

# International groundwater resources law

FAO  
LEGISLATIVE  
STUDY

40



FOOD  
AND  
AGRICULTURE  
ORGANIZATION  
OF THE  
UNITED NATIONS

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by  
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for the  
Legislation Branch  
FAO Legal Office

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## **FOREWORD**

Water is indispensable for both life and agriculture. Considering fresh water alone, 77.2% of it is to be found in the polar ice caps and the glaciers, while groundwater accounts for 22.4%, and lakes and rivers for 0.36%. Groundwater is therefore vital for human life. It also gives rise to specific legal problems, which often extend well beyond national boundaries. This is the question that the present study sets out to analyse, in as complete and exhaustive a way as possible.

Chapter I contains a general description of the natural elements in the context of which groundwater is to be viewed. Since this study is intended for lawyers, some preliminary notions concerning the subsoil and the forms in which groundwater is encountered have been included.

Chapter II describes the different uses to which groundwater is put and the consequences of such uses. Whilst the contents of these first two chapters are not of a strictly legal nature, they enable the reader to consider the subject in its proper prospective.

Chapter III examines international practice with regard to groundwater. Aquifers are classified into two categories. First, those which belong exclusively to one State but are subject in some way to international rules, e.g., an international servitude. There are also cases where an international border is modified so that the aquifer in its entirety may remain within the territory of a single country. Secondly, the concept and the physical limits of aquifers shared by two or more States are examined, and a number of practical examples are cited.

The fourth, and final, Chapter deals with the international juridical norms applicable to groundwater. It has two sections, one dealing with general, or customary, law, the other dealing with cases coming under special rules. There is no doubt that the most complex part of this study is that pertaining to the general provisions applicable to shared aquifers. The author also deals with radioactive pollution, on which recent literature has focussed, and which has now taken on considerable importance.

Almost all international agreements pertaining to groundwater, as well as the major resolutions and recommendations of the international organizations, and the work of academic institutions, are examined. A bibliography will be found at the end.

The study was carried out for the Legislation Branch of the Legal Office by Dr Julio A. Barberis, a jurist with wide experience in the development and administration of international drainage basins, and Professor of international law at the Catholic University, Buenos Aires.

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# CONTENTS

	Page
Abbreviations	vii
<b>CHAPTER I. WATER IN THE NATURAL CONTEXT</b>	<b>1</b>
1. Introduction	1
2. The hydrological cycle	1
3. The soil layers	3
4. Groundwater classification	3
5. Aquifers and other geological structures	4
6. Aquifer recharge zones	5
7. Relationship between groundwater and surface water	5
<b>CHAPTER II. GROUNDWATER AND ITS EFFECTS</b>	<b>7</b>
A. Groundwater uses	7
1. Domestic uses	7
2. Industry	8
3. Agriculture	9
4. Mining	9
5. Electric energy production	9
6. Heating	10
7. Medicinal uses	10
8. Tourism	10
B. Effects of groundwater use	10
<b>CHAPTER III. INTERNATIONAL PRACTICE WITH REGARD TO GROUNDWATER</b>	<b>12</b>
1. General	12
2. The territory of the State and subsoil	13
3. International practice	16

	<u>Page</u>
A. Aquifers belonging exclusively to one Status	20
4. International servitudes for groundwater	20
5. Modifying an international frontier to take account of	22
B. Aquifers shared between States	23
6. The “shared natural resource” concept	23
7. Groundwater as a shared natural resource	25
8. Limits of shared aquifers – International water systems	34
CHAPTER IV. LEGAL RULES GOVERNING SHARED GROUNDWATER RESOURCES	37
1. General	37
A. General international law	38
2. Obligation not to cause appreciable harm	38
3. Groundwater pollution	41
4. Equitable and reasonable use	48
5. Prior notification rule; duty to negotiate	51
B. Particular cases in international law	57
6. Aquifers under joint use	57
7. Special legal regimes	60
EPILOGUE	63
BIBLIOGRAPHY	65

## ABBREVIATIONS

B.F.S.P.	British and Foreign State papers
C. T. S.	Parry, The Consolidated Treaty Series
DM	Deutscher Verband für Wasserwirtschaft und Kulturbau
I.C.J.	International Court of Justice.
I. UWR	Internationales Umweltrecht - Multilaterale Verträge, Herausgeber: W.E. Burhenne
L.N.T.S.	League of Nations, Treaty Series
N.R.G.	Martens, Nouveau Recueil Général de Traités
N.R.J.	Natural Resources Journal
OAS	Organization of American States
OECD	Organization for Economic Cooperation and Development
P.C.I.J.	Permanent Court of International Justice
R.d.C.	Recueil des Cours, Hague Academy of International Law
R.G.D.I.P.	Revue Générale de Droit International Public
R.I.A. A.	Reports of International Arbitral Awards
Schw.J.i.R.	Schweizerisches Jahrbuch für internationales Recht
U.N.T.S.	United nations, Treaty Series
Z.a.ö.R.V.	Zeitschrift für ausländisches öffentliches Recht und Völkerrecht



## **CHAPTER I. WATER IN THE NATURAL CONTEXT**

1. Introduction. Water is an essential element for life on earth and has ever occupied an important place in the natural sciences, philosophy and even religion. For the ancients, water, together with earth, air and fire, made up the four elements, or basic components of the structure of the universe. Biblical texts also attribute to it a fundamental role. In Genesis, on the morning of the first day of Creation, "the spirit of the Lord moved over the surface of the waters". Throughout history, major civilizations have been established along the banks of rivers - Nile, Tigris, Euphrates, Yellow River, Indus, Rhine and others.

Water is distributed unequally in nature, and occurs in the solid, liquid and gaseous states. Unlike some natural resources, such as fish or forests, which can be augmented, or others which are diminishing resources, such as petroleum, the total volume of water in nature is fixed and invariable. Approximately 97.3% of the earth's water is ocean water -salt water, in other words; fresh water accounts for only 2.7%. If we consider the total volume of fresh water, the largest proportion (approximately 77.2%) is encountered in the solid state in the ice caps and glaciers. Water in the liquid state is mainly groundwater, accounting for 22.4% of freshwater. Surface water, to be found in lakes and rivers, represents only 0.36%, while water in the gaseous state, present mainly in the atmosphere, represents a mere 0.04% of fresh water <sup>1</sup>

2. The hydrological cycle. Water passes through what is commonly referred to as the hydrological cycle. The discovery of this phenomenon is a relatively recent one, considering that Man has been trying to solve the enigma since antiquity. Attempts to explain the origin of rain, water in rivers and groundwater often involved stories of supernatural beings or resort to myth. It was only in the sixteenth and seventeenth centuries that the enigma of the cyclical movement of water in nature was explained.

By the effect of solar energy, water evaporates and passes from the oceans, rivers and lakes to the atmosphere. Atmospheric water condenses and falls as rain, snow or hail. A large proportion falls in the oceans.

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<sup>1</sup> UN, United Nations Water Conference, doc. E/CONF.70/CBP/1, p. 10.

The rest falls on land and may remain on the surface, moistening the soil, or form watercourses which flow to lower-lying lands and, finally, in most cases, into the sea. Water taken up by plant roots is transpired through the leaves and returns to the atmosphere. Water on the surface of the seas and continents evaporates once again and the hydrological cycle recommences.

Once the water retention capacity of the soil has been exceeded, the water which has infiltrated there slowly reaches down to the water table. Groundwater moves from areas of higher hydraulic potential to areas of lower hydraulic potential. Since these areas usually coincide with morphologically lower-lying ones, it is here that the water discharges. This groundwater movement is due to gravity. Water permeates the soil and then flows laterally to lower-lying land. However, there is another type of movement, where the water rises from the water table to the surface through capillarity and, on the way, may be taken up through the roots of plants.

As has been seen, water is not immobile in aquifers. It flows toward natural discharge sites such as springs, rivers, lakes, lagoons, swamps and the sea. The rate of flow in the subsoil is slow and is governed by the permeability of the material through which the water moves and on the hydraulic gradient. In a clay soil, where permeability is low, and with a hydraulic gradient of five metres per kilometre, water moves laterally at the rate of one millimetre per day. With an identical gradient and in a soil of medium permeability, e.g., a sandy soil, groundwater travels some 50 centimetres per day; and, in a highly permeable soil such as gravel, it can travel some 20 metres per day. In the underground layers it can cover distances ranging from a few hundred metres to hundreds of kilometres. There have been cases of deep aquifers where the water has travelled more than 500 kilometres.

Groundwater is mainly derived from rainfall. Aquifers are recharged by rainwater or snow falling and permeating down to the water table. Recharge also occurs through the infiltration of water from rivers, lakes and lagoons and, at certain times of the year, from melting snow and glaciers. Some waterworks and human activities such as irrigation, the building of dykes, damming operations and the sinking of tube wells also help to recharge the aquifers.

3. The soil layers. Soil is composed largely of materials of varying sizes, such as sand, silt, gravel and decomposing plant matter. This, the surface layer, rests on more compact rock, such as sandstone or limestone rock. Under this rock layer there is compact crystalline rock which, as a result of lithification and the high pressure to which it is subjected, is practically impermeable. This layer forms the bed for groundwater.

Two different hydrological behaviour zones can be distinguished in the soil: the aeration zone and the saturation zone.

Water that falls on land and permeates the soil first reaches an upper layer which contains solids, water and air. The thickness of this layer, which is termed the aeration zone, ranges from a few centimetres (moist areas) to a few hundred metres (arid areas). Some of the water from this zone is absorbed by plants roots and then transpired, some evaporates and some seeps down to the lower soil layers. The aeration zone terminates in a layer called the capillary fringe. Water rises up into this fringe from the lower, or saturation, zone by capillarity. The depth of this capillary fringe depends on the size of the pores. If these are relatively large, the amount of water rising by capillarity will be small. Smaller pores allow water to rise more easily, and higher.

The saturation zone is located under the capillary fringe. Here the pores are totally saturated with water. The upper limit of this zone is called the water table.

Due to differences in land elevation the water table may appear level with the ground surface, in which case the water will emerge as a spring. When the water table is higher than ground level, a lake or lagoon is formed.

4. Groundwater classification. For the purpose of this study it will be useful to classify groundwater on the basis of whether or not it enters into the hydrological cycle and according to the zone in which it occurs.

As has already been mentioned, the main sources of aquifer recharge are rainfall and surface water. These penetrate the soil and are then taken up by plants and transpired, or they may evaporate into the atmosphere or travel toward discharge points such as spring, rivers, lakes, lagoons or the sea. This type of groundwater enters into the hydrological cycle and bears the generic name of meteoric water.

However, there are some types of water which remained trapped at the time when geological accumulation occurred, since when they have had no part in the hydrological cycle. For this reason they are called fossil waters. Then there are other types which do not enter the hydrological cycle but may be associated with it. These rise from considerable depths and are called juvenile or magmatic waters. They may emerge during volcanic eruptions and in geysers. Some thermal waters may also be of magmatic origin.

The other classification which, as will be seen below, is important from a legal viewpoint, is based on the zone in which the groundwater occurs. Groundwater in the aeration zone is called edaphic water, whilst that found in the saturation zone is termed phreatic water.

5. Aquifers and other geological structures. An aquifer is any geological formation which in addition to absorbing water also carries out the functions of storage and transmission. All aquifers have an impermeable or semi-permeable base layer. If the geological formation consists of an entirely impermeable structure, i.e., both floor and roof are impermeable, and if the pressure to which the stored water is subjected exceeds atmospheric pressure, then it is a confined aquifer. If, on the other hand, the upper limit is the water table, and its water is subjected to atmospheric pressure, it is a free aquifer. Where the top and bottom layers are semi-permeable, it is a semi-confined aquifer, of a kind frequently encountered in flat areas.

Sometimes, aquifers separated by impermeable layers may occur at different depths in the same zone. Or they may be linked to each other by means of permeable or semi-permeable layers.

Water is usually encountered in aquifers in the liquid state. In some very cold regions, such as Siberia, freezing occurs in the upper levels. On the other hand, if found in proximity to or within rocks subjected to high temperatures, it may contain hot water and steam.

Groundwater is not encountered only in aquifers. Other geological formations contain water but they cannot be exploited. Some of these are permeable and, whilst they can store water, they can only transmit small amounts and, again, cannot be exploited. Formations of the kind are known as aquitards.

When the geological formation is permeable and stores but does not transmit water, it is termed an aquiclude. An example would be a clay formation. Water is allowed to penetrate and is stored but cannot be tapped.

An aquifuge is a structure which can neither absorb nor store water. Crystalline rocks are an example.

Finally, underground watercourses also occur in karstic areas, i.e., those consisting mainly of calcareous formations. Such areas are found in Yugoslavia, Greece and Mexico. Calcareous rocks are composed of calcium carbonate, which is only slightly soluble in water. Rainwater contains carbon dioxide absorbed from the atmosphere. The carbon dioxide converts the limestone rock into calcium bicarbonate, which is water-soluble. By this process rainwater forms subterranean channels through which groundwater travels and which may be exploited by drilling down to water level.

6. Aquifer recharge zones. Aquifers are recharged by water that enters into the hydrological cycle and may be derived from rainfall or surface water or come from other aquifers. The recharge zone is the space through which the water infiltrates and travels until it reaches the aquifer. The recharge zone may occur above the aquifer or in the immediate vicinity thereof. However, in some cases aquifer recharge water may infiltrate into a particular zone, travel in the subsoil through cracks in the crystalline rock and reach the aquifer only after having travelled some distance. It is important to underline this point in the present study, since the recharge zone may be separated from the aquifer by an international frontier. A similar situation may arise when an aquifer is recharged by another aquifer.

7. Relationship between groundwater and surface water. Ground and surface water systems are closely interrelated. River, lake or lagoon water may be a source of aquifer recharge, which usually takes place in times of flooding. The river, lake or lagoon is then said to be influent. In times of low water, groundwater may flow into a river or lake, in which case the river or lake is said to be effluent. With some rivers there is a permanent groundwater inflow, which means that they are always effluent.

The infiltration ratio between ground and surface waters depends on the hydraulic potential of the flow and the water table level. Consequently, a change in level may result in an effluent rapidly becoming an influent or vice versa.

Research over the past fifty years has revealed the vital importance of this relationship of reciprocal dependence between surface water and groundwater.

