SHARED NATURAL RESOURCES

[Agenda item 7]

DOCUMENT A/CN.4/539 and Add.1

Second report on shared natural resources: transboundary groundwaters, by Mr. Chusei Yamada, Special Rapporteur

[*Original: English*]
[*9 March and 12 April 2004*]

CONTENTS

Introduction

1. At the fifty-fifth session of the International Law Commission, in 2003, the Special Rapporteur presented his first report on the topic of shared natural resources.[1] The report sought to provide the background to the topic. The Special Rapporteur, while envisaging covering groundwaters, oil and natural gas under the topic, proposed to begin with confined transboundary groundwaters, which had not been covered by the Convention on the Law of the Non-navigational Uses of International Watercourses (hereinafter the 1997 Convention).[2] He emphasized the vital importance of groundwaters for mankind, their distinct differences from surface waters and the need to acquire sufficient knowledge of those groundwaters. A technical briefing for members of the

[1] *Yearbook … 2003*, vol. II (Part One), document A/CN.4/533 and Add.1, p. 117.

[2] Convention on the Law of the Non-navigational Uses of International Watercourses (New York, 21 May 1997), *Official Records of the General Assembly, Fifty-first Session, Supplement No. 49*, vol. III, resolution 51/229, annex.

Commission by experts on the subject of the report was arranged by UNESCO.[3]

2. The members of the Commission commented on the various aspects of the report and gave general support to the Special Rapporteur's approach to focus on groundwaters for the time being.[4] Some serious doubt was expressed on the concept of "shared" in relation to transboundary groundwaters.

3. The discussions in the Sixth Committee of the General Assembly in 2003 indicated general support by the delegations for the Special Rapporteur's approach in his first report.[5] In most of their comments and responses, Governments encouraged the Commission to proceed with the project. However, some delegations voiced apprehension that the term "shared resources" might refer to a shared heritage of mankind or to notions of shared ownership.

4. In view of the sensitivity expressed both in the Commission and in the Sixth Committee on the term "shared" in the title of the topic, the Special Rapporteur intends to focus on the sub-topic of "transboundary groundwaters" in the present report during the time that the Commission deals exclusively with groundwaters.

5. The Special Rapporteur fully recognizes that further efforts for data collection, research and study on groundwaters are required before any definitive proposal can be formulated. Such efforts must be strenuously pursued. However, he has decided to present several draft articles in this report. He feels that the members of the Commission, who are lawyers, might find it easier to react concretely if they are presented with proposals in the form of draft articles. This is meant to provoke substantive discussions, to identify the areas to be addressed and to promote better understanding of the problems of groundwaters. He is by no means suggesting any premature formulation of draft articles. He bears in mind that the mandate of the Commission is codification and that any draft article must be substantiated by the existing international regulations, customary rules and practices of States.

6. In preparing for the present report, the Special Rapporteur has continued to receive valuable assistance from experts under the auspices of UNESCO.[6] The annexes to this report, which will provide hydrogeological and other technical background, including a review of existing relevant treaties, a world groundwater map and case studies, will be based on the inputs from those experts. He is also supported by expert members of the Study Group on Shared Natural Resources established by the Ministry of Foreign Affairs of Japan.[7] The Special Rapporteur wishes to record his most sincere appreciation for their significant contributions.

[3] The briefing was conducted at an informal meeting of the Commission by a group of experts from UNESCO, FAO and the International Association of Hydrogeologists (IAH).

[4] See *Yearbook … 2003*, vol. I, 2778th–2779th meetings, pp. 188–202.

[5] See Topical summary of the discussion held in the Sixth Committee of the General Assembly during its fifty-eighth session (A/CN.4/537), paras. 201–217.

[6] UNESCO organized an Expert Group Meeting on Shared Groundwater Resources for the Special Rapporteur in Paris on 2 and 3 October 2003, with the contribution of FAO and IAH. Alice Aureli (UNESCO) also arranged to send Shammy Puri (IAH), Gabriel Eckstein (Texas Tech University) and Kerstin Mechlem (FAO) to Tokyo to advise the Special Rapporteur from 8 to 11 December 2003.

[7] The members of the Study Group are Naoko Saiki, Yasuyoshi Komizo and Miwa Yasuda of the Ministry of Foreign Affairs, Kazuhiro Nakatani and Hum Tsuruta of the University of Tokyo, Mariko Kawano of Waseda University, Hiroyuki Banzai of Surugadai University and Naoki Iwatsuki of Rikkyo University. The Group is also assisted by Makoto Minagawa of the Graduate School of Waseda University.

Chapter I

General framework

7. There is no doubt that the most relevant existing general treaty is the 1997 Convention. In his first report, the Special Rapporteur, recalling the Commission's resolution in 1994 recommending *mutatis mutandis* application of the principles of international watercourses to groundwaters, stated that "[i]t is obvious that almost all the principles embodied in the Convention ... are also applicable to confined transboundary groundwaters".[8] This statement met with some criticism, both in the Commission and in the Sixth Committee. It was also carefully reconsidered at the UNESCO/FAO/IAH Expert Group Meeting in Paris. Some of those principles could not be transposed automatically to the management of fundamentally non-renewable and finite resources, such as transboundary groundwaters and non-renewable groundwaters. This was, for example, the case of article 5 of the 1997 Convention, which dealt with the principle of equitable and reasonable utilization. In other cases, the provisions of the Convention were too weak or required modification, given the vulnerability of groundwaters to pollution.[9] The Special Rapporteur accepts these criticisms and recognizes the need to adjust those principles. However, he still feels that the 1997 Convention offers the basis upon which to build a regime for groundwaters.

8. It is therefore proposed to consider draft articles within the following general framework, which more or less reflects that of the 1997 Convention.

Part I. Introduction

Scope of the Convention

Use of terms (definition)

[8] *Yearbook … 2003*, vol. II (Part One), document A/CN.4/533 and Add.1, p. 123, para. 20.

[9] Statements by Messrs Economides, Niehaus and Opertti Badan (*Yearbook … 2003*, vol. I, 2779th meeting, pp. 196–197 and 199) and by Brazil, India and Norway (*Official Records of the General Assembly, Fifty-eighth Session, Sixth Committee*, 20th and 21st meetings (A/C.6/58/SR.20–21)).

