was agreed upon within an institutional mechanism having no specific jurisdiction on transboundary groundwater, i.e., the International Boundary and Water Commission.

Two judicial decisions making reference to groundwater resources may essentially be quoted. One is the judgment rendered by the International Court of Justice on 25 September 1997, in the Gabčíkovo-Nagymaros Case (Hungary v. Slovakia). In 1989 Hungary decided to interrupt work on a project that was to be constructed on the basis of a treaty concluded with Czechoslovakia in 1977, consisting of a series of diversions from the Danube. The grounds for the interruption of the works were allegations that the diversion of water from the Danube would result in a reduction of the groundwater level and in an impairment of groundwater quality in Hungarian territory, amongst other things. Thus, the works had to be interrupted due to a ‘state of ecological necessity’. The Court stressed in its judgment that a general obligation of states to ensure that activities within their
jurisdiction respect the environment of other states or areas beyond such jurisdiction is part of international law. It found, however, that a ‘state of ecological necessity’, which may be justified by imminent danger, had not been established by Hungary, due to the fact that it is difficult to assess the effects of slow natural processes (McCaffrey 1999).

The second judicial decision involving groundwater is the one rendered by the German Staatsgerichtshof – a national court in a federal state - in 1927, in the Donauversinkung Case, dealing with interferences in the natural phenomenon by which the water of the Danube at a certain location flows underground and flows then from the aquifer into the Aach, a tributary of the Rhine. In this case the court, applying international law though the case involved the Länder (states) of the Federal Republic of Germany – Württemberg, Prussia and Baden – asserted that states have the duty in regard of international rivers to abstain from injuring the interests of other states. Thus, Baden – the Land interested in an augmented flow in the Aach river - was to refrain from accelerating the natural sinking of the Danube (but was under no obligation to undertake permanent improvements), while Württemberg was not to impede such sinking (McCaffrey 1999).

As far as the doctrine on the subject of transboundary groundwater resources is concerned, we may quote the work of the International Law Association (ILA) which, after years of work on the development of the law of international water resources through its ‘Committee on the Uses of Waters of International Rivers’, adopted the Helsinki Rules on the Uses of Waters of International Rivers (Helsinki Rules) in 1966. A precursor of the UN Water Convention, the Helsinki Rules apply to all water resources located within an international drainage basin, this being defined as ‘a geographical area extending over two or more states determined by the watershed limits of the system of waters, including surface and underground waters, flowing into a common terminus’ (Art. 2). Thus, groundwater falls within the scope of the Rules only in so far as it relates to surface water and forms a system with it, flowing into a common terminus. In the same year, aware of the need to further study groundwater, the ILA instructed the Committee – renamed ‘Committee on International Water Resources Law’ - to carry out such task, and in 1986 the ILA adopted the Rules on International Groundwaters (Seoul Rules). These Rules expanded the scope of the Helsinki Rules by making them applicable to all international groundwater resources, including those not connected to surface water bodies. In addition, they explicitly recognize the interaction between groundwater and other natural resources (Art. 2) and the particular vulnerability of groundwater to pollution (Art. 3) (Manners & Martti Metsalampi 1988).

Further reference to groundwater is made inter alia by the Inter-American Bar Association, which in 1969 adopted a resolution on the legal aspects of the contamination of international rivers and lakes, including groundwater related to them, by the Council of Europe’s 1968 European Water Charter and by the Asian-African Legal Consultative Committee in 1975 (Manners & Martti Metsalampi 1988).

Another remarkable result of legal research on transboundary groundwater is the Bellagio Draft Treaty concerning the use of transboundary groundwaters, which was prepared over an eight-year period by a multidisciplinary group of experts. Rather than dwelling on general principles of international law applying to the use of groundwater, this document, which is in the form of a model treaty containing 20 articles, identifies concrete mechanisms for cooperation in the management of transboundary aquifers in critical areas. Although the model is the USA-Mexico border, it is of interest for aquifers elsewhere in the world, particularly in arid regions. The Agreement addresses aquifer contamination, planned depletion (‘mining’), drought management and transboundary transfers, in addition to abstraction and recharge issues (Hayton & Utton 1989). The Agreement assigns a key role to the joint Commission by vesting it with the power to declare Transboundary Groundwater Conservation Areas (TGCA), to prepare a comprehensive
management plan for each TGCA to allocate, conserve and protect groundwater and to prepare and approve aquifer depletion (‘mining’) plans and a drought management plan applicable to the border region. Water quality protection remains a responsibility of the aquifer states, but based on the information provided by these states on polluting discharges and pollution resulting from other activities within their respective territory the Commission may take action to declare a TGCA which, in turn, triggers the preparation of a management plan. The provisions of the model treaty on the planned depletion of transboundary aquifers are particularly relevant in the case of non-renewable resources, where mining should take place over a calculated period of time, sufficient for finding a ‘way out’ through resort to other water sources, changes in the economic production patterns or other means.