## CHAPTER II. GROUNDWATER AND ITS EFFECTS

### A. Groundwater uses

Groundwater is put to a number of uses by man. The intensity of some of these uses depends on several factors, including available technology, the cultural and economic level of the society involved, and climate. In some cases, groundwater is limited to one use, though the number of uses to which it is put tends gradually to increase. For instance, groundwater used for cooling purposes later serves for irrigation. Modern technology has been developing methods to extend the range of uses of groundwater as well as ways of purifying it so that it may subsequently be utilized for other purposes as well.

At present, groundwater is used mainly for domestic purposes and in agriculture, industry and mining. Its geothermal energy is used to produce electricity and for heating. Thermal and mineral waters have medicinal applications, too.

Surface water also may be used for domestic, agricultural and industrial purposes. Whether or not groundwater will be used in such cases depends on economic factors and on the respective countries' policies for the protection and use of their natural resources. Factors determining the use of groundwater to meet the needs of the population may be the degree of pollution of the surface water and the high cost entailed in treating it to render it suitable for human consumption.

In some cases, the solution arrived is to use ground and surface water in certain proportions. However, for some uses, such as those involving thermal or mineral water, groundwater cannot be replaced by other kinds.

1. Domestic uses. These are among the most traditional. Man makes use of groundwater to meet his basic requirements - drinking, cooking, personal hygiene, washing clothes and cleaning work tools. In communities that are better off economically, heating, swimming pools, car washing, the watering of Lawns, garden fountains, etc., will also come under this heading.

Groundwater for domestic needs may be obtained by the individual user by means of wells located at his home or through neighbourhood or district facilities (public fountains) or through a piped water supply serving individual households. In the last two cases, the body responsible for tapping the groundwater would be either the town council or a public or private undertaking that provides the service under a concession or some other type of contract with the administrative authorities.

Other uses considered as domestic are the watering of city gardens and parks, fire fighting, the washing of streets and the supply of water to public fountains and baths.

The quantity of water required for domestic use varies with the population's standard of living, education and customs, as well as climate, etc. Generally speaking, it is estimated that between 100 and 350 litres per caput per day are required for a piped water supply to households; otherwise, for public fountain arrangements the average will be between ten and 25 litres per caput per day.

2. Industry. Water is widely used in industry. It may form part of the item - ice, beverage, foodstuff - that is being produced. It may also be used for cooling or cleaning purposes or to separate certain components by flotation or precipitation, for the conveying of products in the course of manufacture, and in chemical combinations.

More than half of industrial water is used for cooling, the actual quantities differing from industry to industry. Thermo-electric plants take up enormous quantities for this purpose. Large amounts are necessary in oil refining, to produce paper and related items and in the iron and steel industry. Between 60 000 and 376 000 litres are required to produce one ton of cardboard; between 7 000 and 34 000 to refine enough petroleum to produce 1 000 litres of gasoline, and between 8 000 and 60 000 litres to produce one ton of steel. These figures may vary depending on the water treatment and recycling methods resorted to in the respective plants.

The proportion of water used for industrial purposes varies according to each country's level of development. In Canada, for example, industry accounts for some 84 percent of the water used, while in India it takes a mere one percent.

3. Agriculture. Because of world population growth, land now being given over to agriculture is of progressively poorer quality or located in areas which require irrigation. Irrigation is a heavily consumptive use. Some crops require water of a specific quality (i.e., with a low sodium salt content). Water efficiency in irrigation is usually very low. Considerable losses occur due to evaporation and to seepage through irrigation channels. In recent decades methods to impermeabilize the channels, and other water-saving irrigation systems such as sprinklers, have been introduced.

The uses of groundwater in agriculture are specific. Some geothermal waters contain potassium chloride, which is used as fertilizer. Geothermal water also plays a major role in some modern farming techniques such as hydroponics. Low-pressure endogenous steam is used to produce a micro-climate, which, as experiments have shown, significantly enhance crop productivity. Yet another application for groundwater is in aquicultural techniques, where water condensed from geothermal vapour is exploited for its high natural plant nutrient content.

Groundwater is also used for livestock watering and for washing or cleansing the animals in dips, including medicated dips, to combat parasites or to disinfect wounds or insect bites.

4. Mining. Groundwater is put to use in two ways by the mining industry. Dissolved minerals are obtained from it; and it also serves as a means of extracting ores.

Some groundwater contains a high proportion of soluble mineral salts and is specially treated so that the borates, sodium sulphate, sodium carbonate and potassium, bromine and lithium salts, etc., can be obtained. It is also used to extract minerals in solution such as common salt, borax, potassium and phosphates. This is done by injecting water into the deposit through wells. Both the water and the dissolved minerals are then brought to the surface via the same or other perforations. Yet another mining use for groundwater is seen in the application of powerful jets to disintegrate conglomerates or "pay-dirt" and thus separate out the minerals. Groundwater, again, is used in oil wells for secondary recovery purposes.

5. Electric energy production. In the present state of the art, only relatively small quantities of electricity can be produced using geothermal

energy, and only in some regions of the world, where the hot water is harnessed by means of wells. One region producing electricity in this way is Mexicali, on the border between the United States and Mexico. Because of a geological fault here, the rocks forming the normally deeply seated mantle rise close to the surface of the earth and transmit their heat to the water in the aquifers. Electricity was first produced here in 1973, and six years later commercial operations began. The potential of the Mexicali geothermal zone is estimated at between 850 and 1 700 MW.

The coolant used in thermal and atomic power plants is usually obtained from groundwater.

6. Heating. Another use for hot water and steam is heating. On the whole, this is the major use to which medium-temperature thermal water is put.

7. Medicinal uses. Some types of groundwater, such as thermal or mineral waters, possess curative properties.

Because of the depth from which thermal water emerges or is pumped, its temperature is usually higher than normal. The geothermal gradient, that is to say the temperature rise in relation to depth, is three degrees for every 100 metres. In addition to thermal water there may be pools of hot mud, also used for medicinal purposes. An example of these are the Copahue baths in Argentina.

8. Tourism. In karstic areas, underground caves and lagoons are a tourist attraction. Well-known examples are those in Yugoslavia - the Postjanska and Skocianska caves, the Raspojana valley and the many geological formations in that country's autonomous region of Kossovo. Geysers, too, are a tourist attraction. Examples include those in the Yellowstone National Park in the United States, and in Iceland, where the excursion to the Great Geyser, whose jet can rise as high as 60 metres, is extremely popular with tourists.

#### B. Effects of groundwater use

The various uses of groundwater described in what precedes may affect the quantity and quality of the resource and the geological structure of the aquifer.

Overdrawing an aquifer causes the gradual lowering of the water table and may result in its exhaustion. When the rate at which water is abstracted exceeds its natural rate of replenishment, the aquifer is said to be overdrawn. Rational use would be that whereby withdrawals are more or less balanced by the inflow.

The manner in which groundwater is used may also affect its quality. Thus, overdrawing from an aquifer situated in proximity to a sea coast may result in saline water intrusion. This occurs along the Mar del Plata coast and at San Joaquin in California. Judicious use of the aquifer would preserve the quality of the resource by maintaining a balance between the fresh and the saline water.

In addition to determining the quality and the quantity of the resource, groundwater use can also affect the geological structure of the aquifer. Overdrawing from aquifers situated at a certain depth may cause subsidence as a consequence of the falling off of the hydraulic pressure. The recent happenings in Mexico City are a stark illustration of this.

### **CHAPTER III. INTERNATIONAL PRACTICE WITH REGARD TO GROUNDWATER**

1. General. The preceding chapters have covered a number of considerations concerning groundwater, its use by man and the effects of such use.

Aquifer recharge and discharge, described there, may take place entirely within the territory of a single State, in which case both the aquifer and its recharge zone will be located within the confines of that State and the water would not be linked to other aquifers or to any international surface waters. From the legal viewpoint, exploitation of such groundwaters falls, in principle, within the jurisdiction of the territorial State.

However, in many cases, the groundwater entering into the hydrological cycle may occur within the territory of more than one State. There is no lack of examples of this. An aquifer may be traversed by an international boundary leaving one part of it in one State and the other part in another State. It is also possible for an aquifer to be situated entirely within the territory of one State but to be hydraulically dependent upon an international river or an aquifer situated in another State; or, again, it may be situated within the territory of a particular State whilst its recharge zone may be in another. In all these examples, it is quite possible that activities affecting groundwater within the territory of one country may have repercussions extending well beyond its frontiers and may modify the natural status of the water. Over-working of an aquifer straddling an international boundary will affect the part belonging to the other State. Changing a river regime may bring about a change in the water table level in another territory. Likewise, deforestation, soil impermeabilisation or man-made climatic changes in the recharge zone of an aquifer situated in a particular State may affect the volume of water that, the neighbouring State will be able to withdraw.

The question is to determine whether, international law contains any juridical norms regulating groundwater use.

A rather simplistic approach to the problem would be to conclude that once an international border is agreed upon and demarcated, the territorial competence of each State remains perfectly clearly defined and all likelihood of dispute between them is thus removed. But this is not

a satisfactory answer since, practically speaking, some natural resources extend from the territory of one State into that of another and cannot be partitioned merely by drawing a demarcation line. In a river whose thalweg constitutes the boundary between two States fish are constantly moving from one country to the other. If one country overexploits the resource, the other suffers the consequences. In the case of a contiguous lake, if one State draws off large quantities of water, the volume of water within the territory of the other will diminish. As pointed out earlier, groundwater, too, is a natural resource which cannot be partitioned between States simply by drawing a demarcation line since the use made of the resource on one side of the border may be to the detriment of the contiguous State. All these examples highlight the need to have legal rules governing activities whose consequences may be, or indeed are, felt well beyond the territory of the State in which they are carried on.

2. The territory of the State and the subsoil. When considering international regulations for groundwater a preliminary question facing the lawyer is: to what depth does the territory of the State descend ?

So far, land frontiers have been agreed upon according to methods specified in international law. As technology progresses, this process of determining international limits has been extended to other spheres. The question of an upper limit to a State's jurisdiction over airspace arose recently following Man's conquest of space, particularly the launching of the first man-made satellite (4 October 1957). A similar problem came to the fore with respect to the law of the sea. The 1958 Geneva Convention on the Continental Shelf authorized States, for the purpose of exploiting natural resources, to extend their jurisdiction to a depth of 200 metres or beyond, where the depth of the superjacent water admits of such exploitation. Subsequently, technological progress made it possible for Man to exploit the wealth of the sea-bed, particularly the metallic nodules present there. Later, the Montego Bay Convention (1982) set an outer limit to States' jurisdiction over the continental shelf, beyond which the sea-bed becomes the common heritage of mankind. When considering this development in international law, it must be borne in mind that the questions of an upper limit to airspace and an outer limit to the continental shelf did not

arise until technological progress made the conquest or exploitation of their resources possible. This is because the law is called upon to deal with practical and not with theoretical questions, as would have been the case at the beginning of the century.

International law has not addressed itself to the question of the subsoil. When two States enter into an international border treaty, the general rule is that the borderline extends vertically into the subsoil, unless otherwise provided. The only agreements expressly stating that the borderline also applies in the subsoil are certain of those concluded by Eastern European States with their neighbours<sup>1</sup>

In answer to the question: to what depth does the territory of the State descend?, classical law replied "cujus est solum, ejus est usque ad coelum et ad inferos". The subject has been largely neglected in scholarly writing possibly because it has been of little practical interest. However, with the advances in technology it may become possible to exploit the subsoil to great depths, and the question may acquire importance in coming decades. It is possible to imagine the landward subsoil being used as territory, as a source of energy, and for mining purposes, and for tunnels for communications. It can also be a source of geothermal and atomic energy and, at considerable depths, would also yield abundant supplies of minerals.

For the purpose of this study, the question is whether groundwater, considered in terms of depth, is located within or without the territory of a State.

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<sup>1</sup> See article 4 of the agreement signed between Austria and Czechoslovakia on 12 December 1928 (L.N.T.S., vol. CVIII, p. 12); article 1, paragraph 2 of the agreement between Norway and the USSR of 29 December 1949 (U.N.T.S., vol. 83, p. 316); article 2 of the agreement between Poland and the German Democratic Republic of 6 July 1950 (U.N.T.S., vol. 319, p. 97); article 1, paragraph 2 of the agreement between the USSR and Czechoslovakia of 30 November<sup>1956</sup> (U.N.T.S., vol. 266, p. 244); article 1 of the agreement between the USSR and Iran on 14 May 1957 (U.N.T.S., vol. 457, p. 163); article 1 of the agreement between the USSR and Afghanistan of 18 January 1958 (U.N.T.S., vol. 379, p. 281); article 2 of the agreement between the USSR and Poland of 15 February 1961 (U.N.T.S., vol. 420, p. 166); article 2 of the agreement between Hungary and Romania of 13 June 1963 (U.N.T.S., vol. 576, p. 333) and article 2 of the agreement between Austria and Yugoslavia of 8 April 1965 (U.N.T.S., vol. 587, p. 170).

In various treatises on the law of nations a number of theses are put forward regarding the extension of State territory into the subsoil. Some authors maintain that the territory of the State comprises the subsoil as far as the centre of the Earth. Since our planet is round, a State's territory would be shaped rather like an inverted cone, the apex reaching into the centre of the earth<sup>2</sup>. Others consider that the territory of the State extends into the subsoil to the depth where it is technically possible to exploit it<sup>3</sup>. A third school of thought holds that the State territory extends to the depth at which technology allows it to be effectively exploited<sup>4</sup>, irrespective of whether the State is actually able to apply that technology.

The latter two theses restrict the territory of the State to a depth at which technology, whether available to the State in question or to Mankind in general, allows it effectively to be exploited, yet they concur in holding that only that State, assuming it has the technology, may go on extending its territory to ever deeper levels.

A fourth and last theory takes the geological structure of the subsoil into consideration. The Earth's crust is its outermost layer, overlying the lithosphere. In 1909, the Yugoslav seismologist Mohorovicic discovered that in his country, at a depth of some 60 kilometres, a change in the geological structure was observable - at the point where the Earth's crust ends and the lithosphere begins. This modification was given the name of Mohorovicic discontinuity after its discoverer, and it can be defined with considerable accuracy by technical means. The depths at which it is encountered vary depending on the geological structure of the continent or the ocean in question. One view is that a State's jurisdiction over its subsoil should

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2 FAUCHILLE, Traité de Droit International Public, 8th ed., Paris, 1925, t. I, deuxième partie, p. 99. SCHOENBORN "La nature juridique du territoire", R.d.C., 1929-V, pp. 146-147. OPPENHEIM, International Law, seventh ed., edited by H. Lauterpacht, London-New York-Toronto, 1948, vol. I, p. 417. GUGGENHEIM, Traité de droit international public, Geneva, 1953, t. I, pp. 377-378.