PART II. GENERAL PRINCIPLES

Principles governing uses of transboundary groundwaters

Obligation not to cause harm

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Relationship between different kinds of uses

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Impact assessment

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9. This framework is still preliminary and would be subject to substantial modifications. It is also noted that the draft articles on prevention of transboundary harm from hazardous activities, which were adopted by the Commission at its fifty-third session, in 2001,[10] provide a useful guide to this exercise. In this present report, the Special Rapporteur presents several draft articles for parts I and II. For the benefit of the readers, the compilation of the proposed draft articles is given in annex I to the present report.

[10] *Yearbook ...2001*, vol. II (Part Two), pp. 146–148, para. 97.

CHAPTER II

Scope of the Convention

10. The proposed draft article reads as follows:

"*Article 1*

"*Scope of the present Convention*

"The present Convention applies to uses of transboundary aquifer systems and other activities which have or are likely to have an impact on those systems and to measures of protection, preservation and management of those systems."

11. In his first report on shared natural resources,[11] the Special Rapporteur suggested using the term "confined transboundary groundwaters" to denote the body of water that was not covered by article 2 (*a*) of the 1997 Convention and that was to be the subject of the sub-topic. Upon reflection and after consultation with hydrogeologists, he now proposes to employ the term "transboundary aquifer system" in the draft articles.

12. The term "groundwaters", which has been consistently used in the Commission, should not mean all the underground waters, but a body of underground waters constituting a unitary whole which could be extracted. Although it is perfectly adequate to use the term in normal writing, it lacks precision as a legal term. It would be more appropriate to opt for the technical term "aquifer", which leaves no ambiguity. The definition of "aquifer" and the need to have reference to "aquifer system" will be studied in draft article 2 (Use of terms).

13. The term "confined" has been used in the Commission to mean "unrelated" or "not connected" to surface waters. For hydrogeologists, however, "confined" means a hydraulic state where waters are stored under pressure and does not refer to the lack of connection to a body of surface waters. Therefore, it would be advisable not to use the term "confined".

14. Furthermore, the assumption under which the Special Rapporteur started to cover only those groundwaters not covered by article 2 (*a*) of the 1997 Convention might need reconsideration. Take the case of the Nubian sandstone aquifer system.[12] It is a huge aquifer system being shared by Chad, Egypt, the Libyan Arab Jamahiriya and the Sudan. The present recharge of the aquifer is very low. It happens to be connected with the Nile south of Khartoum, although that connection is negligible. The small portion of the aquifer system around the connecting point may have similar characteristics to those of the River Nile and could be governed by the 1997 Convention. However, the greatest part of the aquifer system has the distinct characteristics of groundwaters and should be governed by the new groundwater convention. Accordingly, the Special Rapporteur decided to discard the concept of "confined", "unrelated" or "not connected". This may result in the dual applicability of the 1997 Convention and the new convention to certain groundwaters. Should a problem arise as a result of this dual applicability, an article could subsequently be drafted to set out a rule for addressing such situations.

15. The activities regulated by article 1 of the 1997 Convention are (*a*) uses of the resources and (*b*) measures of protection, preservation and management related

[11] *Yearbook … 2003*, vol. II (Part One), document A/CN.4/533 and Add.1.

[12] *Ibid*., annex II B.

to the uses of those resources. In addition to these two categories of activities, in the case of groundwaters it would also be necessary to regulate activities other than uses of the resources. Such activities would include those related to industry, agriculture and forestation carried out on the ground that adversely affect groundwaters.[13] The phrase "which have or are likely to have" could be replaced by "which involve a risk of causing". The Special Rapporteur adopted the term "impact" over "adverse effect" or "harm" as he felt that the term "impact" is more appropriate in an environmental treaty.

[13] *Ibid*., paras. 20 and 40–48, respectively.

Chapter III

Use of terms (definition)

16. The proposed draft article reads as follows:

"*Article 2*

"*Use of terms*

"For the purposes of the present Convention:

"(*a*) "Aquifer" means a permeable water-bearing rock formation capable of yielding exploitable quantities of water;[14]

"(*b*) "Aquifer system" means an aquifer or a series of aquifers, each associated with specific rock formations, that are hydraulically connected;

"(*c*) "Transboundary aquifer system" means an aquifer system, parts of which are situated in different States;

"(*d*) "Aquifer system State" means a State Party to the present Convention in whose territory any part of a transboundary aquifer system is situated.

17. An aquifer is a geological formation capable of yielding useful groundwater supplies to wells and springs. All aquifers have two fundamental characteristics: a capacity for groundwater storage and a capacity for groundwater flow. Nonetheless, different geological formations vary widely in the degree to which they exhibit these properties and their area can vary widely with a geological structure from a few square kilometres to many thousands of square kilometres.[15] Article 1 of the 1997 Convention refers to uses of both "international watercourses" and "their waters". There is no need to follow the example of the 1997 Convention, as the term "aquifer" covers both the rock formation and the waters contained in it. Recharge and discharge zones are outside aquifers.

18. Aquifers exist independently from and can also be linked with other aquifers. There are many cases where two or more adjacent aquifers have hydraulic consistency between them. In such cases, these aquifers must be treated as a single system for proper management. For example, if aquifer A is located entirely within a State, then it is a domestic aquifer and would not be subject to international regulations. However, if aquifer A has a hydraulic link with underlying aquifers B and C, one of which is transboundary, then aquifer A must be treated as part of a transboundary aquifer system consisting of aquifers A, B and C.

19. Some groundwater experts hold the view that all categories of aquifers, regardless of whether they are domestic or transboundary, must be subject to international regulations. The Special Rapporteur feels that this view of emphasizing environmental protection would not be readily accepted by Governments. Only transboundary aquifer systems will therefore be regulated for some time to come.

20. The definition of terms needs to be revisited after the context of the uses of these terms in the substantive provisions has been determined. The definition of additional terms may also be required.

[14] UNESCO-WMO, *International Glossary of Hydrology*, 2nd rev. ed. (Paris/Geneva, 1992).

[15] World Bank, Groundwater Management Advisory Team (GW-MATE) Core Group, "Characterization of groundwater systems: key concepts and frequent misconceptions", *Sustainable Groundwater Management: Concepts and Tools*, Briefing Note 2 (Washington, D.C., World Bank).

Chapter IV

Principles governing uses of aquifer systems

21. The Special Rapporteur is not yet ready to submit a draft article on principles governing uses of aquifer systems because it is first necessary to conduct further research. The problems here are manifold. The basic principles embodied in article 5 of the 1997 Convention are "equitable" use, "reasonable utilization" and participation by States "in an equitable and reasonable manner". These principles may not be automatically transposed to the case of groundwaters.