Finally, mention should be made of the resolutions and recommendations of international bodies. In this connection, the United Nations Water Conference, which was held in Mar del Plata, Argentina, in 1977, recommended the adoption of measures to utilize aquifers as collective and integrated systems and the conduct of studies to explore the potential of groundwater basins, the use of aquifers as storage and the conjunctive use of groundwater and surface water (Manners & Martti Metsalampi 1988). The United Nations Conference on Desertification, which was held in Nairobi in the same year, placed emphasis on the implementation of transnational projects for ‘developing and strengthening regional activities concerning the assessment of surface and groundwater resources’ (Caponera & Alhéritière 2003). Aquifer management is also referred to in the Statement on Water and Sustainable Development, adopted at the International Conference on Water and the Environment, Dublin, in 1992, and in Agenda 21, produced by the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992 (Mechlem 2004).

3.2 The codification of groundwater law

A recent review of international groundwater law (Mechlem 2004) arrives at the conclusion that the UN Watercourses Convention presents a number of shortcomings when transboundary groundwater resources come into consideration. These shortcomings, which are summarized in Table 1, relate both to the scope of the Convention and to the adequacy of its provisions to address groundwater management issues within a transboundary context.

<table>
<thead>
<tr>
<th>Table 1 - Shortcomings of the UN Watercourses Convention (summary from Mechlem 2004)</th>
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<tr>
<td><strong>Definition and scope</strong></td>
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<tr>
<td><strong>Art. 2- Use of terms</strong></td>
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<td>‘Watercourse’ means a system of surface waters and groundwaters constituting by virtue of their physical relationship a unitary whole and normally flowing into a common terminus’</td>
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<tr>
<td>- Aquifers not ‘related’ to surface water bodies (such as the Nubian Sandstone Aquifer System) are excluded from the scope of the Convention.</td>
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<tr>
<td>- Groundwater and surface water do not necessarily share a ‘common terminus’.</td>
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<td><strong>Adequacy of provisions</strong></td>
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<td><strong>Art. 6 – Factors relevant to equitable and reasonable utilization</strong></td>
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<td>The factors to determine ‘equitable and reasonable utilization’ do not explicitly include ‘hydrogeological’ factors (though reference is made to ‘other factors of a natural character’)</td>
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<tr>
<td><strong>Art. 7 – Obligation not to cause significant harm</strong></td>
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<tr>
<td>Watercourse States shall, in utilizing an international watercourse in their territories, take all appropriate measures to prevent the</td>
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<td>- The no significant harm formula is not stringent enough in the case of groundwater, where the effects of human activities may be irreversible. Articles 7 and 5, if read together, may be interpreted in the sense that concern for utilization prevails on protection</td>
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</table>
3.3 International institutional arrangements

A number of institutional mechanisms – commissions, committees, etc. - for cooperation in the management of international water resources have been established in the course of the 20th century. Their jurisdiction, however, tends to cover groundwater resources only in so far as these are part of the river basin/river system concerned. Thus, groundwater is considered only through surface water management and plays a secondary role, although the specific characteristics of groundwater may warrant the establishment of specialized institutional mechanisms, or of specialized units within basin institutions.
The only known institutional mechanisms for cooperation in the management of international groundwater resources as such are:

- the commission established under the Agreement (*Arrangement*) relating to the protection, utilization and recharge of the Geneva Aquifer, which was mentioned earlier. This commission is composed of six members - three representing Switzerland and three France - of which at least four (two for each country) must be experienced in water matters. The commission is responsible for the formulation of an annual programme relating to the use of the aquifer's water resources. In addition, it makes recommendations on the measures to be taken in order to protect water against pollution, approves the construction and modification of water abstraction works and installations, and controls aquifer recharge activities.