3 VERDROSS, Völkerrecht, 5th ed., Vienna, 1964, p. 274.

4 DAHM, Völkerrecht, Stuttgart, 1958, t. I, p. 620. SCHNEIDER, "Staatsgrenzen", Wörterbuch des Völkerrechts, 2nd ed., Berlin, 1962, t.III, p. 333.

descend as far as the Mohorovicic discontinuity<sup>5</sup>. The superjacent State would exercise some measure of jurisdiction over deeper layers still, until a zone was reached which would be the common heritage of Mankind.

In accordance with general and constant practice, the depths at which aquifers currently being worked are encountered fall within State jurisdiction. Accordingly, the international law may be said to acknowledge that groundwater occurs in a zone of the subsoil which is part of the territory of the State.

3. International practice. Most international frontiers were traced many centuries ago and rarely take into account the groundwater situation. This is why aquifers often straddle international boundaries, with the result that neighbouring States share the resource. Whilst this is a common occurrence along many international borders, there has been no systematic provision for it in treaties and similar international instruments. The reason in some cases is that the States do not attach importance to any disputes that might perhaps arise over shared groundwater. In other cases, neighbouring States may have adopted a particular practice regarding groundwater use which has given satisfactory results, but do not consider it necessary to embody it in the text of a convention. Yet State practice in the use of international groundwater is an important element in determining the juridical regime, since it may provide the basis from which general or particular customary rules are evolved.

Few treaties and international agreements deal with groundwater<sup>6</sup>. Relevant provisions can be found in multilateral agreements applicable to

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5 AVERY, "In Anticipation of Subterres trial Delimitation", Hastings International and Comparative Law Review, vol. 6, 1983, pp. 80 and 81.

6 A compendium of international agreements covering groundwater is contained in TECLAFF-UTTON, International Groundwater Law, London-Rome-New York, 1981, pp. 189 ff.

a continent <sup>7</sup>, a particular region <sup>8</sup>, or catchment basin <sup>9</sup>, or in bilateral agreements pertaining to water flowing contiguous to an international boundary <sup>10</sup> or to a particular aquifer <sup>11</sup>.

Yet another way of ascertaining international practice is through judicial decisions and awards. So far no international ruling on groundwater has been handed down. However, one may look for precedents in disputes arising between members of a federal State <sup>12</sup>, which can be applied to international situations. Conversely, when no express rule of

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7 See article 5 of the African Convention on the Conservation of Nature and Natural Resources of 15 November 1968 (I.UWR., vol. III, p. 968: 68/31).

8 See article 4 of the Protocol dated 17 May 1980 for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources (I.UWR. vol. V p. 980: 37/23) and article 2 of the Protocol dated 22 July 1983 for the Protection of the South Pacific against Pollution from Land-Based Sources (I.UWR., vol. V, p. 983: 54/11).

9 See articles 4 and 5 of the Statute of the Lake Chad Commission dated 22 May 1964 (I.UWR. vol. III, p. 964: 38/14 f).

10 See articles 1, 2 and 4 of the agreement dated 13 March 1965 between the German Democratic Republic and Poland (Gesetzblatt der Deutschen Demokratischen Republik, 1967, Part I, No 11, pp. 94 and 95) and article 1 of the agreement dated 22 June 1981 between Hungary and the USSR.

11 See the convention ratified by exchange of notes between Switzerland and France dated 19 July 1978 and U August 1978 regarding the protection, use and artificial recharge of the Geneva water table (LAJOUANE, Recueil des accords internationaux conclus par les Cantons suisses, Berne-Frankfurt/Main, 1982, pp. 220 ff. The convention in question was that originally made on 9 June 1978 between the Prefecture of Haute-Savoie and the Canton of Geneva.

12 See the decision of the U.S. Supreme Court on 2 March 1936 in State of Washington v. State of Oregon (United States Reports, vol. 297, pp. 517 ff).

federal law is applicable to the case, analogies in the law of nations<sup>13</sup> will be applied.

Next there are the resolutions of the international organizations and learned bodies on the use and development of international groundwater, and these are extremely useful in determining the applicable rules. Examples include the work done by the United Nations through General Assembly resolutions and the recommendations of the Conference on the Human Environment (Stockholm 1972), the Water Conference (Mar del Plata, 1977), and the Conference on Desertification (Nairobi, 1977)<sup>14</sup>. The UN International Law Commission<sup>15</sup> has also turned its attention to groundwater and to the rights to uses of international water courses<sup>15</sup>. The OECD and the European Community have also adopted resolutions relating to groundwater.

Among the work being carried forward by learned bodies, that of the International Law Association should be mentioned. As its 52nd Conference (1966) the Association approved the Helsinki Rules and appointed a

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13 Cf. FRIEDRICH, "The Settlement of Disputes between States concerning Rights to the Waters of Interstate Streams", Iowa Law Review, vol. 32, 1946-47, p. 248. COWLES, "International Law as applied between subdivisions of Federations", R.d.C., 1949-I, pp. 669-670. SCHWEBEL, Third Report on the law governing international water course uses for purposes other than navigation, Yearbook of the International Law Commission, 1982, vol. II, part One, p. 225.

With respect to more recent decisions, cf. the ruling of the German Federal Constitutional Court of 31 July 1973 (Entscheidungen des Bundesverfassungsgerichts, t. 36, p. 24); the ruling of the Swiss Federal Court of 2 July 1980 concerning the Nufenen Pass, between the Valais and Ticino cantons (Entscheidungen des Bundesgerichts, t. 106, I b, pp. 159-160) and the reports of the Argentine National Interprovincial Border Commission of 30 November 1968 (Buenos Aires-La Pampa), 14 February 1969 (Formosa-Salta), 14 March 1969 (Salta-Chao) and 27 May 1969 (Córdoba-La Pampa).

14 Regarding the role of international organization resolutions in establishing precedent, cf. VERDROSS "Kann die Generalversammlung der Vereinten Nationen das Völkerrecht weiterbilden?", Z.a.ö.R.V., 1966, p. 690; and by the same author, "Entstehungsweisen und Geltungsgrund des universellen wölkerrechtlichen Gewohnheitsrechts", Z.a.ö.R.V., 1969, p. 648.

15 See SCHWEBEL (Special Rapporteur) (Third Report), Yearbook of the International Law Commission 1982, vol. II, Part One, pp. 79 ff. For the Commission's work on groundwater, see HAYTON, "The Law of International Aquifers", N.R.J., vol. 22, 1982, pp. 80 ff.

Committee on International Water Resources Law. The latter has a working group on groundwater,<sup>16</sup> which has met on a number of occasions, the most recent being at Vancouver in August 1985. That meeting approved a draft resolution for submission to the following Conference, to be held in Seoul in 1986<sup>17</sup>.

Agreements between members of a federal State are of particular interest from the standpoint of international law<sup>18</sup>. Generally, national law is more highly developed than the law of nations with respect to groundwater regulation. This is why the agreements made between member states of a federation can throw light on the legal rules governing the use of an interjurisdictional aquifer<sup>19</sup>

By analysing international practice one can distinguish between aquifers which belong exclusively to one State and those shared by two or more States.

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16 Cf. HAYTON, "The Law of International Aquifers", N.R.J., vol. 22, 1982, pp. 73 and 78 ff.

17 INTERNATIONAL LAW ASSOCIATION, Committee on International Water Resources Law, The Law on International Groundwater Resources (Intermediate Report, rev. 2), by R.D. Hayton (Rapporteur), Vancouver, August 1985.

18 cf. CAPONERA-ALHERITIÈRE, "Principles for International Groundwater Law", Natural Resources Forum, vol. 2, 1978, pp. 359 ff. UTTON, "The Development of International Groundwater Law", N.R.J., vol. 22, 1982, pp. 104 ff.

A compendium of agreements signed between States of the United States of America in which groundwater is mentioned may be found in TECLAFF-UTTON, op. cit., pp. 276 ff.

19 Cf. ALHERITIÈRE, "International Co-operation and Inland Waters: The Influence of Federalism", N.R.J., vol. 16, 1976, p. 913. See also CANO "Los Tratados y convenios entre divisiones políticas de países federales como fuentes del derecho fluvial internacional", Revista Jurídica Argentina La Ley, t. 98, pp. 775 ff.

A. Aquifers belonging exclusively to one State

These are located entirely within the boundaries of a single State, i.e., both the formations themselves and their recharge zones. In principle, their use and development fall within the jurisdiction of the State in whose territory they are located and the law in their regard will be part of national law.

However, some international agreements will apply to this type of aquifer mainly in two cases: , first, when a servitude in respect of groundwater use is created in favour of a neighbouring State: in this case, an international agreement establishes the right of use or development by one State over an aquifer belonging to another State; secondly, when two States agree to modify an international boundary so that an aquifer belonging to one State is incorporated into the territory of the other.

4. International servitudes for groundwater. Communities are usually provided with a permanent supply of water which does not vary unless circumstances change, e.g., the if source dries up, is depleted, or becomes excessively polluted, or demands increase. In some cases, the modifying of the frontier between two States has resulted in a situation whereby the population is located in one country and its groundwater supply in another. Situations of this kind can come about when new border agreements are made following a war or when colonial powers enter into agreements on behalf of their dependent territories. In such cases, it is agreed that the population concerned may continue to use the sources which have been transferred to the neighbouring country, and accordingly, international use servitudes are sometimes created.

Exchanges of notes dated 18 March 1904 and 25 April 1904 between the United Kingdom and France constitute an agreement relating to the boundary between the Gold Coast and French Sudan, which provides that "The villages situated in proximity to the frontier shall retain the right to use ... springs and watering places, which they have heretofore used, even in cases in which such ... springs and watering places are situated within the territory of the one Power, and the village within the territory of the other "<sup>20</sup>. Exchanges of notes of 11 and 15 May 1905 between the same

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20 B.F.S.P., vol. 99, p. 206.

countries, constituting an agreement relating to the frontier between the Gold Coast and the Ivory Coast, contain a memorandum in which a similar <sup>21</sup> clause appears . A similar agreement was entered into by France and Great Britain by exchange of notes dated 19 October 1906 relating to the frontier between the British and the French possessions from the Gulf of Guinea to the Niger <sup>22</sup>. The Franco-British protocol of 10 January 1924, establishing the borders between French Equatorial Africa and the Anglo-Egyptian Sudan, grants France the right to tap the wells at Sindi, located in Sudanese territory <sup>23</sup>. A Franco-British agreement dated February 1925 established the border between Senegal and Gambia in the village of N'Baïen <sup>24</sup>. The agreement grants the inhabitants of the French side of this village the right to use water from the well situated on the British side for a period of one year.

The frontier between Turkey and Iran has been the subject of similar agreements. Article 1 of the protocol dated 4 (17) November 1913, between Great Britain, Russia, Persia and Turkey grants such a right to Turkish tribes who usually pass the summer period at the Gadyr and Lavene springs in Iran <sup>25</sup>. The Turko-Persian frontier agreement by exchange of notes dated 23 January 1932 provides that the border guards of each country may use certain springs situated near the border and either side of it <sup>26</sup>.

Article 12 of the agreement between Persia and the USSR of 26 February 1921 provides that the former shall not hinder citizens of the USSR currently using the springs found in the territory of Persia in the Kelta-Chinar Valley <sup>27</sup>.

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21 United Nations, Legislative Texts and Treaty Provisions Concerning the Utilization of International Rivers for other Purposes than Navigation (doc. ST/LEG/SER.B/12), p. 122).

22 B.F.S.P., vol. 99, p. 229; (doc. ST/LEG/SER.B/12), p. 122).

23 L.N.T.S., vol. XXVIII, p. 478. This protocol was ratified by an agreement by exchange of notes, dated 21 January 1924 (L.N.T.S., vol. XXVIII, pp. 462 ff).

24 L.N.T.S., vol. XCIII, pp. 32 and 33. This was ratified by the agreement dated 6 May 1929 (L.N.T.S., vol. XCIII, pp. 29 ff).

25 Doc. St/LEG/SER.B/12, p. 266.

26 B.F.S.P., vol. 135, pp. 676 and 677.

27 Doc. ST/LEG/SER.B/12, p. 374.

One of the oldest examples of international groundwater rights in Europe is article 20 of the agreement between Belgium and Luxembourg, dated 7 August 1843, which grants the inhabitants of Guirsch in Belgium<sup>28</sup> the right to use the spring at Oberpallen in Luxembourg<sup>28</sup>. There are numerous examples of agreements following on the two world wars. Under the provisions with respect to the German-Belgian border, established on 6 November 1922 by a boundary commission, in compliance with the Treaty of Versailles, Germany undertakes not to deepen existing wells or sink new wells in its territory which may have a negative effect on the supply from groundwater sources in German territory<sup>29</sup> to specified Belgian communities. Following the peace treaty between Italy and the Allied Powers in 1947, the former signed an agreement with Yugoslavia on 18 July 1957 relating to the provision of water to the portion of the Commune of Gorizia remaining in Italian territory<sup>30</sup>. The agreement provides that Gorizia shall be supplied from the Mrzlek source (Fontefredda), in Yugoslavia and also stipulates the conditions under which this shall be done.

The examples given illustrate international groundwater servitudes whereby use rights over aquifers that are the exclusive property of one State are granted to a neighbouring State.

5. Modifying an international frontier to take account of groundwater. To avoid the situation where an international frontier comes between a population and its source of groundwater the States concerned have in some cases agreed to adjust the border so that the water source becomes part of the country to which the population using it belongs. The Italian-Egyptian

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28 Doc. ST/LEG/SER.B/12, p. 535.

29 "Le Gouvernement allemand se porte fort que la ville d'Aix n'approfondira pas les puits existant à Lichtenbusch et à Schmidthof ni ne modifiera en aucune manière par le creusement de puits nouveaux ou de galeries nouvelles la situation actuelle de l'approvisionnement en eau des communes belges..." (N.R.G., 3ème. Série, t. 14, p. 872).

30 Article 1 states: "La République populaire fédérative de Yougoslavie continuera à assurer grâce à ses installations Mrzlek ( Fonte fredda ) ... l'alimentation en eau de la partie de la commune de Gorizia qui, aux termes du Traité de paix, est restée à l'Italie" (doc. ST/LEG/SER.B/12, p. 866).

agreement of 6 December 1925 illustrates this<sup>31</sup>. Under its terms, Italy transferred the Ramla well to Egypt so that the people of Solium could obtain drinking water. Italy also transferred an area around the well together with a strip of land to join it to Egyptian territory.