22. The principle of equitable use by the watercourse States is relevant to shared resources. The waters of international watercourses flow from the zone under the jurisdiction of an upstream State to that under the jurisdiction

of a downstream State. They are like fish stocks migrating from the zone of exclusive jurisdiction of one State to that of another. They are shared resources in the true sense of the term. In the case of a transboundary aquifer system, the waters in the system also flow naturally across borders. However, such flow is slow compared with the flow of surface waters. On the other hand, extraction of waters in a transboundary aquifer system by State A would certainly have the effect of lowering the water level of that aquifer system in State B. In this sense, the waters are shared by two States. In any event, the concept of equitable use may call for some modification *vis-à-vis* groundwaters.

23. The principle of "reasonable utilization" or "optimal" use is viable for renewable resources such as a river system and marine living resources. Scientific criteria for the optimal use of renewable resources require that the level of such resources be kept at the maximum sustainable yield. However, groundwaters may be either renewable or non-renewable. Non-renewable groundwaters can be compared to mineral resources. There would of course be political, social, economic and ecological constraints to the exploitation of such groundwaters. Several scientific criteria and tools point to and recommend the most appropriate exploitation regimes. The principle of participation by States "in an equitable and reasonable manner" also requires detailed study. It is obvious that States should have the right to participate in the management of transboundary aquifer systems. However, what other kinds of rights of participation are to be accorded to States? Does there exist any principle governing the use of groundwaters ready for codification?

Chapter V

Obligation not to cause harm

24. The proposed draft article reads as follows:

"*Article 4*

"*Obligation not to cause harm*

"1. Aquifer system States shall, in utilizing a transboundary aquifer system in their territories, take all appropriate measures to prevent the causing of significant harm to other aquifer system States.

"2. Aquifer system States shall, in undertaking other activities in their territories which have or are likely to have an impact on a transboundary aquifer system, take all appropriate measures to prevent the causing of significant harm through that system to other aquifer system States.

"3. Aquifer system States shall not impair the natural functioning of transboundary aquifer systems.

"4. Where significant harm nevertheless is caused to another aquifer system State, the State whose activity causes such harm shall, in the absence of agreement to such activity, take all appropriate measures in consultation with the affected State to eliminate or mitigate such harm and, where appropriate, to discuss the question of compensation."

25. *Sic utere tuo ut alienum non laedas* is the established principle of international liability. The draft is designed to implement this principle for activities related to groundwaters. Paragraph 1 refers to the use of a transboundary aquifer system and paragraph 2 refers to activities other than use which have a risk of causing harm. In the debates in the Commission and in the Sixth Committee, the view has been expressed that a lower threshold than "significant" harm is required for groundwaters, which are more fragile and, once polluted, take longer to purify than surface waters. Human activities at the ground surface, e.g. landfill of waste, can result in aquifer pollution. The polluted groundwater from one side of an international boundary can travel to the other. Once polluted, aquifer clean-up is slow and expensive. The detection of its sub-surface distribution can also be costly. One of the differences between surface water and groundwater resources is that, in the case of the latter, sometimes more time is needed to detect pollution. In the aquifer systems an impact generated by the present generation may be detected by future generations.[16] The Special Rapporteur, however, did not feel it necessary to find an alternative term for "significant". The threshold of "significant" harm is a flexible and relative concept. Even when groundwaters are contaminated by only small amounts of pollutants, the harm they may suffer could be evaluated as significant if the contamination has an irreversible or lasting effect.

26. The time element is also important. It might take years, decades or even more before the physical harm caused by a certain activity related to groundwaters manifests itself. This point was made by one delegation, which stated that the Commission should take a practical approach by focusing on solving current issues or those which will arise in the near future.[17]

27. Paragraph 3 deals with the situation where a transboundary aquifer system is permanently destroyed. Hydrogeologists tend to place importance on the obligation contained in the provision. What would be the justification for this principle? Is it that such destruction causes significant harm to another aquifer system State? If the retention of the principle is warranted, it might be preferable to place the paragraph in part IV of the draft articles, which deals with preservation.

28. Paragraph 4 still focuses on the aspect of prevention, as do the other paragraphs of the draft article. It does not deal with the question of international liability,

[16] Shammi Puri, ed., *Internationally Shared (Transboundary) Aquifer Resources Management—their Significance and Sustainable Management: a Framework Document*, Series on Groundwater No. 1 (Paris, UNESCO, November 2001), p. 17.

[17] *Official Records of the General Assembly, Fifty-eighth Session, Sixth Committee*, 20th meeting, statement by China (A/C.6/58/SR.20), para. 48.

though reference is made to the discussion of the question of compensation. The Special Rapporteur intends to propose at a later stage draft articles on procedures that would lead to and expedite the solution of international liability involving aquifer systems. However, he feels that the substantive question of international liability should be left to the exercise which the Commission is undertaking under the topic of "International liability for injurious consequences arising out of acts not prohibited by international law".

Chapter VI

General obligation to cooperate

29. The proposed draft article reads as follows:

"*Article 5*

"*General obligation to cooperate*

"1. Aquifer system States shall cooperate on the basis of sovereign equality, territorial integrity, mutual benefit and good faith in order to attain appropriate utilization and adequate protection of a transboundary aquifer system.

"2. In determining the manner of such cooperation, aquifer system States are encouraged to establish joint mechanisms or commissions, as deemed necessary by them, to facilitate cooperation on relevant measures and procedures in the light of experience gained through cooperation in existing joint mechanisms and commissions in various regions."

30. This draft article sets out the principle of a general obligation to cooperate among aquifer system States and the procedures for such cooperation. The draft is self-explanatory. Article 8 of the 1997 Convention referred to "optimal utilization" in its paragraph 1. For the reasons noted in paragraph 23 above, "optimal" is replaced by "appropriate" in this draft.

Chapter VII

Regular exchange of data and information

31. The proposed draft article reads as follows:

"*Article 6*

"*Regular exchange of data and information*

"1. Pursuant to article 5, aquifer system States shall, on a regular basis, exchange readily available data and information on the condition of the transboundary aquifer system, in particular that of a geological, hydrogeological, hydrological, meteorological and ecological nature and related to the hydrochemistry of the aquifer system, as well as related forecasts.

"2. In the light of uncertainty about the nature and extent of some transboundary aquifer systems, aquifer system States shall employ their best efforts to collect and generate, in accordance with currently available practice and standards, individually or jointly and, where appropriate, together with or through international organizations, new data and information to more completely define the aquifer systems.