- The joint Authority for the study and development of the Nubian Sandstone Aquifer System, which was established by Egypt and Libya in 1991. The Sudan and Chad have become members of the Authority subsequently (Chad in 1998). Amongst other things, the Authority is responsible for the collection and updating of the data relating to the aquifers, the conduct of studies, the formulation of plans and programmes for water resources development and utilization, the implementation of common groundwater management policies, the training of technical personnel, the rationing of water and the study of the environmental aspects of water resources development. The Authority has a board of directors consisting of three members for each state, an administrative secretariat and a director who is appointed by the board. The board of directors is chaired on a rotation basis by a representative of each member state. The board meets two times each year and takes its decisions with a majority vote. In spite of its rather ambitious mandate, this consultation mechanism has only been operational with regard to data collection to date. An integrated regional information system (NARIS) was developed with the support of the Center for Environment and the Development of the Arab Region and Europe (CEDARE). However, on 4 October 2000 the four member states have signed two agreements relating to modalities for data collection and access to the system. Within the framework of a technical assistance programme, they aim at developing a strategy for integrated development of the aquifer system (Nanni, Burchi, Mechlem & Stephan 2005).

Since 1999, cooperation efforts are also ongoing with regard to the North-Western Sahara Aquifer System - SASS is its acronym in French - which spans Algeria, Libya and Tunisia. The three countries have agreed to set up an institutional mechanism for cooperation consisting of a small secretariat attached to the inter-governmental *Observatoire du Sahara et du Sahel (OSS)*. Such a secretariat will ensure continuity of cooperation in hydrogeological data collection and aquifer modelling in aid of domestic planning and decision-making by the concerned countries. Focus will mainly be placed on designated ‘hot spots’, such as the Ghadames Basin (Continental Intercalaire), the Artesian and Tunisian Outlet Basins (also in the Continental Intercalaire) and the *chotts* basin. The secretariat is expected to study options for a more complex and autonomous structure, which would be vested with functions such as aquifer planning in addition to data-related functions (Nanni, Burchi, Mechlem & Stephan 2005).

The Food and Agriculture Organization of the United Nations (FAO) is now supporting a project the objective of which is the setting-up of a permanent tripartite mechanism for cooperation in the integrated and sustainable management of the portion of the Iullemeden aquifer common to Mali, Niger and Nigeria.

Finally, a GEF-sponsored project for the Guaraní Aquifer System aims at assisting the system states (Argentina, Brazil, Paraguay, Uruguay) in the pursuance of the long-term objective of creating a common legal, institutional and technical framework for the system’s management and
preservation. An international agreement on the subject is expected to be entered into by the states concerned. The issue here is whether an autonomous institutional mechanism for cooperation in system management should be created, or whether groundwater management should take place within the existing framework of the Intergovernmental Commission for Coordination (ICC). However, since the Guarani Aquifer System although somehow related to the Plata basin is largely independent of surface water flows (Mechlem 2004), it would perhaps be more logical to have a separate cooperation mechanism, though coordinating with the ICC.

4 Conclusion

Domestic systems of groundwater law are far more developed than the law of transboundary aquifers. This might be due to the fact that given the specific characteristics and behaviour of groundwater, and in particular the relationship between groundwater and land, most of the action needed to control abstractions and adopt effective protection and conservation measures may be taken within national boundaries, often locally.

There are varying degrees of development as far as national legal frameworks for groundwater management are concerned, also because the financial means and the institutional capacity needed for implementation differ from country to country. It is nonetheless important that states sharing transboundary groundwater resources agree on common resource management principles and goals and, starting from what is feasible at a given point in time, gradually harmonize their legislation and institutions and increase their level of cooperation.

The above review shows that international cooperation in the management of transboundary aquifers has principally been established in order to solve specific problems, to carry out joint or coordinated studies and research, or to facilitate the exchange of hydrogeological data and other aquifer-related data and information. However, it is increasingly being recognized that international cooperation covering a broader spectrum of activities and functions, possibly through a joint body, is desirable and might become necessary at a certain stage. Thus, it is important for an international legal instrument for the management of transboundary aquifers to provide a snapshot of what is considered to be acceptable principles according to prevailing state practice, at the same time leaving room for progressive improvements.
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