Under the Aachen arrangement of 7 November 1929, Belgium granted Germany permission to drill for groundwater at the Breitenbach source in Belgium to supply the Germany village of Kalterherberg<sup>32</sup>. The Belgian Government is to be informed of the outcome of these activities. Article 67 states that, provided the exploitation of the Breitenbach source is not detrimental to Belgium, sovereignty over it shall be transferred to Germany.

#### B. Aquifers shared between States

6. The "shared natural resource" concept. International law distinguishes three categories of natural resources - natural resources that belong to one State, natural resources that belong to the international community, and natural resources shared between two or more States.

Natural resources belonging to one State are those that lie entirely within its confines - a forest, a lake, or a sulphur or silver mine, for example - their working being governed by the laws of that State.

Natural resources belonging to the international community are those that are met with outside the territories of States and whose working is governed by international law. Examples of this category are the moon (see article 4 of the Treaty of 18 December 1979), and the seabed (article 137 of the UN Convention on the Law of the Sea).

Shared natural resources may be of two kinds. One of them comprises fluids (Liquids, gases) that transit from one State territory to another or extend over the territories of several States. The other comprises animals

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31 B.F.S.P., vol. 133, pp. 976 ff.

32 L.N.T.S., vol. CXXI, pp. 328 ff.

that migrate, or whose habitat lies, across international frontiers. According to this concept, the atmosphere, international rivers and lakes, and gas and oil fields situated astride international boundaries, as well as the animals mentioned above constitute shared natural resources.

These shared natural resources come within the exclusive jurisdiction of the State in whose territory they happen to be <sup>33</sup>; However, international law lays down certain norms that need to be respected by the sharing States.

Such shared natural resources consist of elements which of their very nature cannot be partitioned between States simply by drawing a demarcation line. A lead mine or a gold mine astride an international frontier can be so divided but this is not possible with a gas deposit because a borehole driven by one State can very well extract gas originating in the other. In the same way, to set an international boundary in a contiguous river creates no hindrance to fish passing from one side to the other, while poaching on one side will surely be to the detriment of that part of the river that belongs to the neighbouring State. The erection of a dam in a river with successive reaches in different countries for electric power generation, or for leading off for irrigation purposes, can have deleterious effects in the downstream country.

Shared natural resources which have been made the subject of more precise legal rules are, of course, the international rivers. More recently, this process has begun to be applied to wildlife, mineral

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33 The concept needs stressing here because there are States that are disinclined to subscribe to it, since in their view it implies constituting a sort of condominium or shared sovereignty over the resource, but this is not the case.

resources and the atmosphere; and the rules so introduced are similar in all three cases<sup>34</sup>.

The idea of introducing a generally applicable set of legal rules for shared natural resources emerged at the 1972 United Nations Conference on the Human Environment. Even the terminology "shared natural resource" is new, where, previously, "shared resource" had been usual. It may be said that the shared natural resources concept first came into use with a certain degree of precision with resolution 3129 (XXVIII) of the United Nations General Assembly<sup>35</sup>. At the same time, the similarity between legal rules governing the respective resources warrants the conclusion that there are certain general international law rules applying to all such resources<sup>36</sup>.

7. Groundwater as a shared natural resource. A detailed examination of international practice will show that groundwater is deemed to form part of one and the same cycle as surface waters. One form of such practice may be seen in international instruments that recognize the reciprocal dependence between underground and surface water, and embody provisions accordingly.

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34 For an illustration of the legal rules applying to international rivers, shared mineral resources, the fauna and the atmosphere, see BARBERIS, Los recursos naturales compartidos entre Estados y el Derecho internacional, Madrid, 1979, pp. 26 ff, 65 ff, 103 ff and 121 ff.

35 It should be recalled that the immediate antecedent to this rule is the Economic Declaration approved by the Fourth Summit Conference of Non-Aligned Countries, where the expression "common natural resources" is used in order to refer to shared natural resources. (Fourth Conference of Heads of State or of Government of the Non-Aligned Countries, Algiers, 5-9 September 1973, Textes fondamentaux, p. 81). Resolution 3129 (XXVIII) has "shared natural resources" in its title, though in operative provisions refer to "common natural resources". Recommendation 51 of the Stockholm Conference (paragraph (c) (viii)) uses the words "shared resource".

36 BARBERIS, op. cit., pp. 150 ff.

This dependence relationship received express recognition in the Act signed on 1 September 1957 between Greece and Yugoslavia concerning lake Dorjan. Among the hydrological research that the parties undertake to carry out in order to determine the lake regime, there figures the monitoring of the groundwater level in relation to the different levels observed in the surface water (section A, II (d))<sup>37</sup>. The Act further stresses the utility of studying the level of the water table, since this makes it possible to obtain sufficient data on the influence of the groundwater on the level of the lake, and vice versa (section B, II, (d))<sup>38</sup>.

Certain international agreements allow for the possibility that the use of groundwater may have an effect on the surface regime. Examples are the Convention between Switzerland and Austria-Hungary, of 30 December 1892, on the regulation of the Rhine<sup>39</sup>; article 29 of the agreement<sup>40</sup> between Germany and Denmark, of 10 April 1922, on frontier waters<sup>40</sup>; article 10 of the treaty between Haiti and the Dominican Republic, of 20 February 1929<sup>41</sup>; article 1 of the Franco-Swiss convention of 16 December 1962 on the protection of Lake Geneva against pollution<sup>42</sup>, and article 35 of the Statute of the River Uruguay<sup>43</sup>.

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37 Doc. ST/LEG/SER.B/12, p. 814.

38 Doc. ST/LEG/SER.B/12, p. 816.

39 B.F.S.P., vol. 84, pp. 690 and 691.

40 L.N.T.S., vol. X, p. 103.

41 L.N.T.S., vol. CV, p. 220.

42 Journal officiel de la République française, 22 Nov. 1963, p. 10405.

43 COMISIÓN ADMINISTRADORA DEL RIO URUGUAY, Documentos y antecedentes), Paysandú, 1981, p. 23.

Other instruments of the kind cater for the reverse hypothesis, namely that the working of surface waters may affect groundwater. Such are the agreement between the Kingdom of Prussia, the Kingdom of Bavaria, the Grand Duchy of Baden and the Grand Duchy of Hesse, of 21 April 1906, on the canalization of the river Main <sup>44</sup>, and the State treaties between Luxembourg and the Land Rhineland-Palatinate (25 April 1950), <sup>45</sup> on hydroelectric schemes on the rivers Sauer (Sûre) and Our (10 July 1958), respectively. Yet other examples can be cited in the conventions between France and Germany, of 27 October 1956 <sup>47</sup> and 4 July 1969, <sup>48</sup> on the Rhine in respect of the reaches between Basle and Strasbourg, and between the latter city and Lautenbourg, and, again, the convention entered into by Finland and Sweden on 16 September 1971 <sup>49</sup>.

The international organizations have in their turn adopted a series of recommendations which consider groundwater as an integral part of the hydrological cycle. As a first example of these should be cited the European Water Charter <sup>50</sup>. This document takes express cognizance of the hydrological cycle that operates in nature and states the principle (XII) that "Water knows no frontiers; as a common resource it demands international co-operation".

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44 See article 4 (2) (C.T.S., vol. 201, p. 101).

45 See article 10 (doc. ST/LEG/SER.B/12, p. 723)

46 See Annex II, paragraph 4 (doc. ST/LEG/SER.B/12, p. 734).

47 See article 4 (2) (Bundesgesetzblatt, 1076, II, p. 1865).

48 See article 2 (U.N.T.S., vol. 760, p. 308).

49 See article 1 of Chapter 3 (U.N.T.S., vol. 825, p. 281).

50 Approved by the Consultative Assembly of the Council of Europe in recommendation 493, of 28 April 1967, and by the Committee of Ministers in their resolution 67, of 26 May 1967.

The recommendation contained in document C(78)4(Final) and approved by the OECD on 5 April 1978 holds one of the main objectives of water management to be "to safeguard and improve the hydrological cycle in general". The explanatory note accompanying this recommendation states that "underground and surface waters constitute a clearly interrelated hydrological system which should be managed as a single entity."

The Economic Commission for Europe has done much interesting work on groundwater, in which due recognition is accorded to the interdependence of this resource and surface water. The declaration of policy on the rational use of water, approved by decision C (XXXIX) in 1984, makes reference to the "close interrelation" obtaining between them (Principle 3(e))<sup>51</sup>. Similarly, in the draft principles on the use of groundwater prepared by the ECE Committee in 1985, Principle 3 calls specifically for the coordinated utilization of both surface water and groundwater, taking into account that close interrelation<sup>52</sup>.

In academic writings, too, this interdependence between surface water and groundwater is fully recognized. At New York, in 1958, the International Law Association adopted a resolution stressing the need to consider the interdependence of all component elements of a basin, and making express reference to groundwater.<sup>53</sup> In 1980 the Association approved a further resolution which also recognizes the

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51 Doc. E.ECE/1084-ECE/WATER/38, p. 25.

52 Doc. WATER/GE/1/R.66, Annex, p. 1.

53 INTERNATIONAL LAW ASSOCIATION, Report of the Forty-Eighth Conference held at New York (September 1st to September 7th, 1958), London, 1959, p. ix.

reciprocal influence at work between water and other natural resources, and with other constituent elements of the environment <sup>54</sup>.

The 1976 Conference of the International Association for Water Law on Water Law and Administration (AIDA II), held at Caracas, takes the hydrological cycle as a basic premise for its recommendations, the first of which states that water should be considered from the standpoint of the unity of the hydrological cycle <sup>55</sup>. Groundwater is, of course, comprised within this cycle. Recommendation 16, b, makes this clear when it calls for the integration of groundwater management with that of all other water resources <sup>56</sup>.

A second context in which this practice of considering surface water and groundwater as forming part of one and the same cycle is that of international treaties and also the many resolutions and recommendations of the international organizations and scientific bodies.

The first steps in this direction were taken in the agreements concluded by Yugoslavia and by Poland with their neighbouring countries from 1955 onwards. Thus, the agreements concluded by Yugoslavia with Hungary (8 August 1955) <sup>57</sup> and with Albania (5 December 1956) <sup>58</sup> rely on the water system concept. Within the meaning of article 1 (3) in each of the agreements in question, a water system comprises watercourses, whether surface or underground, whether natural or man-made, and any installations, facilities or works which may affect the hydrological regime, and water-

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54 INTERNATIONAL LAW ASSOCIATION, Report of the Fifty-ninth Conference held at Belgrade (August 17th, 1980, to August 2nd, 1980)

55 INTERNATIONAL ASSOCIATION FOR WATER LAW, Annales Juris Aquarum, Caracas, 1976, vol. II, t. 1, p. CCLXXXIV. See also recommendation 32 on p. CCLXXXIX, ibid.

56 INTERNATIONAL ASSOCIATION FOR WATER LAW, Annales Juris Aquarum, vol. II, t. 1, p. CCLXXXVII.

57 Doc. ST/LEG/SER.B/12, p. 830 ff.

58 Doc. ST/LEG/SER.B/12, p. 441 ff.

courses or installations contiguous with an international frontier. This definition and the technical approach to these agreements call for certain critical remarks. In the first place, the definition of water system contemplates only underground watercourses, when the bulk of water underground is present in porous formations. In the second place, the expression water system makes no reference to contiguous rivers or to successive reaches of rivers where the contracting States are concerned but only to waters, installations, facilities and works that may affect such rivers. Lastly, it should be noted that these agreements restrict that expression to cases where there is some connection with an international frontier.

This - in any case complicated - terminology was discarded, and in the next agreement that Yugoslavia made with Bulgaria on 4 April 1958<sup>59</sup>, the simpler form was adopted which provides that matters now regulated refer to rivers, their tributaries and basins contiguous with or lying across an international frontier. A list is made of these matters, among which is contemplated "the surveying and use of groundwater". The agreement does not define basin but from a reference thereto it may be deduced that groundwater is comprised under it, as article 1 (2) (f) is explicit on the point. A further two paragraphs refer to geological surveying and exchange of statistics, plans and information where groundwater is concerned.

The agreements entered into by Poland with Czechoslovakia (21 March 1958)<sup>60</sup>, the USSR (17 July 1964)<sup>61</sup> and the German Democratic Republic (13 March 1965)<sup>62</sup> use the expression "frontier waters". The concept

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59 U.N.T.S., vol. 367, p. 104 ff.

60 U.N.T.S., vol. 538, p. 108 ff.

61 U.N.T.S., vol. 552, p. 177 ff. The USSR on 22 June 1981 concluded an agreement with Hungary in which the expression frontier waters is used in the same sense.

62 Gesetzblatt der Deutschen Demokratischen Republik, 1967, I, No. 11, pp. 93 ff. For an analysis of treaties entered into by Poland, see RUMMEL-BULSKA, "Der Schutz der Grenzgewässer im Lichte der bilateralen Verträge der Volksrepublik Polen", Fünftes deutsch-polnisches Juristen-Kolloquium, Baden-Baden, 1981, t. I, p. 81.

connotes certain surface waters and underground waters. Where groundwater is concerned, only such water when intersected by an international frontier is considered. The agreements with Czechoslovakia and the German Democratic Republic state that they affect groundwater flowing from one State to another, but only at the points where the international frontier is crossed.

These instruments, it will be noted, seek to comprise under a single concept both surface water and groundwater, but go about the task using definitions that are too complicated or too restrictive, though they do have the merit of being a first attempt in the desired direction.

Following on the treaties here described, the fact that surface water and groundwater belong to one and the same natural cycle finds expression in the basin concept. The first example of this is to be seen in the Statute of the Lake Chad Commission, of 22 August 1964<sup>63</sup>, where this concept is adapted to the realities of nature and connotes both surface water and groundwater. As time went on, the basin approach gained in importance in academic circles, to the point where it was taken as the fundamental premise underlying the Helsinki Rules on the Use of the Waters of International Rivers, which were approved by the International Law Association on 20 August 1966.<sup>64</sup> Article II of the Helsinki Rules defines the international drainage basin as "a geographical area extending over two or more States determined by the watershed limits of the system of waters, including surface waters and groundwaters flowing into a common terminus".