"3. If an aquifer system State is requested by another aquifer system State to provide data and information that is not readily available, it shall employ its best efforts to comply with the request, but may condition its compliance upon payment by the requesting State of the reasonable costs of collecting and, where appropriate, processing such data or information.

"4. Aquifer system States shall employ their best efforts to collect and, where appropriate, to process data and information in a manner which facilitates its utilization by the other aquifer system States to which it is communicated."

32. Regular exchange of data and information is the first step in cooperation between transboundary aquifer system States. Article 9 of the 1997 Convention is adjusted to meet the special characteristics of groundwaters. In particular, paragraph 2 is newly drafted in view of the insufficient status of scientific findings of some aquifer systems. Data and information in this draft article are limited to those concerning the condition of aquifer systems. Data and information related to uses and other activities of transboundary aquifer systems and their impact will be dealt with later in part III of the draft articles (Activities affecting other States).

Chapter VIII

Different kinds of uses

33. The proposed draft article reads as follows:

"*Article 7*

"*Relationship between different kinds of uses*

"1. In the absence of agreement or custom to the contrary, no use of a transboundary aquifer system enjoys inherent priority over other uses.

"2. In the event of a conflict between uses of a transboundary aquifer system, it shall be resolved with special regard being given to the requirements of vital human needs."

34. Like uses of international watercourses and of their waters, uses of transboundary aquifer systems are numerous, especially in arid and semi-arid countries, where they often constitute the only source of water. Even in wetter regions, groundwaters are often the only source of drinking water since they are of better quality. Groundwaters are a source of freshwater in agriculture (irrigation), industrial development, human domestic needs and support terrestrial and aquatic ecosystems. The need for this draft article would also depend on the final formulation of the principles governing uses of aquifer systems and the factors to be taken into account in implementing such principles.

Chapter IX

Aquifer models

35. Annexes III–V of the present report on shared natural resources have been prepared in order to provide some technical and factual data on transboundary groundwaters. They include aquifer models, case studies on selected regional aquifers and a selected bibliography.[18]

36. Annex III to the present report contains models of various aquifers. Case 1 shows a domestic aquifer that is outside the scope of the proposed convention. Case 2 shows a single transboundary aquifer. Case 3 shows a domestic aquifer hydrologically connected to an international watercourse, which would be covered both by the 1997 Convention and the proposed convention. Case 4 shows a transboundary aquifer system, consisting of a series of aquifers hydrologically connected. Case 5 shows a domestic aquifer whose recharge area is located in another State. In the instance of case 5, such an area might need to be subject to certain international regulations for proper management of the aquifer.

[18] UNESCO arranged to send three experts to Tokyo in March 2004 to work together with the Special Rapporteur to prepare these annexes. Those experts are Alice Aureli and Raya Stephan of UNESCO and Jaroslav Vrba, Chairman of the IAH Commission on Groundwater Protection. Materials have been contributed by the members of the Internationally Shared Aquifer Resources Management Initiative.

Annex I

DRAFT CONVENTION ON THE LAW OF TRANSBOUNDARY AQUIFER SYSTEMS

PART I. INTRODUCTION

Article 1. Scope of the present Convention

The present Convention applies to uses of transboundary aquifer systems and other activities which have or are likely to have an impact on those systems and to measures of protection, preservation and management of those systems.

Article 2. Use of terms

For the purposes of the present Convention:

(*a*) "Aquifer" means a permeable water-bearing rock formation capable of yielding exploitable quantities of water;[a]

(*b*) "Aquifer system" means an aquifer or a series of aquifers, each associated with specific rock formations, that are hydraulically connected;

(*c*) "Transboundary aquifer system" means an aquifer system, parts of which are situated in different States;

(*d*) "Aquifer system State" means a State Party to the present Convention in whose territory any part of a transboundary aquifer system is situated.

PART II. GENERAL PRINCIPLES

Article 3. Principles governing uses of aquifer systems

[Draft to be proposed later]

Article 4. Obligation not to cause harm

1. Aquifer system States shall, in utilizing a transboundary aquifer system in their territories, take all appropriate measures to prevent the causing of significant harm to other aquifer system States.

2. Aquifer system States shall, in undertaking other activities in their territories which have or are likely to have an impact on a transboundary aquifer system, take all appropriate measures to prevent the causing of significant harm through that system to other aquifer system States.

3. Aquifer system States shall not impair the natural functioning of transboundary aquifer systems.

4. Where significant harm nevertheless is caused to another aquifer system State, the State whose activity causes such harm shall, in the absence of agreement to such activity, take all appropriate measures in consultation with the affected State to eliminate or mitigate such harm and, where appropriate, to discuss the question of compensation.

Article 5. General obligation to cooperate

1. Aquifer system States shall cooperate on the basis of sovereign equality, territorial integrity, mutual benefit and good faith in order to attain appropriate utilization and adequate protection of a transboundary aquifer system.

2. In determining the manner of such cooperation, aquifer system States are encouraged to establish joint mechanisms or commissions, as deemed necessary by them, to facilitate cooperation on relevant measures and procedures in the light of experience gained through cooperation in existing joint mechanisms and commissions in various regions.

Article 6. Regular exchange of data and information

1. Pursuant to article 5, aquifer system States shall, on a regular basis, exchange readily available data and information on the condition of the transboundary aquifer system, in particular that of a geological, hydrogeological, hydrological, meteorological and ecological nature and related to the hydrochemistry of the aquifer system, as well as related forecasts.

2. In the light of uncertainty about the nature and extent of some transboundary aquifer systems, aquifer system States shall employ their best efforts to collect and generate, in accordance with currently available practice and standards, individually or jointly and, where appropriate, together with or through international organizations, new data and information to more completely define the aquifer systems.

3. If an aquifer system State is requested by another aquifer system State to provide data and information that is not readily available, it shall employ its best efforts to comply with the request, but may condition its compliance upon payment by the requesting State of the reasonable costs of collecting and, where appropriate, processing such data or information.

4. Aquifer system States shall employ their best efforts to collect and, where appropriate, to process data and information in a manner which facilitates its utilization by the other aquifer system States to which it is communicated.

[a] See footnote 14 of the report, above.