Recommendations 51 to 55 of the UN Environment Charter (Stockholm, 1972) refer to water resources<sup>65</sup>, the expression connoting both surface water and groundwater.

The Conference held at Caracas in 1976 on Water Law and Administration (AIDA II) also uses this expression, which again is taken to refer to both surface water and groundwater, as may be seen in recommendation 16, b,

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63 I.UWR., vol. III, p. 964: 38/1.

64 Helsinki Rules on the Use of the Waters of International Rivers adopted by the International Law Association at the 52nd Conference held in Helsinki on 20th August, 1966; London, 1967.

65 Doc. A/CONF.48/15, pp. 33 ff.

referred to earlier <sup>66</sup>. In the case of water resources encountered in the territories of more than one State, the Conference speaks of "international water resources" - in the Spanish version finding two expressions: "recursos hidráulicos internacionales" <sup>67</sup> and "recursos internacionales de agua" <sup>68</sup> - referring to waters encountered in the territories of more than one State.

The UN Water Conference held at Mar del Plata in March 1977 adopts the generic terminology of water resources. Where these extend beyond a single State, it speaks of shared water resources <sup>69</sup>, without making any distinction between surface and groundwater. In its resolution VIII it refers to the Plan of Action for the management and development of water resources, both surface and groundwater being intended <sup>70</sup>.

Following the same line of reasoning and by analogy with the Mar del Plata Plan, the Economic Commission for Europe in 1982 adopted decision D (XXXVII) on international cooperation in connection with water shared by two or more States <sup>71</sup>, again connoting these resources in their twin locations.

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66 INTERNATIONAL ASSOCIATION FOR WATER LAW, Annales Juris Aquarum, vol. II, t. I, p. CCLXXXXVII, as cited at note 56 to this Chapter.

67 Recommendation 49 (INTERNATIONAL ASSOCIATION FOR WATER LAW, Annales Juris Aquarum, vol. II, t. 1, p. CCXCV).

68 Recommendation 52, c (INTERNATIONAL ASSOCIATION FOR WATER LAW, Annales Juris Aquarum, vol. II, t. 1, pp. CCXVI and CCXVII).

69 Doc. E/CONF/70/29, pp. 51 and 53.

70 Doc. E/CONF.70/29, p. 80 (resolution VII (a)).

71 Doc. E/ECE/1084 - ECE/WATER/38, pp. 30 ff.

The OECD recommendation C(78)4(Final) cited earlier uses the expression water resources and specifies that it covers both surface water and groundwater<sup>72</sup>.

International treaties and the resolutions and recommendations of the international organizations bear out the fact that groundwater, when hydraulically connected with surface water, stands in a reciprocal relationship of dependence with the latter, and that all such waters form a natural cycle. State practice, too, corroborates what is said here. This approach leads on to the conclusion that international aquifers are seen as constituting a shared natural resource within the meaning given earlier<sup>73</sup> Current academic work tends to confirm such a conclusion, since it starts from the premise that international groundwater is a shared natural resource. The Committee on International Water Resource Law of the International Law Association held a meeting in Vancouver in August 1985. On that occasion Professor Hayton presented his report on groundwater<sup>74</sup>. Underlying this report is the same premise, namely that international groundwater is a shared natural resource<sup>75</sup>. At this same meeting, the Committee adopted rules under according to which international

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72 "Water resources, both surface (lakes, rivers, estuaries and coastal waters) and underground, should be managed ...".

73 Cf. CANO, "Trends in International Environmental Law, with Particular Reference to the Western Hemisphere", in HAGUE ACADEMY OF INTERNATIONAL LAW - UNITED NATIONS UNIVERSITY, L'avenir du droit internaional de l'environnement (Colloque 1984), p. 403.

74 INTERNATIONAL LAW ASSOCIATION, Committee on International Water Resources Law, The Law of International Groundwater Resources (Intermediate Report, rev. 2) by R.D. Hayton (Rapporteur), Vancouver, August 1985.

75 INTERNATIONAL LAW ASSOCIATION, Committee on International Water Resources Law, op. cit., p. 20 ff.

groundwater should be treated as a shared natural resource <sup>76</sup>. A further academic study meriting attention is that prepared by the Ixtapa Working Group. This is The Ixtapa Draft Agreement Relating to the Use of Transboundary Groundwaters <sup>77</sup>, and from its provisions it is clear that groundwater is considered to be a shared natural resource.

8. Limits of shared aquifers - International water systems. Once it is ascertained that some aquifers constitute shared natural resources, it is necessary to establish where their boundaries lie. This will be possible by reference to their geological structure, each aquifer being an autonomous unit. It is now possible to determine extension and limits by means of hydrogeological prospecting and geophysical techniques.

The main question, from the juridical standpoint, concerning the limits of an aquifer is to determine whether the edaphic water, i.e., that in the aeration zone, is or is not part of that aquifer. In usual State practice, groundwater is taken as being phreatic water, i.e., water encountered in the saturation zone <sup>78</sup>.

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76 INTERNATIONAL LAW ASSOCIATION, Committee on International Water Resources Law, International Groundwater Rules as Revised at Vancouver (13 August 1985).

77 See text and commentary in RODGERS-UTTTON, "The Ixtapa Draft Agreement Relating to the Use of Transboundary Groundwaters", N.R.J., vol. 25, 1985, pp. 713 ff.

78 Cf. INTERNATIONAL LAW ASSOCIATION, Committee on International Water Resources Law, The Law of International Groundwater Resources (Intermediate Report, rev. 2) by R.D. Hayton, p. 21.

Such practice receives additional confirmation in the legislation of the European Economic Community. Thus, the Council Directive of 17 December 1979 on the Protection of Groundwater against Pollution caused by Certain Dangerous Substances (80/68/5EC) <sup>79</sup> in article 1 (2) defines groundwater as meaning "all water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil".

Besides the limits of aquifers, it is necessary to determine what aquifers and structures make up a shared natural resource. Here the system concept is useful, as proposed by the UN International Law Commission, thus:

"A watercourse system is formed of hydrographic components such as rivers, lakes, canals, glaciers and groundwater constituting by virtue of their physical relationship a unitary whole; thus any use affecting waters in one part of the system may affect waters in another part.

An "international watercourse system" is a watercourse system, components of which are situated in two or more States.

To the extent that parts of the waters in one State are not affected by or do not affect uses of water in another State, they shall not be treated as being included in the international watercourse system. Thus, to the extent that the uses of the waters of the system have an effect on one another, but only to that extent..." <sup>80</sup>.

The expression "international watercourse system" is not the best suited to refer to a concept that has already been defined, since it appears to assign primacy to the water course as distinct from the other elements making up the system - lakes, glaciers, groundwater and so on. It is therefore more appropriate to speak of an international water system. Moreover, as will be explained later, a system does not only consist of the water but also contains structures or formations where that water circulates, flows or accumulates.

Accordingly, groundwater constituting a shared natural resource is groundwater that is part of an international water system, by which token it

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79 Official Journal of the European Communities, 26 January 1980, No L 20, p. 44.

80 Yearbook of the International Law Commission, 1908, vol.11, Part Two, p. 105.

is necessary to distinguish four main cases in which groundwater so forms part of an international water system. These are:

(i) - this is the simplest case - where a confined aquifer is intersected by an international boundary, and is not linked hydraulically with other groundwater or surface water and, as such, it alone constitutes the shared natural resource;

(ii) where an aquifer lies entirely within the territory of one State but is hydraulically linked with an international river. Here it is necessary to distinguish between the situations where the river is influent and where it is effluent. Thus,

- if one is dealing with an influent river and the aquifer lies in the downstream State, the use of the river water by an upstream State may affect the recharge regime; and

- if the river is effluent, excessive withdrawals from the aquifer feeding it may reduce the volume of flow in the latter.

In either example, where the aquifer is situated wholly within the territory of one State, it will form part of an international water system only if the use made of it affects the waters constituting that system; (iii) where the aquifer is situated entirely within the territory of a single State and is linked hydraulically with another aquifer in a neighbouring State, the connection may arise through the presence of a semi-permeable layer of, for example, clayey loam.

In such a case, the groundwater will flow from one aquifer to the other according to the difference in head between them. Now it may happen that intensified withdrawals from one aquifer will lead to an increase in the difference in head; and thus will intensify flow from one aquifer to the other, with a corresponding depletion in reserves. If, on the contrary, excessive withdrawals are made from an aquifer that naturally feeds another aquifer, then the piezometric level may fall in the formation and the direction of flow of the groundwater from one aquifer to the other may change;

(iv) where an aquifer is situated entirely within the territory of a given State but has its recharge zone in another State. Situations of the kind are met with in mountain areas, where the divortium aquarum at the surface does not coincide with its groundwater counterpart. Changes affecting the recharge zone, such as its becoming impermeable, may adversely in their turn affect the use made of the aquifer.

## **CHAPTER IV: LEGAL RULES GOVERNING SHARED GROUNDWATER RESOURCES**

1. General. The rules applying to groundwater have evolved considerably thanks to the progress made in hydrogeological research. In the early decades of this century, jurists thought that water behaved underground in the same way as it did on the surface. Thus, they assumed the existence of watercourses underground similar to rivers, and bodies of water similar to lakes and ponds <sup>1</sup>. Hydrogeology now tells us that most groundwater is to be found in porous water bearing strata and only exceptionally - as in certain limestone areas - in watercourses resembling rivers. Moreover, as pointed out in Chapter I, the flow of water underground comes about in very different conditions from those associated with surface waters.

Progress in science, then, has had an influence on law, and to-day it is generally accepted that international groundwaters enter into the hydrological cycle and constitute shared resources. As mentioned in the previous chapter, there are treaties and agreements and there are the resolutions of the international organizations that make use of one and the same term or expression (e.g., basin, water resources) referring to both surface and groundwater; and at other times reference is similarly made to surface water and groundwater without actually applying a single terminology in their regard <sup>2</sup>.

In current international law there are to be found rules generally applicable to groundwater shared between States; and such rules apply to all shared aquifers, save where specific provisions are made for individual cases. The 1977 United Nations Water Conference approved a recommendation (93(b)) to the effect that, "In the absence of bilateral or multilateral agreements, Member States continue to apply generally accepted principles of international law in the use, development and management of shared water resources".

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1 Cf. POKELA, "Interstate Groundwater Rights: Protecting the Interests of the States", South Dakota Law Review, vol.20, 1975, p. 643 ff.

Among authors of an earlier period may be cited NEUMEYER, "Ein Beitrag zum internationalen Wasserrecht", Festschrift für Georg Cohn zu seinem siebenzigstem Geburtstag, Zürich, 1915, pp. 157-158.

2 See for example the treaty between Italy and Switzerland of 20 April 1972 (R.G.D.I.P., 1975, pp. 265 ff.)

A. General international law

2. a) Obligation not to cause appreciable harm. The harm that one State may cause to another in connection with a given aquifer will affect the quantity or quality of the water or the associated geological structures.

As regards quantity, an aquifer can be adversely affected by withdrawal in excess of its rate of recharge or by a change in the sources whence that recharge derives. The latter state of affairs can develop, for example, if any artificial alteration is made in the volume of flow of a river feeding the aquifer in question or if any modification occurs in the terrain in the natural recharge area. Some changes, such as a change in the course of a river or the silting up of a lagoon, can lead to the exhaustion of the aquifer.

Deterioration in water quality is called pollution, and the term includes any impairment due to human agency in the composition or content of the water.

The geological structure of an aquifer can be impaired, for example, by underground nuclear testing done in a neighbouring country. Again, excessive withdrawals in certain deep-lying aquifers may lead to subsidence. Deleterious results of the kind may make themselves felt if mining activities in a neighbouring State include intentional caving methods.

In general international law, every State is under an obligation not to cause harm to another<sup>3</sup>. This refers not only to acts done directly by the organs of a State on its own territory but also to the duty of each State not to allow its territory to be used in such a way as to injure the rights of other countries<sup>4</sup>.

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<sup>3</sup> R.I.A.A., vol. II, p.839; vol. III, p.1965.

<sup>4</sup> I.C.J., Reports of Judgments 1949, p. 22.

The rule is reaffirmed in Principle 21 of the Stockholm Declaration, which reads:

"States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction<sup>5</sup>.

Recommendation 90 of the UN Water Conference stresses the need to apply this principle to shared water resources<sup>6</sup>.

With particular reference to groundwater, this same principle is invoked in article 3 of the agreement of 27 February 1974 between Czechoslovakia and the German Democratic Republic<sup>7</sup>.

Now, in international matters, it is made clear that the harm must be of a certain gravity and not a mere inconvenience. This rule has been formed through general and constant practice, and is accordingly recognized as a customary rule. Learned opinion shares this view<sup>8</sup>.

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5 On this principle see OECD, "Le devoir et la responsabilité des Etats en matière de pollution trans frontière" (Reports prepared by the Environment Committee), 1984, doc. No.24306, pp. 4 and 5. Principle 21 is also invoked by OECD in recommendations C(74)24, of 14 September 1974, and C(78)4(Final), of 5 April 1978.

6 Doc. E/CONF.70/29, p.53.

7 Sozialistische Landeskultur - Umweltschutz (Herausgegeben von der Akademie für Staats- und Rechtswissenschaft der DDR und vom Ministerium für Umweltschutz und Wasserwirtschaft), Berlin, 1978, p. 376.

8 Cf. the citations of practice and doctrine in BARBERIS, op. cit., pp. 28 ff, 66 f, 103 f, 121 ff and 150 ff. As regards international rivers, see also the Third Report by the Special Rapporteur, S.M. Schwabel, Yearbook of the International Law Commission, 1982, vol. II, part One, p. 103 ff; and LAMMERS, Pollution of International Watercourses, Boston - The Hague - Dordrecht - Lancaster, 1984, p.384. For an example of more recent practice see the ruling of the Rotterdam Court of 16 December 1983, Netherlands Yearbook of International Law, 1984, pp. 480 and 481.

Resolution 2995 (XXVII) of the United Nations General Assembly is pertinent. It states:

"The General Assembly ... Emphasizes that, in the exploration and development of their natural resources, States must not produce significant harmful effects in zones situate outside their national jurisdiction" <sup>9</sup>.

Where groundwater is concerned, a number of treaties make express reference to the rule which requires that no appreciable harm shall be caused <sup>10</sup>.

The question has sometimes been raised as to whether a State is obliged to do certain acts to modify the natural state of affairs where appreciable harm is caused to a neighbouring country. In other words, does international law only prohibit the doing of specific acts which may aggrieve a neighbour or does it also require that certain acts be done ?