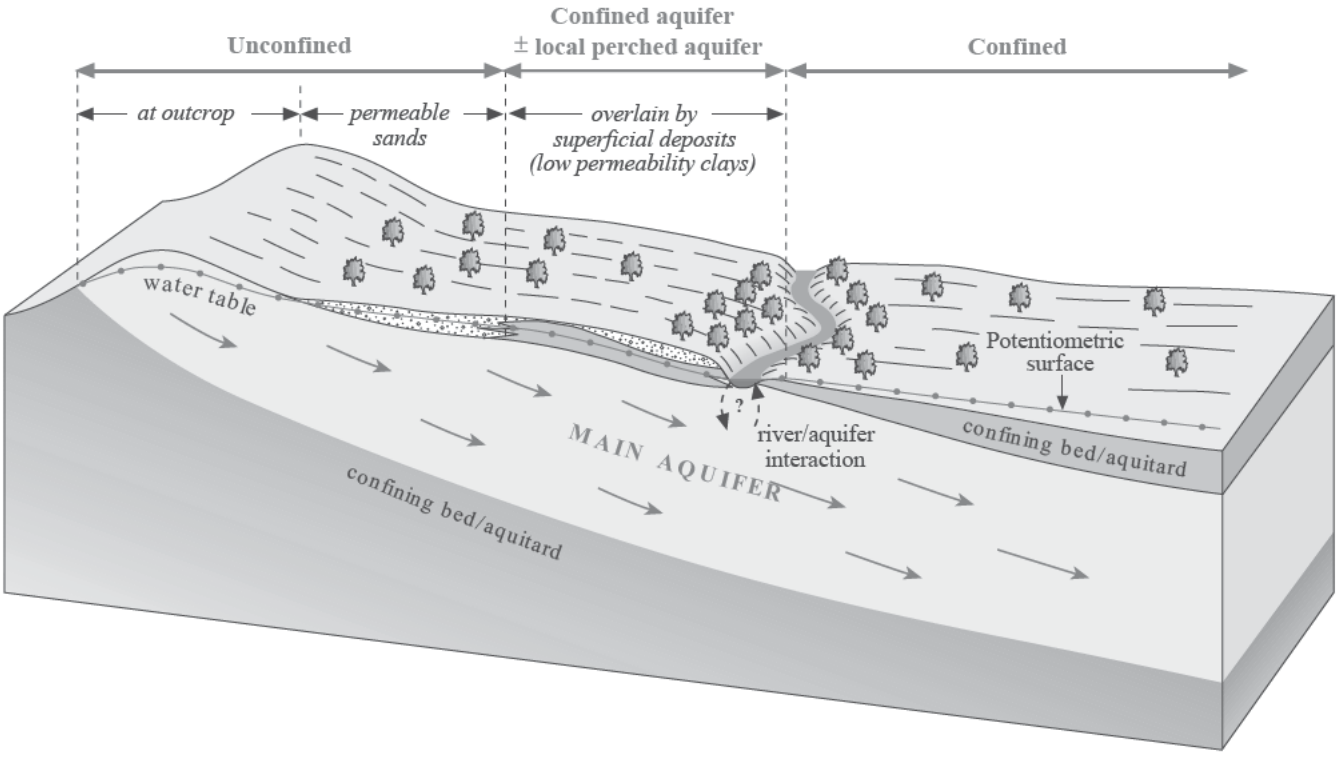
Article 7. Relationship between different kinds of uses

1. In the absence of agreement or custom to the contrary, no use of a transboundary aquifer system enjoys inherent priority over other uses.

2. In the event of a conflict between uses of a transboundary aquifer system, it shall be resolved with special regard being given to the requirements of vital human needs.

Annex II

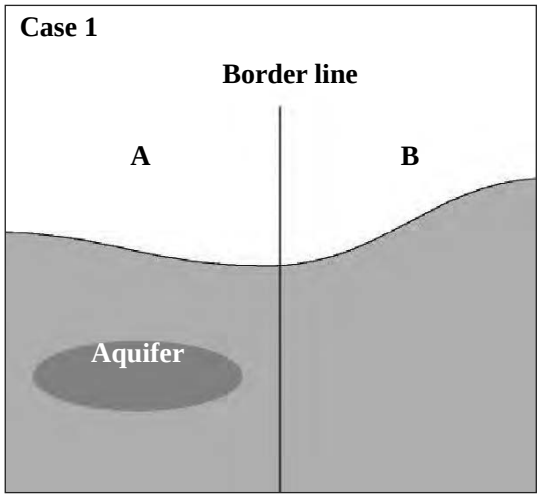
SCHEMATIC REPRESENTATION OF AN AQUIFER SYSTEM



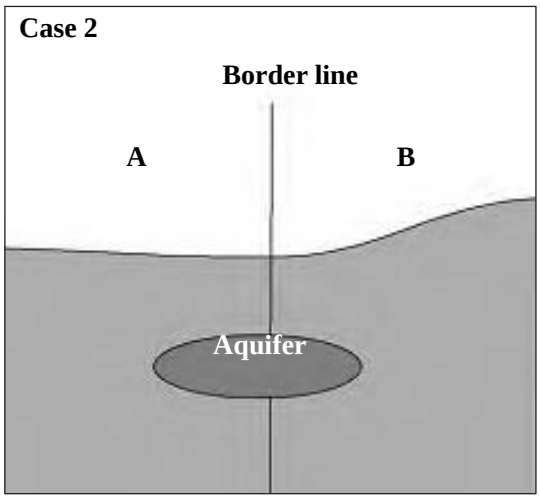
Source: B. L. Morris and others, *Groundwater and its Susceptibility to Degradation: a Global Assessment of the Problem and Options for Management*, Early Warning and Assessment Report Series, RS. 03–3 (Nairobi, UNEP, 2003).

Annex III

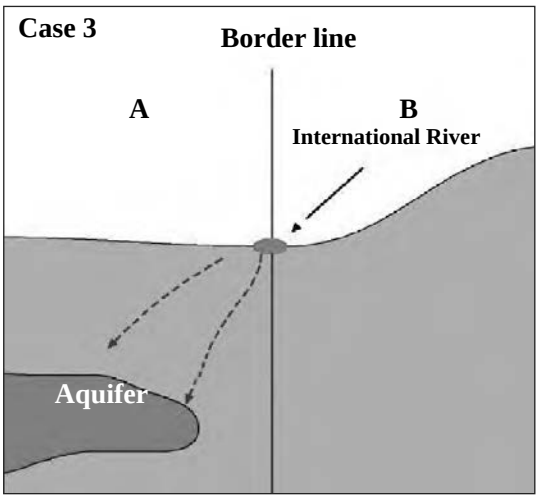
AQUIFER MODELS [a]