The matter was tested in the dispute over the infiltration of the water of the Danube. Where that river enters the Jura region, a substantial amount of water infiltrates below ground, aided also by the limestone formations of the terrain, and some of it later reappears at the surface, to empty into the Aach, a minor tributary of the Rhine. The infiltration occurred in Baden. Württemberg, downstream, claimed that Baden had an obligation to take the necessary measures to prevent this natural seepage, which was causing serious harm by diminishing the volume of flow of the Danube. Baden countered that international law did not oblige a State to alter a natural situation within its borders <sup>11</sup>.

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9 See also articles 5 and 11 of the Nordic Environment Protection Convention, of 19 February 1974 (I.UWR., vol. IV, pp.974: 14/16 f) and article 5 (a) of the Annex under recommendation C (74) 224 of the OECD, of 14 November 1974.

10 See for example article 5 of the Statue of the Lake Chad Commission (I.UWR., vol. III, p. 964: 38/14).

11 On this question see LEDERLE, "Die Donauversinkung", Annalen des Deutschen Reichs, 1917, p. 693 ff.

The matter was decided by the Reich State Tribunal, 17/18 July 1927, by reference to international law. The disputants in the case were the Länder of Württemberg and Prussia on the one hand, and the Land of Baden on the other. The ruling found that international law forbade only the causing of appreciable harm to another State, i.e., harm brought about through human agency. A State, however, was not obliged to modify natural conditions of its terrain for the benefit of another State. On these grounds the Tribunal ruled that Baden was not obliged to prevent the Danube infiltrations as long as this was due to natural causes<sup>12</sup>.

It is clear, then, that international law requires States not to cause appreciable harm to another State. Current doctrine tends to widen the prohibition by bringing within its purview not only cases of actual appreciable harm but even those of serious risk of harm, such as might arise as a result of the erection of a nuclear-fired generating station close to an international frontier, with the source of serious radioactive pollution of aquifers that this might prove to be<sup>13</sup>.

3. Groundwater pollution. In line with article IX of the Helsinki Rules, water pollution can be defined as any detrimental change resulting from human conduct in its natural composition, content, or quality<sup>14</sup>.

An interesting feature of this definition is that pollution is at all times seem as being due to human agency. Accordingly, where an aquifer is fed from a river that naturally washes down in its course a certain amount of boron salts, making the groundwater unfit for irrigation purposes, this is not an example of "pollution". Similarly, it is not pollution where groundwater undergoes a major increase in salinity due to the evaporation occurring in parts of arid zone countries, such as the Tafilat valley in southern Morocco.

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12 Entscheidungen des Reichsgerichts in Zivilsachen, t. 116 Annex, p. 32.

13 Cf. HANDL, "An international Legal Perspective on the Conduct of Abnormally Dangerous Activities in Frontier Areas: The case of Nuclear Power Plant Siting", Ecology Law Quarterly, vol. 7, 1978-79, p. 41.

14 See also the definition of pollution in article 4 (2) of the agreement between Poland and USSR of 17 July 1964 (U.N.T.S., vol. 552, pp. 179-180) and in article 41 of the Rio Plata Treaty of 19 November 1973.

Groundwater pollution can have several causes, among them the introduction there of chemicals or microorganisms. Man's activities leading to such situations are many, and they include farming, industry, mining and the operation of urban sewerage and drainage services.

The agricultural use of pesticides and of fertilizers in excessive amounts may affect groundwater. The former comprise weedkillers, fungicides, insecticides and rodenticides. Synthetic organo-chlorines such as DDT and organo-phosphides such as malathion are the most widely used. As for fertilizers, their action on groundwater comes about through the application of nitrogen dressings, the chemical reappearing in water as nitrates. In all these examples, the phenomenon is brought about through leaching by the irrigation water or rainwater that finds its way into the underlying layers. The case may also arise where a river or stream contains these elements in solution and feeds these into an aquifer.

Industrial activities are another major source of pollution. Here the predominant factor is waste - wastewater, solid waste, smoke, gases - in all of which are to be found innumerable pollutants such as metals, acids, phenols, cyanides, oils, organic residues and petroleum products. Wastewater may be discharged into surface watercourses or bodies of water - rivers, torrents, lakes, lagoons, ponds - or on lower-lying or waterlogged land. Other potential sources are to be seen in the conveyance of fluids by means of ditches or canals, or in losses from raw material deposits, or leakages or other losses of industrial materials due to breakages, accidents or other damage occurring to tanks or piping and to underground storage. In all these examples the pollutants reach the aquifer by seepage. Rainwater contributes to the process by washing out the pollutants present in the air (acid rain) and in dissolving solids present in or under the surface of the soil. Wells or injection operations may also introduce these pollutants into an aquifer.

Mining likewise may lead to groundwater pollution. Opencast methods unquestionably hasten the process by exposing the subsoil to direct access. Underground mining techniques, where the minerals such as common salt, phosphate and borax are dissolved in water and pumped to the surface. The underground career of such water, with its load of highly contaminating substances, may have a detrimental effect on the waterbearing strata. An analogous source of pollution is the use of hollows occurring in the ground for the storage of liquified petroleum gas, natural gas or other hydrocarbons.

Urban drainage entails the evacuation of wastewater and sewage from households - nightsoil and waste from personal hygiene - and that caused by the municipal services - cleansing of thoroughfares, evacuation of rainwater and waste from the trade and industrial activities carried on in the town. In the case of groundwater, pollution from the faecal load is a matter of prime concern, since sewage contains pathogens of all kinds bacteria, viruses, protozoans and parasites. In places where there is no sewerage, household wastewater is eliminated by means of septic tanks.

In some countries, aquifers that are subject to excessive withdrawals are artificially recharged, a process which, again, may lead to pollution if the water used for the purpose is not properly treated first.

As a result of the human activities here described, pollution comes about because contaminant elements are introduced into the aquifer either by seepage by water containing them or when such water is injected of set purpose.

A further cause of groundwater pollution is to be found in excessive withdrawals. In water-bearing layers located in coastal areas which connect hydraulically with the sea, and layers linking up with semi-permeable formations containing water of acceptable quality, the overdraw may lead to saline intrusion making the aquifer unsuitable for further use.

International law has recently begun to concern itself with the important question of protecting the quality of groundwater . Earlier, the main object was to protect the water in rivers and lakes, even at the expense of groundwater <sup>15</sup>. As an example of this one may cite article 6 of the convention between France and Switzerland, of 9 March 1904, regulating fishing on lake Geneva, which provides:

"Il est interdit aux fabriques, usines ou établissements quelconques placés dans the voisinage du lac d'abandonner aux eaux les résidus ou matières nuisibles au poisson.

Ces établissements sont tenus d'organiser, à leurs frais, l'écoulement de ces matières dans le sol". <sup>16</sup>

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15 On this point see TECLAFF-TECLAFF, "Transboundary Ground Water Pollution: Survey and Trends in Treaty Law", N.R.J., vol.19, 1979, p.629 ff.

16 C.T.S., vol. 195, p. 110.

The Convention on the protection of the Rhine against pollution by chlorides, of 3 December 1976, also contemplates the solution of injecting salts into the subsoil in order to prevent a deterioration in the river water. Under its terms France - the country where the bulk of the pollution originates - agrees to drive injection wells in the vicinity of Mulhouse for the purpose, precisely, of eliminating these salts. At the same time, the Convention has a restrictive clause in article 4, to the effect that the French Government may, on its own initiative or at the request of a signatory party, suspend the injection process if it becomes clear that serious harm is being done to the environment and to the water table in particular <sup>17</sup>

No generally applicable agreement contains provisions regulating groundwater pollution. There are, however, particular agreements between certain contiguous States which deal with the question when frontier waters are affected. Examples are the agreement between the USSR and Poland, of 17 July 1964 (article 3) <sup>18</sup>, and the agreement between the German Democratic Republic and Poland, of 13 March 1965 (articles 1 and 8) <sup>19</sup>.

As provided in these instruments, it is usual for a commission to be appointed to be responsible for the protection of groundwater against pollution. Sometimes the task is assigned to a joint commission or frontier waters commission with terms of reference extending to all water-related matters, such as those set up by the agreements made by Yugoslavia with Hungary, of 8 August 1955, <sup>20</sup> Albania, of 5 December 1956 <sup>21</sup>, and

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17 I.U.W.R., vol. IV, p. 976: 90/12.

18 U.N.T.S., vol. 552, p. 179. Gesetzblatt der Deutschen Demokratischen Republik, 1967, I, No. 11, pp. 94 and 96.

20 See article 4 and the statute of the commission (doc.ST/LEG/SER.B/12, pp. 832 and 834 ff).

21 See article 4 and Annex I to the agreement (doc.ST/LEG/SER.B/12, pp. 443 and 445 ff).

Bulgaria, of April 1958<sup>22</sup>, and, again, the agreements between Finland and Sweden, of 16 September 1971<sup>23</sup>, and between Czechoslovakia and the German Democratic Republic, of 27 February 1974<sup>24</sup>. In other cases special commissions have been set up for the protection of water against pollution, their terms of reference extending to groundwater. On the other hand, these commissions concern themselves with groundwater only to the extent necessary to preserve the quality of surface waters. Under this group may be mentioned the commission for the protection of the waters of lake Geneva, set up under the Franco-Swiss convention, of November 1962<sup>25</sup>, the joint commission for the protection of Italo-Swiss waters against pollution, set up under the agreement of 20 April 1972<sup>26</sup>, and the commission for the protection of the Rhine against pollution<sup>27</sup>.

International cooperation to combat pollution has had its greatest development in Europe. The European Water Charter approved by the Council of Europe in 1967, lays down in Principle III the general rule that "surface water and groundwater need to be preserved from pollution". The Council of the European Communities has also issued several directives providing for

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22 See article 4 and the statute of the commission (U.N.T.S., vol. 367, pp. 109 and 115 ff).

23 See Chapter 4 and Annex I to the agreement (U.N.T.S., vol. 325, pp. 227 ff and 331 ff).

24 See article 13 (Sozialistische Landeskultur – Umweltschutz (Herausgegeben von der Akademie für Staats- und Rechtswissenschaft der DDR und vom Ministerium für Umweltschutz und Wasserwirtschaft)), p.378.

25 Journal officiel de la République française, 22 November 1963, p.10405.

26 R.G.D.I.P., 1975, p. 265.

27 Article 7 (2) of the Convention of on the Protection of the Rhine against chemical pollution of 3 December 1976 (I.UWR., vol. IV, p. 976: 89/21 f).

the protection of groundwater from pollution<sup>28</sup>. Among these should be noted those on the disposal of waste oils (75/439/EEC)<sup>29</sup>, of 16 June 1975; on residues from the titanium dioxide industry (78/176/EEC), of 25 February 1978<sup>30</sup>, and No 80/68/EEC of 17 December 1979 on the Protection of Groundwater against Pollution caused by Certain Dangerous Substances (80/68/EEC), of 17 December 1979<sup>31</sup>. The Economic Commission for Europe in 1980 approved (decision B (XXXV)) a declaration of principles on the preservation of water from pollution<sup>32</sup>. Principle 13, in particular, deals with the pollution of shared water resources. Yet the most complete document on the subject is unquestionably that prepared by an ECE committee in 1985<sup>33</sup>. The draft deals with all the main aspects of aquifer pollution, proposing (among others) seven principles dealing, respectively, with: seawater invasion of coastal aquifers; artificial recharge; heat storage in water tables; disposal of wastewater; pollution due to farming and mining activities, and radiological pollution.

In the context of the Americas, only one recommendation has been forthcoming, namely that of the Specialist Conference on Renewable Natural Resources (Mar del Plata, October 1965), which is directed to Member States of the Organization of American States, and calls on them to take measures to prevent the pollution of drinking water supplies<sup>34</sup>.

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28 On this subject see SCHEUR, "Aktuelle Probleme der Durchführung der EG-Gewässerschutzrichtlinien in den Mitgliedstaaten der Gemeinschaft", Zeitschrift für Umweltpolitik, 1982, pp. 65 ff. Official Journal of the European Communities, 25 July 1975, No L 194, pp. 23 ff.

30 Official Journal of the European Communities, 25 February 1978, No L 54, pp. 19 ff.

31 Official Journal of the European Communities, 26 January 1980, No L 20, pp. 43 ff.

32 Doc. E/ECE/1084-ECE/WATER/38, pp. 17 ff.

33 Doc. WATER/GE.1/R.66, Annex.

34 Doc. OAS/Ser.C.VI-9-2, p. 23. Final Report of the Inter-American Conference on Problems relating to the Conservation of the Renewable Natural Resources of the Continent, Mar del Plata, 18 to 22 Oct. 1965.

The OECD has also concerned itself with this problem, most notably in recommendation C (74) 222 of 14 November 1974 on studies on transfrontier pollution<sup>35</sup>.

Of worldwide concern is the Declaration adopted by the UN Environment Conference, together with numerous recommendations on this subject. Principle 6 of the Declaration on the Environment states:

"The discharge of toxic substances or of other substances and the release of heat, in such quantities or concentrations as to exceed the capacity of the environment to render them harmless, must be halted in order to ensure that serious or irreversible damage is not inflicted upon ecosystems. The just struggle of the peoples of all countries against pollution should be supported."

Recommendation 51 is to the effect that States are under a duty to consider "that the basic objective of all water resource and development activities from the environment point of view is to ensure the best use of water and to avoid its pollution in each country". The Conference also adopted several recommendations dealing with pollution in general.

The United Nations Water Conference of 1977 reminded States and international organizations of their need to comply with this same Stockholm recommendation 51<sup>37</sup>, and adopted several recommendations of its own on water pollution, some of them referring expressly to groundwater<sup>38</sup>.

As mentioned earlier, there is no general international instrument that lays down explicit rules on groundwater pollution; nor are there any

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35 On this point see OECD, Aspects juridiques de la pollution trans frontière, Paris, 1977.

36 Recommendations 70 to 85 (doc. A/CONF.48/14, pp. 40 ff.

37 See recommendations 36 (a) and 37 (iii) (doc. E/CONF.70/29, pp. 25 and 27).

38 See, e.g., recommendation 39 a) and 39 o) (doc. E/CONF. 70/29, pp. 28 and 29).

specific customary rules in international law. It seems from the research carried out for the present study that international law contains no specific rules on the pollution of international groundwaters. The legal rules described in the previous paragraph - to the effect that one should not cause appreciable harm to another - applies equally in the case of pollution, which, precisely, is one way in which harm may be caused.

4. b) Equitable and reasonable use. A State may, within its own territory, make use of groundwater as long as it causes no appreciable harm to another State in the process. This customary rule applies to the conduct of the State that exploits a resource and in so doing may affect the territory of its neighbour. The other basic rule governing the use made of shared natural resources is that such use shall be equitable and reasonable - the commonly employed terminology being "equitable utilization" or "equitable apportionment". The rule enjoys wide acceptance nowadays and has its place in general international law<sup>39</sup>.

The equitable/reasonable concept where international aquifers are concerned needs to be considered from two standpoints - that relating to the use in itself and that relating to the form in which the benefits deriving therefrom are to be apportioned between States. The use made of groundwater must be reasonable and equitable, and so must the apportioning of the benefits .

In recent decades, increasing demands made on groundwater, and the adverse effects of excessive withdrawals in certain instances, have awakened States to the need to manage the resource and adjust the use made of it to defined needs. To make reasonable use of an aquifer means in the first place to conserve the resource, by adapting withdrawals to the recharge regime. And reasonableness is inseparable from gearing withdrawals to

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39 For a discussion on practice and doctrine where this rule governing the use of the different shared natural resources is concerned see BARBERIS, op. cit., pp. 35 ff, 68 ff, 104 ff, 131 ff and 154 ff-, and on international rivers, see also the Third Report by S.M. Schwebel, Yearbook of the International Law Commission, 1982, vol. II, Part One, pp. 91 ff.

differing requirements. It would not be reasonable to use an aquifer mainly in order to supply ornamental fountains or boating ponds to the detriment of the drinking water supply.

The general rule of reasonable use is spelled out in principle 2 of the Stockholm Declaration:

"The natural resources of the earth including the air, water, land, flora and fauna and especially representative samples of natural ecosystems must be safeguarded for the benefit of present and future generations through careful planning or management, as appropriate."

Recommendation 51 (c) (v) of the same Conference also contains a reference to the "rational use, including a programme of quality control, of the water resources as an environmental asset".

The African Convention on the Conservation of Nature and Natural Resources (1968) extends the connotation of natural resources to groundwater and names reasonable utilization as one of its objectives<sup>40</sup>.

Among the bilateral agreements dealing with groundwater, that between the German Democratic Republic and Czechoslovakia (1974) prescribes, in article 5, specific measures for securing such reasonable use (rationelle Nutzung) of frontier waters<sup>41</sup>.

The most complete document on the subject of the present study is unquestionably the Declaration of Policy on the Rational use of water adopted by the Economic Commission for Europe in 1984 in its decision C (XXXIX)<sup>42</sup>.

Reasonable use of a natural resource also implies an approach intended to secure the maximum possible yield. This is referred to as optimization. Article 3 of the Charter of Economic Rights and Duties of States (resolution 3281.XXIX) makes express reference to it<sup>43</sup>. Among bilateral

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40 I.UWR., vol. III, p. 968: 68/28.

41 Sozialistische Landeskultur - Umweltschutz, Berlin, 1978, p. 376.

42 Doc. E/ECE/1084-ECE/WATER/38, p. 6.

43 "In the exploitation of natural resources shared by two or more countries, each State must cooperate ... in order to achieve optimum use of such resources ...".

agreements on groundwater may be cited that between the German Democratic Republic and Poland (1965), which provides in this sense <sup>44</sup>.

The apportionment of the benefits between sharing countries, too, must be equitable and reasonable. The task must be approached in such a way that each country can obtain the maximum satisfaction for its needs with the minimum harmful effects. It is not a question of mathematical precision in apportioning in exact halves, but of deciding in accordance with the needs of the respective States.

In applying the equitable utilization rule, overall account must be taken of all the benefits and disturbances that these withdrawals entail for the respective States. It may happen that, in a given case, the decision is taken on the use of an aquifer that will yield noteworthy benefits for several States in terms of drinking water supply and livestock watering, yet will result in appreciable disadvantages to irrigation in a given area of one of those States. Benefits and disadvantages must not be assessed separately for the respective uses made of the water but together, and in the process allowance must be made for social and cultural factors as well, such as the education, customs, lifestyle of the population and the latter's own scale of values.

The Stockholm Conference on the Environment refers to the equitable utilization rule when, in its recommendation 51 (b) (iii), that:

"the net benefits of hydrologic regions common to more than one national jurisdiction are to be shared equitably by the nations affected".

In its turn the UN Water Conference embodied this same rule in a recommendation (No. 91) to the effect that:

"In relation to the use, management and development of shared water resources, national policies should take into consideration the right of each State sharing the resources to equitably utilize such resources as the means to promote bonds of solidarity and cooperation" <sup>45</sup>.

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44 See article 3 (2) (Gesetzblatt der Deutschen Demokratischen Republik, 1967, I. No. 11, p. 95).

45 Doc. E/CONF.70/29, p. 53.

Equitable apportionment means that special account must be taken of the volume of water extant in the respective States. Where two States share an aquifer, an equitable solution would be that the volume that each may withdraw should be proportionate to that segment of the aquifer lying within its territory. This rule is usually applied in the working of mineral resources - gas or oil deposits - extending either side of an international frontier<sup>46</sup>.

Among the instruments dealing specifically with groundwater and embodying the equitable/reasonable rule may be mentioned the convention of 9 June 1978 between the Canton of Geneva and the Department of Haute-Savoie on the Geneva water table<sup>47</sup>. This appoints (article 2 (2)) a commission whose terms of reference are to put forward a year-by-year schedule for the use to be made of the underground aquifer as geared to the needs of the various users. Article 10 likewise provides that in order to secure une exploitation rationnelle, users and user groups shall notify the Commission at the beginning of each year of the volume of water that each proposes to withdraw.

5. c) Prior notification rule; duty to negotiate. As already pointed out, where the use of international groundwater is concerned, the applicable rules are that no appreciable harm shall ensue, and that such use shall be equitable and reasonable. There are general customary rules which govern the specific matter in question. Now, if a State is to ascertain whether a neighbouring country's plans for the use of the water or the installation of works will cause it appreciable harm or whether the use will be equitable and reasonable, then it will need to be informed of those plans. Generally, for such cases States establish a procedure whereby each will communicate these plans and the necessary data for the other to determine the likely effects of withdrawals.

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<sup>46</sup> See article 5 (1) of the agreement between Austria and Czechoslovakia, of 23 January 1960, on the Vysoká-Zwerndorf aquifer; article 2 (2) of the agreement between Germany and Denmark on the North Sea Platform, of 28 January 1971; articles 43 and 71 of the Treaty on the Rio de la Plata, of 19 November 1973, and article 32 of the Statute of the River Uruguay, of 26 February 1975.

<sup>47</sup> LEJEUNE, *op. cit.*, pp. 200 ff.

The notification procedure consists primarily in the mandatory communicating of intended groundwater withdrawals. This must be the responsibility of an organ of the government, even where the actual working of the resource is to be in private hands. The notification must give all technical details necessary in order for the other State to assess the effects likely to be felt in its territory; and it must be given sufficiently in advance for the other country or countries to do their assessing before operations are put in hand, and for them to make known their conclusions to the notifying State. Furthermore, it must be addressed to governments and not to private persons, even where the latter are those directly concerned.

In the second place, interested States may make known to the State that proposes to work the resource any objections they may have, together with scientific and technical considerations showing that the intended use will cause them appreciable harm or is not a reasonable use. As the working of the resource proceeds, the objecting States may carry out checks in the territory of the notifying State in order to ascertain whether the use corresponds to the plan as originally notified.

The procedure here described is intended as a means of giving prior notice to other countries but it is not one requiring their consent<sup>48</sup> Resource working plans are usually communicated by States sharing a natural resource<sup>49</sup> - this being recognized as a customary rule<sup>50</sup> or,

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48 Cf. UTTON, "International Environmental Law and Consultation Mechanisms", Columbia Journal of Transnational Law, 1973, p. 64.

49 Regarding international practice see BARBERIS, op. cit., pp. 45 ff, 72 ff, 108 ff, 136 ff and 156 ff.

50 Cf. UN, Management of international water resources: institutional and legal aspects, 1975 (doc. ST/ESA/5), pp. 50 and 51. JIMENEZ ARECHAGA, "International Law in the Past Third of a Century", R.d.C., 1978-1, p. 198. KIRGIS, Prior Consultation in International Law, Charlottesville (U.S.A.), 1983, pp. 86 and 128 ff.

again, "as a principle generally recognized in international environmental law"<sup>51</sup>.

The prior notification rule was recognized by the Stockholm Conference on the Human Environment (1972) in recommendation 51 (b) (i), which provides:

"... when major water resource activities are contemplated that may have a significant environmental effect on another country, the other country should be notified well in advance of the activity envisaged".

In that same year the matter was also taken up by the UN General Assembly in its resolutions 2995 (XXVII) and 2996 (XXVII). Prior notification was again discussed at the Fourth Summit Conference of Non-Aligned Countries at Algiers, 5 - 9 September 1973, and was included in paragraph XII of the Economic Declaration emanating from that Conference<sup>52</sup>.

The UN General Assembly returned to the subject in 1973 and 1974, when it approved recommendations 3129 (XXVII) and 3281 (XXIX). The latter constitutes the so-called Charter of Economic Rights and Duties of States. Article 3 provides:

"In the exploitation of natural resources shared by two or more countries, each State must co-operate on the basis of system of information and prior consultation in order to achieve optimum use of such resources without causing damage to the legitimate interest of others".

Resolutions 2995 (XXVII), 2996 (XXVII), 3129 (XXVII) and 3282 (XXIX) represent a major contribution by the General Assembly toward consolidating

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51 LAMMERS, "The Present State of Research Carried Out by the English-Speaking Section of the Centre for Studies and Research", in Académie de Droit International de La Haye - Centre d'étude et de recherche de droit international et de relations internationales, La pollution transfrontière et le droit international, 1985, p. 110. On pp. 109 ff, the author gives many examples of international practice.

52 Fourth Conference of Heads of State or of Government of the Non-Aligned Countries, Algiers, 5-9 September 1973, Textes fondamentaux, p. 81.

the prior notification and consultation principle; and they state in progressively clear language the need for such notification and consultation among States sharing a natural resource.

Contemporaneously with the work done by the United Nations, the same question of prior notification and consultation where shared resources are concerned was examined by the OECD. Thus, on 14 November 1974, the Council of that Organization adopted recommendation C(74)224, title E of the Annex dealing with this subject.<sup>53</sup> The Council subsequently extended these terms by means of recommendations C(77)28(Final) of 17 May 1977 and c(78)77(Final) of 21 September 1978.

On the prior information and consultation question, the UN Water conference approved recommendation 86 (g), which reads:

"In the absence of agreement on the manner in which shared water resources should be utilized, countries which share these resources should exchange relevant information on which their future management can be based in order to avoid foreseeable damage."

Among the bilateral agreements that deal with groundwater, one finds precise examples of the obligation of States to notify and the right of others to be notified of resource uses likely to cause appreciable harm. Clause 6 of Act No. 242 of the International Boundaries and Waters Commission, as approved by the U.S.A. and Mexico on 30 August 1973 merits consideration. This reads:

"With the objective of avoiding future problems, the United States and Mexico shall consult with each other prior to undertaking any new development of either the surface of the groundwater resources, or undertaking substantial modifications of present developments, in its own territory in the border area that might adversely affect the other country."<sup>54</sup>

A farther interesting agreement in this connection is that between Austria and Czechoslovakia of 18 November 1982 concerning nuclear

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53 For an analysis of this recommendation see SEIDL-HOHENVELDERN, "La pollution trans frontière et la recommandation C(74)224 de l'OECD.", *Temis*, No. 33-36, 1973-1974, pp. 273 ff.

54 OAS, Ríos y Lagos internacionales (Utilización para fines agrícolas e industriales) (doc. OAS/Ser.I.VI-CJI-75 rev. 2, Suppl. 1, p. 39.)

installations<sup>55</sup>. This calls for a system of information exchange and prior consultation regarding any nuclear plant to be installed or operated in areas near the frontier<sup>56</sup>. Under the system it is provided that information shall be exchanged on radioactivity monitoring in specified cases where, for example, air, surface water, the fruits of the earth and drinking water supplies are affected. To the extent that the last-mentioned are obtained from groundwater sources, they will be covered by the reciprocal information and consultation arrangements.

Among the regional agreements providing expressly for prior consultation on groundwater use may be cited the African Convention on the Conservation of Nature and Natural Resources<sup>57</sup>, article V, 2, and the Statute of the Lake Chad Commission<sup>58</sup>.

Where, following such exchange of information or consultation, a dispute arises between the State proposing to use a shared aquifer and the State assuming it will be aggrieved thereby, both States are expected to come to an agreement by diplomatic negotiation. In the Lake Lanoux case, for example, the Arbitral Tribunal held that a customary rule obtained to the effect that the States concerned must negotiate<sup>59</sup>. This obligation does not mean that agreement must perforce be reached but that the parties must negotiate<sup>60</sup> - an obligation that has been taken by the International

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55 For the text see Oesterreichische Zeitschrift für öffentliches Recht und Völkerrecht, vol. 34, 1983-84, pp. 424 ff.

56 Article 1, c) of the agreement defines a nuclear installation near the common frontier as one which, due to an unforeseen event, may cause harm to the population of the other contracting Party.

57 I.U.W.R., vol. III, p. 968: 68/31.

58 I.U.W.R., vol. III, p. 964: 38/14 f.

59 R.I.A.A., vol. XII, p. 308. Cf. BOURNE, "Procedure in the Development of International Drainage Basins: The Duty to Consult and to Negotiate", Annuaire Canadien de Droit International, 1972, p. 219,

60 "... l'engagement de négocier n'implique pas celui de s'entendre" (P.C.I.J., Annual Reports Series A/B, No. 42, p. 116). This precedent is invoked in I.C.J., Reports of Judgments 1982, p. 144 (Gros dissenting).

Court of Justice as a fundamental principle at the basis of all international relations<sup>61</sup>.