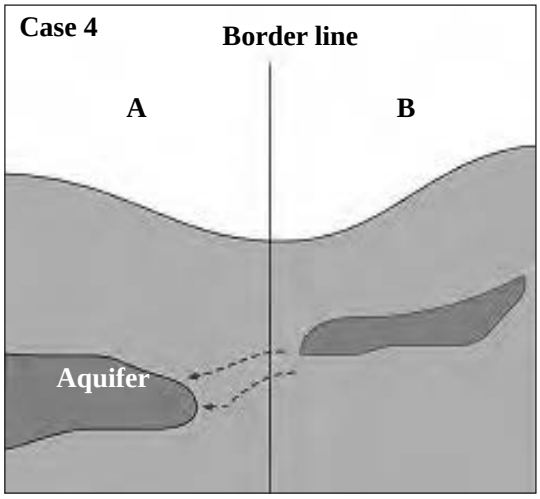
A domestic aquifer



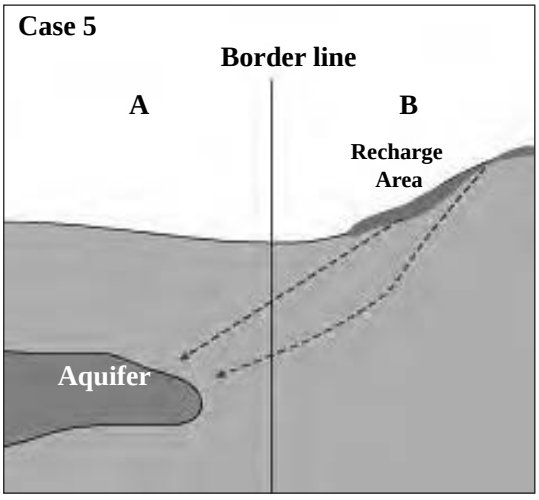
A transboundary aquifer unrelated hydrologically with surface water



An aquifer that is entirely in the territory of a State linked hydrologically with an international river



An aquifer that is entirely in the territory of a State but is hydrologically linked with another aquifer in a neighbouring State



An aquifer that is entirely in the territory of one State but whose area of recharge is in a neighbouring State. The recharge could be any body of surface water

[a] Based on the presentation by Shammy Puri, Chairman of the IAH Transboundary Aquifer Resource Management Commission and Coordinator of the International Shared Aquifer Resource Management Initiative, during the meeting held at UNESCO headquarters in Paris on 2 and 3 October 2003.

Annex IV

CASE STUDIES

A. Nubian sandstone aquifer system[a]

1. Geographical location

1. The Nubian sandstone aquifer system is one of the largest regional aquifer resources in Africa and in the world. It consists of a number of aquifers laterally and/or vertically connected, extending over more than 2 million km^2 in the eastern part of the Libyan Arab Jamahiriya, Egypt, north-eastern Chad and the northern part of the Sudan. The Nubian aquifer is a strategically crucial regional resource in this arid region, which has only a few alternative freshwater resources, a low and irregular rainfall and persistent drought and is subject to land degradation and desertification. Under current climatic conditions, the Nubian aquifer represents a finite, non-renewable and unrelated groundwater resource (the connection with the River Nile is negligible). Its filling process, that is when the recharge and discharge balance each other, is considered to have ended 8,000 years ago.

2. The aquifer system

2. The Nubian sandstone aquifer system can be differentiated into two major systems:

(*a*) The Nubian aquifer system

This part of the system occurs all over the area and constitutes an enormous reservoir of water of excellent quality in its southern part and of hyper-saline water in the north. The system is under unconfined conditions south of the 25th parallel, and under confined conditions north of it. Its thickness ranges from less than 500 metres to more than 5,000. The calculated storage capacity of the Nubian aquifer system in both its unconfined and confined parts, within the four sharing countries, exceeds 520,000. The total volume of fresh groundwater in storage is approximately 373,000 km^3. The economically exploitable volume, estimated at 150,000 km^3, represents the largest freshwater mass and one of the most important groundwater basins in the world.

(*b*) Post-Nubian aquifer system

This part of the system is located to the north of the 26th parallel in the western desert of Egypt and the north-eastern part of the Libyan Arab Jamahiriya, and is under unconfined conditions. Its cumulative thickness is about 5,000 metres. The total volume of groundwater in storage in the post-Nubian aquifer system is 845,000 km^3, while the amount of fresh groundwater is 73,000 km^3. Low permeability layers separate the two systems.

3. Groundwater extraction

3. Groundwater from the Nubian sandstone aquifer system has been utilized for centuries from the oases all over the area through springs and shallow wells. However, as a result of population growth, food demand and economic development, pressure on the supply of groundwater in the region has increased rapidly over the past decades. It is estimated that 40 billion m^3 of water were extracted from the aquifer over the past 40 years, in Egypt and the Libyan Arab Jamahiriya alone. No historical data is available for Chad and the Sudan where the present extractions and socio-economic uses are limited. Most of the present water extracted from the system is used for agriculture. Data collected shows that the present extraction represents only some 0.01 per cent of the estimated total recoverable freshwater volume stored in the system. However, this has already caused a drop of the water table, which reaches 60 metres in some places. Ninety-seven per cent of the free flowing wells and springs have already been replaced by deep wells. This has led to a rise in extraction costs as the water level falls and raises the issue of equity and affordable access to this unique water source for indigenous, low-income populations. In the arid, scarcely populated Chad section of the aquifer, concerns are focused on the protection of vulnerable ecological values, including humid zones with oases and desert lakes that depend on seepage and springs from the Nubian aquifer. It is generally accepted that the huge but non-renewable Nubian storage will be sufficient for many centuries of planned mining. It is also understood that as extractions grow with the socio-economic demands, the entire shared[b] aquifer will be affected.

4. Water quality

4. In the unconfined part of the Nubian aquifer system, water quality is good to excellent all over the area. In its confined part (to the north, in Egypt and in the Libyan Arab Jamahiriya), the water quality changes laterally and vertically; the upper part of the aquifer system contains freshwater while the lower part of the aquifer system becomes saline very rapidly.

5. The groundwater of the post-Nubian aquifer system shows a wide variation in chemical quality. In areas of intensive development, the good quality of the water is endangered by the upcoming and/or the lateral flow of saline water. There is lack of detailed information to make a synthesis of this problem, even at the regional level. Increased groundwater extraction, where it is close to the freshwater/saline water interface, may augment the risk of deterioration of the water quality by the intrusion of saline water into the freshwater.

5. International cooperation

6. Since the early 1970s, Egypt, the Libyan Arab Jamahiriya and the Sudan have expressed their interest in regional cooperation in studying and developing their shared resource. In July 1992, a joint authority was

[a] Contributed by Raya Stephan and Bo Appelgren (UNESCO).

[b] Experts use the term "shared" in this annex in the geographical sense that the aquifer is located across borders.

established between Egypt and the Libyan Arab Jamahiriya, subsequently joined by Chad and the Sudan. Among other things, the Authority is responsible for collecting and updating data, conducting studies, formulating plans and programmes for water resources development and utilization, implementing common groundwater management policies, training technical personnel, rationing the aquifer waters and studying the environmental aspects of water resources development. An integrated regional information system was developed with the support of the Center for Environment and Development for the Arab Region and Europe. On 5 October 2000, the four Member States signed two agreements on procedures for data collection, sharing and access to the system, as well as for updating the information.

B. Guarani aquifer system[c]

1. General description and beneficial uses

7. The Guarani aquifer system, also called the Mercosul aquifer, includes areas of Argentina, Brazil, Paraguay and Uruguay. It is contained in aeolian and fluvial sands, usually covered by thick basalt flows (Serra Geral Formation), which provide a high confinement. Its thickness ranges from a few metres to 800. Water of very good quality is exploited for urban supply, industry, irrigation and for thermal, mineral and tourist purposes. A project for the environmental protection and integrated sustainable management of the Guarani aquifer is being elaborated with the support of the Global Environmental Fund, the World Bank, OAS and the universities of the four abovementioned States.

2. Mathematical model and database

8. The mathematical model assists in introducing improvements in the conceptual model and better identifying the uncertainties. Data needs to be consistent and comparable. It would be necessary to create, arrange and disseminate a full database, to be shared by all stakeholders of the Guarani aquifer system. A *Consejo Superior*, drawn from the four States, has been established to coordinate the work programme for the management of a study of the aquifer resources. Guarani consultative meetings were held in August 2001 to discuss the international shared aquifer resource management programme and its scope.

3. Essential data

9. Surface area: 1,200,000 km^2.

Population: 15 million inhabitants, 6 million living where the aquifer outcrops.

Resources in storage: 40,000 km^3.

Current production: More than 700 wells draw 1,000 m^3 per hour by pumping or 100 to 500 m^3 per hour using surge wells.

[c] Contributed by Emilia Bocanegra and Carlos Fernandez-Jáuregui in case studies from *Internationally Shared (Transboundary) Aquifer Resources Management* (see footnote 16 of the report, above).

C. Franco-Swiss Genevese aquifer[d]

1. Geographical location

10. The Franco-Swiss transboundary Genevese aquifer extends between the southern extremity of Lake Geneva and its effluent the Rhone River. The aquifer is located partly on the southern border of the Canton of Geneva with the French Department of Haute Savoie. The aquifer is crossed over from east to west by the Arve River, a tributary of the Rhone originating in France, and thus benefits from natural recharges averaging 7.5 million m^3 per annum. The average water level is between 15 and 80 metres deep.

2. Groundwater extraction

11. The Genevese aquifer is exploited for drinking water supply by 10 wells on the Swiss side and 5 on the French side. The total extracted volume of water averages 15 to 17 million m^3 per annum, out of which the French withdrawals represent some 2 million m^3. Between 1940 and 1960, water extractions from the Genevese aquifer were very close to the average natural recharge. Between 1960 and 1980, the aquifer was overdrafted, with extractions reaching up to 14 million m^3 in 1971, almost twice its potential yield. Such an overpumping has lowered the water table by more than 7 metres in 20 years, reducing the total groundwater storage by about one third. For this reason, the Canton of Geneva initiated negotiations with the French Department of Haute Savoie to consider the implementation of a recharge installation for the joint management of the transboundary aquifer.

3. International cooperation

12. The negotiations between the Canton of Geneva and the French Department of Haute Savoie were concluded in 1977 with the signature of an arrangement on the protection, utilization and recharge of the Franco-Swiss Genevese aquifer. The agreement entered into force on 1 January 1978.

13. The essential provisions of the arrangement cover the following matters:

(*a*) *The Commission*

The arrangement created a Genevese Aquifer Management Commission, composed of three members from each party, with the stipulation that two members of each delegation must be water specialists (art. 1). The mandate of the Commission is to propose a yearly aquifer utilization programme, taking into account, as far as possible, the needs of various users on each side of the border, to formulate any proposals required to ensure the protection of the resource and to remedy possible causes of pollution (art. 2, para. 1). The Commission gives its technical opinion on new water extraction works and utilization, as well as on the modification of existing ones and audits the construction and operation costs of the groundwater recharge installation (art. 2, paras. 2–3). The Commission has the duty to take an inventory of all exist-

[d] Contributed by Raya Stephan (UNESCO).

ing waterworks allowing the utilization of the resources of the aquifer, whether public or private (art. 4). All waterworks must be equipped with a device for the recording of the volume of water extracted from the aquifer. Such a device shall be gauged and sealed at the initiative of the Commission. Water extractions shall be read and registered periodically (art. 6).

(*b*) *The groundwater recharge installation*

The arrangement provides (art. 8) for the Republic and Canton of Geneva to construct and to operate the required groundwater recharge installation of which it is and remains the sole owner. The Canton is liable for any damages caused to the quality of the waters of the aquifer resulting from failure to maintain the recharge installation (art. 18, para. 1).

(*c*) *Water rights*

Article 9, paragraph 1, provides that, based on the dimensions and capacity of the artificial recharge installation, the French authorities shall ensure that the aggregate of water extractions by the users located within French territory shall not exceed 5 million m^3, inclusive of a free allocation of 2 million m^3. Exceptionally, the Swiss party may request the French party to forfeit part or all of its free allocation.

(*d*) *Water pricing*

The Canton of Geneva has proceeded with the computation of the corresponding construction costs of the groundwater recharge installation. The operational costs are reconciled yearly. The French share is then computed yearly, including the French contribution to the construction of the groundwater recharge installation (amortization annuity) and the operational costs in proportion to the total volume extracted by French users.

(*e*) *Water quality*

Water extracted from the aquifer shall be analysed by both sides on the basis of standard qualitative analysis criteria established by the Genevese Aquifer Management Commission; such analyses shall be made at regular intervals (art. 16). A warning system shall be maintained in the case of accidental pollution likely to affect the water quality of the aquifer (art. 17). The French and Swiss collectivities are liable for acts of pollution occurring within their national territories.