In the specific context of groundwater, the obligation to negotiate means exactly that, and implies that the negotiations shall be conducted in good faith. The parties are expected to go beyond a mere exchange of notes or talks merely going through the motions of negotiating. The latter process need not be governed by formal conditions - it may consist of meetings between technical officers of the respective Governments, in an exchange of successive drafts between the diplomatic representatives, and so on. States must so conduct themselves that the negotiation is meaningful, which is not the case when one party limits itself to reiterating its position and considers no modification of it to be possible<sup>62</sup>. Negotiations, moreover, must always be conducted in good faith<sup>63</sup>, a rule which in the Lake Lanoux case finds expression in the award, where it is affirmed that the obligation to negotiate in good faith is not respected when one party breaks off the conversations without justification, or

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61 Cf. I.C.J., Reports of Judgments 1969, p. 47. See also I.C.J., *ibid.*, 1973, p. 45 (Padilla Nervo dissenting): "The obligation to negotiate is a principle of general international law".

62 Cf. I.C.J., Recueil 1969, p. 47; award of 26 January 1972 of the arbitral tribunal on the agreement of the external debts of Germany in the dispute between Greece and Albania (Scheidegerichtshof und Gemischte Kommission für das Ablommen über deutsche Auslands schulden, Entscheidungen und Gutachten, 1970/72, p. 48. Cf. HAHN, "Das pactum de negotiando als völkerrechtliche Entscheidungsnorm", Ausserwirtschaftsdienst das Betriebs-Berates, 1972, p. 489.

63 Cf. BOURNE, *op. cit.*, Annuaire Canadien de Droit International, 1972, pp. 224 and 225. MARION, "La notion de pactum de contrahendo' dans la jurisprudence internationale", R.G.D.I.P., 1974, p. 385.

64 R.I.A.A., vol. XII, p. 315.

imposes abnormal time limits, or fails to adhere to the agreed procedure or systematically refuses to consider the proposals or the interests of the other party<sup>65</sup>.

The agreement that the parties may reach by means of negotiation may settle the matter at issue or merely consist in the choice of a method or procedure for arriving at a definitive solution<sup>66</sup>.

B. Particular cases in international law

There are cases where shared aquifers are made the subject of a treaty by the States in whose territory they are found. Some treaties provide for a joint-use regime, others for a special regime.

6. Aquifers under joint use. In international law it is necessary to distinguish between those cases in which two States exercise joint sovereignty over a given territory and those where two such States exercise jointly only the use or the working of that territory. The former situations are generally referred to as a condominium, the second as an international joint use<sup>67</sup>.

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65 R.I.A.A., vol. XII, p. 307. The Tribunal invokes as precedent the award rendered by President Coolidge, of 4 March 1925, in the Tacna - Arica case, and the advisory opinion of the Permanent Court of International Justice, of 15 October 1931, on rail traffic between Lithuania and Poland.

66 On this question see CHAUHAN, Settlement of International Water Law Disputes in International Drainage Basins, Berlin, 1981, pp. 321 ff.

67 Regarding this distinction, cf. VERDROSS, "Staatsgebiet, Staatengemeinschaftsgebiet und Staatengebiet", Niemeyers Zeitschrift Für internationales Recht, vol. 37, 1927, pp. 301 ff. VERDROSS-SIMMA, Universelles Völkerrecht, 3rd Ed., Berlin, 1984, p. 661. BARDONNET analyses a similar case (which does not concern groundwater) and also distinguishes between territorial condominium and condominium for exploitation of an aquifer ("Les frontières terrestres et la relativité de leur tracé", R.d.C., 1976-V, pp. 74, 75 and 143).

In boundary treaties entered into since the eighteenth century and up to the present, one may find provisions dealing with groundwater situated along the frontier. In order to facilitate the use of such water by the local population it is usual to agree that the frontier shall be deemed to pass through the source - a spring, for example, or a fountain - and that the two States may use the water in common.

A case in point is catered for in article 2 of the boundary treaty between France and Spain, of 22 August 1785, which determined the dividing line between Val Carlos and Quinta Real, thus:

"...mais comme cette ligne de démarcation suit en plusieurs endroits le cours des eaux et la direction des chemin, et qu'elle traverse quelques fontaines, ainsi qu'il constera par les verbaux de l'apposition des bornes, il a été convenu que toutes les eaux et les fontaines qui sont sur la ligne, seront communes entre les frontaliers des deux nations, soit pour leur propre usage, soit pour celui des leurs troupeaux..."<sup>68</sup>.

A similar example may be seen in the treaty between Italy and Switzerland, of 5 October 1861, on the determination of the frontier between Lombardy and the Canton Ticino. In the Val Rovina zone, the boundary line passes through the Trevigno fountain and the adjacent hut. The relevant part of the text reads:

"...Si è stabilito che la fontana di Trevigno sia di uso comune ai pastori dei due Stati, e libero di ogni circostanza il transito dall'Alpe di questo nome alla fontana ed all'annesso casello"<sup>69</sup>.

Likewise article 2 of the boundary treaty between Spain and Portugal, of 29 September 1864, provides:

"En atención a que la linea internacional sigue en varias partes el curso de las aguas y la dirección de los caminos y toca en algunas fuentes, se conviene en que la aguas, caminos y fuentes que se hallen en aquel caso sean de uso común para tos pueblos de ambos Reinos..."<sup>70</sup>.

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68 C.T.S., vol. 49, p. 320.

69 C.T.S., vol. 124, p. 371.

70 C.T.S., vol. 129, p. 439.

A further example is the agreement by exchange of notes between France and Great Britain, of 2 and 9 February 1888, on the boundary in Somaliland.

"Les Protectorats exercés ou à exercer par la France et la Grande Bretagne seront séparés par une ligne droite partant d'un point de la côte situé en face des puits d'Hadou et dirigée sur Abassouén en passant à travers les dits puits... . Il est expressément convenu que l'usage des puits d'Hadou sera commun aux deux parties..."<sup>71</sup>

The Franco-British protocol of 10 January 1924 establishing the limits between French Equatorial Africa and the Anglo-Egyptian Sudan provides for the frontier to pass through several wells, which are declared to be for common use by the tribes inhabiting either side of that frontier<sup>72</sup>.

On 11 December 1953 Albania and Yugoslavia signed a protocol regulating the use of the waters occurring at their common frontier<sup>73</sup>. In this, article 1 (a) refers to a well situated exactly on the dividing line and provides that its water may be used both by the inhabitants of Gorozup (Yugoslavia) and by those of Pogaj (Albania). Water may be drawn during the daytime, but not continuously by either village. The protocol also provides that when the inhabitants of one village are using the water, the frontier guard of the other country must prevent other persons approaching the well.

Here, then, the international boundary is the line clearly determined in the respective cases, yet at the same time there is a natural resource that is under joint use. This is not tantamount to bringing the territory under a condominium, for the joint entitlement holds only for the use and develop-

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71 B.F.S.P., vol. 83, p. 673.

72 The protocol declares the wells of Bouessa, Diabelouit, Tiré and Bahai (L.N.T.S., vol. XXVIII, pp. 474-475, 476 and 477) to be common. The protocol was approved by agreement by exchange of notes as mentioned supra in note 23 to Chapter III.

73. See text in Medunarodni Ugovori Federativne Narodne Republike Jugoslavije, 1955, No. 28.

ment of the groundwater, each State continuing to exercise jurisdiction within its borders for all other purposes. If the aquifer were to dry up, then the joint use would cease, and the frontier line alone would continue to be enforceable.

7. Special legal regimes. Within the regimes governing specific aquifers, the best known are those applying to groundwater, between Mexico and the U.S.A., and to the Geneva water table, between France and Switzerland.

The question of the groundwater between Mexico and the U.S.A. has been 74 the subject of many technical and juridical studies . Certain rules

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74 See BURMAN-CORNISH, "Needed; A Ground-Water Treaty between the United States and Mexico", N.R.J., vol. 15, 1975, p. 385 ff. DAY, "Urban Water Management of an International River: The Case of El Paso-Juarez", N.R.J., vol. 15, 1975, p. 453 ff. CLARK, "Institutional Alternatives for Managing Groundwater Resources: Notes for a Proposal", N.R.J., vol. 18, 1978, p. 153 ff. DAY, "International Aquifer Management; The Hueco Bolson on the Rio Grande River", N.R.J., vol. 18, 1978, p. 163 ff. HAYTON, "Institutional Alternatives for Mexico-U.S. Groundwater Management", N.R.J., vol. 18, 1978, p. 201 ff. UTTON, "International Groundwater Management: The Case of the U.S.-Mexican Frontier", Nebraska Law Review, vol. 57, No. 3, 1978, p. 633 ff. MUMME, "The U.S.-Mexican Conflict Over Transboundary Groundwaters; Some Institutional and Political Considerations", Case Western Reserve Journal of International Law, vol. 12, 1980, p. 505 ff. CHARBENEAU, "Groundwater Resources of the Texas Rio Grande Basin", N.R.J., vol. 22, 1982, p. 957 ff. EIBENSCHUTZ, "Recursos geotérmicos en la frontera noroccidental", N.R.J., vol. 22, 1982, p. 991 ff. HENRY-MORTON, "Trans-boundary Geothermal Resources of Texas and Mexico", N.R.J., vol. 22, 1982, pp. 973 ff. RINCON VALDES, "Aguas subterráneas en la region de Ciudad Juarez-El Paso", N.R.J., vol. 22, 1982, p. 939 ff. SEPULVEDA, "Los recursos hidráulicos en la zona fronteriza México-Estados Unidos. Perspectiva de la problemática hacia el año 2000 - Algunas recomendaciones", N.R.J., vol. 22, 1982, p. 1081 ff. UTTON, "An Assessment of the Management of U.S.-Mexican Water Resources: Anticipating the Year 2000", N.R.J., vol. 22, 1982, p. 1093 ff. VICTORIA MASCORRO, "Experiencia en el manejo de recursos de aguas compartidos entre México y Estados Unidos: Problemas, oportunidades y recomendaciones para el futuro", N.R.J., vol. 22, 1982, pp. 1119 ff. UTTON, "La administración internacional de aguas subterráneas; el caso de la región fronteriza México-Estados Unidos", Boletín Mexicano de Derecho Comparado, año XVI, No. 47 (May-August 1983), pp. 545 ff.

were proposed in this connection in Act No. 242 of the International Boundary and Water Commission on 30 August 1973, and these were approved by exchange of letters by these two countries on the same date. This Act No. 242 contains only a provisional set of juridical rules. Point 5 States that the conclusion of a definitive agreement is still pending regarding the frontier groundwater between the two countries. It provides that at the Arizona-Sonora frontier, in the vicinity of San Luis, and over a strip eight kilometres wide in the territory of each State, groundwater abstractions shall be limited to 197 378 000 m<sup>3</sup>. It also introduces prior consultation arrangements in connection with proposed new abstractions or any substantial modification of existing ones that might engender harmful effects in the territory of the neighbouring State <sup>75</sup>.

The convention for the protection, use and recharge of the Geneva water table was signed on 9 June 1978 between the Canton of Geneva and the Prefecture of Haute-Savoie, and was confirmed by exchange of notes between France and Switzerland on 19 July 1978 and 11 August 1978 <sup>76</sup>.

A commission is appointed to supervise groundwater use. It has a membership of six, three from either side, two of whom must be specialists in water matters.

The chief item in the commission's terms of reference is that of preparing the annual use plan. The commission also proposes measures designed to protect the groundwater against pollution, gives its technical approval for new withdrawal equipment and for any change in that already installed. It is responsible for checking building and operating costs for the pumping station that ensures the artificial recharge of the aquifer.

The commission maintains a complete inventory of public and private pumping installations in the two countries, all such installation having a metering device indicating the volume of water taken by each user.

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<sup>75</sup> For texts see doc. OAS/Ser.I/VT-CJI 75 rev. 2, Suppl.1, pp. 35 ff.

<sup>76</sup> See the texts of these instruments in LEJEUNE, *op. cit.*, pp. 200 ff.

The artificial recharge station is provided by, and is the property of, the Canton of Geneva. France's contribution to defraying the recharge costs is assessed by reference to the amount of water taken by that country's users together with the natural recharge deriving from French territory. The convention also provides for quality analysis of the water withdrawn and of the water injected in the recharge process.

From this description, it will be seen that the commission has at its command a system of control whereby it knows exactly the intensity of use of the aquifer and thus plan withdrawals in the light of users' needs <sup>77</sup>.

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<sup>77</sup> For a commentary on this convention see WITMER, Grenznachbarliche Zusammenarbeit, Zürich, 1979, pp. 134 ff.

## EPILOGUE

An examination of international practice - illustrated chiefly in treaties and other agreements and in the resolutions and recommendations of the international organizations - reveals the different ways in which international law has addressed itself to the groundwater question. In the earliest international treaties of the kind, some of them dating from the eighteenth century, the major concern is the availability of groundwater and, with it, access to wells or springs. This state of affairs lasted until the 1960s. Since then, the main concern has been pollution. The UN Conference on the Human Environment held at Stockholm in 1972 and the UN Water Conference held at Mar del Plata in 1977 have had a major role in the development of international law concerning shared aquifers. Both these conferences had a decisive influence in ensuring that international groundwaters were included in the category of shared natural resources. And this approach now commands general acceptance.

From the preceding pages, then, it is possible to establish a distinction between aquifers that are exclusive to one State and those that are shared between States.

As a general rule, the former are governed by the laws of the State in whose territory they lie; and international law will concern itself with them only if they are burdened by some servitude in favour of a neighbouring State or at times when boundaries are being adjusted in such a way as to leave an aquifer entirely within the territory of one State.

Shared aquifers, on the other hand, come under international rules. Which groundwaters come under the category of shared aquifers has been illustrated in the present study. Here it should be recalled that a shared aquifer is not simply one that is traversed by an international boundary, but the expression covers all aquifers which, even when they are situated entirely within the territory of a single State, form part of an international water system.

According to the law of nations as it stands to-day there are certain general norms applying to all international groundwaters, among them two fundamental precepts that require, first, that a State shall not cause appreciable harm beyond its frontiers and, secondly, that the use made of the resource shall be equitable and reasonable. To these two juridical norms must be added another of a procedural nature. This requires that consultation shall take place before the working of a shared aquifer is put in hand. These three rules, then, are embodied in current international law. They are customary international rules. The complete background and doctrinal premises leading to this conclusion are set forth in the preceding pages.

Among the shared aquifers there are some that come under a common-use regime. As a general rule, these lie across international frontiers. In such cases, no international condominium comes into being, because the what is subject to the common use is the groundwater and not its physical location.

Aquifers subject to a special regime have also been treated, together with the legal rules relating to their artificial recharge.

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