14. The arrangement has been concluded for a period of 30 years (art. 19). It is automatically renewable for periods of five years unless terminated by either party serving the other a one year prior notice. The 1978 arrangement between the Canton of Geneva and the French Department of Haute Savoie has adopted a pragmatic approach, and now represents more than 25 years of practical success.

D. Mexico-United States of America border[e]

15. Along their common border, Mexico and the United States share surface water, mainly in the Rio Grande (Rio Bravo in Mexico) and Colorado rivers as well as groundwater in at least 15 aquifers. The fact that most of the common border lies within water-scarce regions has resulted in intense competition over the water resources of the two major rivers and also of the aquifers. This is illustrated in the two examples below: the El Paso-Juárez case and the Upper San Pedro River Basin case.

1. Bilateral cooperation

16. Mexico and the United States have concluded several treaties since the nineteenth century related to their common border. The table below lists some recent agreements related to the environment and water resources. No agreement related to groundwater management exists,

Date	Agreement	Purpose
14 November 1944	"Water treaty"[f]	To regulate the utilization of the Colorado and Tijuana Rivers, and of the Rio Grande (Rio Bravo). Creates the International Boundary and Water Commission with one section in the United States and one in Mexico
30 August 1973	Minute 242: Permanent and definitive solution to the international problem of the salinity of the Colorado River	The Minute incorporates the decisions adopted to definitely solve the salinity problem of the Colorado River. The Minute limits groundwater pumping in the immediate vicinity of the Arizona-Sonora Boundary (concerns the Yuma Mesa aquifer) "*[p]ending the conclusion by the Governments of the United States and Mexico of a comprehensive agreement on groundwater in the border areas*"*
14 August 1983	Agreement on co-operation for the protection and improvement of the environment in the border area[g]	Establish the basis for cooperation between the parties for the protection, improvement and conservation of the environment
13 November 1992	Minute 289 of the International Boundary and Water Commission—observation of the quality of the waters along the United States and Mexico border	The International Boundary and Water Commission will develop an appropriate monitoring programme and database for the observation of the quality of the surface and groundwaters under the Integrated Border Environment Plan (25 February 1992)

[e] Contributed by Raya Stephan (UNESCO).

[f] Treaty relating to the utilization of the waters of the Colorado and Tijuana Rivers, and of the Rio Grande (Rio Bravo) from Fort Quitman, Texas, to the Gulf of Mexico (Washington, D.C., 3 February 1944), and Supplementary Protocol (Washington, D.C., 14 November 1944), United Nations, *Treaty Series*, vol. 3, No. 25, p. 313.

[g] Signed at La Paz, Baja California (United Nations, *Treaty Series*, vol. 1352, No. 22805, p. 67).

despite the recommendation made in Minute 242 of the International Boundary and Water Commission.[h]

2. The El Paso-Juárez case

17. The two adjacent border cities of El Paso, Texas, United States, and Ciudad Juárez, Chihuahua, Mexico, face a severe water crisis. The region, which is home to close to 2 million people, has a climate typical of arid to semi-arid regions (the annual rainfall is less than 17 mm). The main sources of water are the Rio Grande and two aquifers, the Hueco Bolson and the Mesilla Bolson.

18. The Hueco Bolson, the primary source of water, extends northwards into New Mexico (United States) and southwards into Mexico. El Paso currently depends on groundwater from the Hueco Bolson for about 45 per cent of its water needs. The rest is provided from the Rio Grande (40 per cent) and the Mesilla Bolson (15 per cent). Ciudad Juárez, which has roughly double the population of El Paso, depends entirely on water from the Hueco Bolson to meet its demand.[i] It is estimated that the aquifer will be depleted of all freshwater that can be economically retrieved by 2025, or even earlier. Since 1940, the level has dropped by as much as 45 metres.

19. The Mesilla Bolson is located primarily in New Mexico, with small portions in Mexico and Texas. The Rio Grande is considered its main source of recharge. Water levels in the aquifer remain relatively constant.

20. Water quality in the Hueco Bolson has been degraded over time as a result of groundwater withdrawals and other human activities. The water quality pumped from the Mesilla Bolson improves with the depth of wells. While the aquifer is showing some level of water quality deterioration, the overall quality is better than in the Hueco Bolson. Generally, historical large-scale groundwater withdrawals, especially from municipal well fields in the downtown areas of El Paso and Ciudad Juárez, have caused major water-level declines. These declines, in turn, have significantly changed the direction of flow, rate of flow and chemical quality of groundwater in the aquifers.

21. The region has experienced a very high growth rate, especially on the Mexican side. As the population growth is expected to continue, so is the demand for water. Through strict conservation efforts, the city of El Paso has reduced its per capita water use. However its per capita consumption (around 600 litres per person per day) is double that of Ciudad Juárez where hundreds of thousands of residents live without direct water supply in their households. Beyond the specific issue of groundwater depletion, the case underlines the wider issue of cross-border economic issues of wealth and affordability.

3. The Upper San Pedro River Basin case

22. The San Pedro River is one of only two rivers that originate in Mexico and flow northwards into the United States. One of the most outstanding features of the basin is its native biodiversity. More than 400 bird species, as well as many other species, live in or migrate through the basin.

23. Groundwater in the basin has two main sources, the regional and the flood-plain aquifer, which are interconnected. The recharge of the regional aquifer comes mainly from the mountain fronts. The aquifer is mostly unconfined, although it is confined in some of its parts. The flood-plain aquifer is recharged mainly by run-off and regional aquifer contribution. The flood-plain aquifer is unconfined.

24. In the United States, the Upper San Pedro River Basin area has experienced rapid population growth, which has increased water demand and put pressure on the groundwater supply. Most hydrologists agree that excessive pumping from the regional aquifer has produced a cone of depression that dewaters the flood-plain aquifer by lowering the water table. As a result, the San Pedro River has become ephemeral in some locations. This could have serious effects on the international bird flyway and could also impact the economy of neighbouring communities. At issue is not only the availability of water, but also the threat of excessive lowering of the water table, which puts riparian vegetation and biodiversity at risk.

[h] Exchange of notes constituting an agreement confirming minute No. 242 of the International Boundary and Water Commission, United States and Mexico, relating to Colorado River salinity (Mexico City and Tlatelolco, 30 August 1973), United Nations, *Treaty Series*, vol. 915, No. 13055, p. 203.

[i] Octavio E. Chávez, "Mining of internationally shared aquifers: the El Paso-Juárez case", *Natural Resources Journal* (New Mexico), vol. 40, No. 2 (spring 2000), p. 237.

Annex V

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[a] Compiled by Raya Stephan (UNESCO).