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UNESCO Chair Workshop on International Strategy for Sustainable Groundwater Management: Transboundary Aquifers and Integrated Watershed Management

IHP-VII

WATERDEPENDENCIES

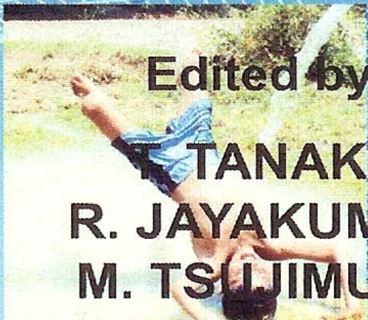
Systems under Stress and Societal Responses

[2008-2013]

6 October, 2009

University of Tsukuba
Tsukuba City, Japan

PROCEEDINGS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International Hydrological Programme
Division of Water Sciences

CN/2009/SC/RP/5

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University of Tsukuba
Tsukuba City, Japan

Organized by
Terrestrial Environment Research Center, Univ. Tsukuba
Institute of Geo-ecology, MAS
JSPS-DGHE Joint Research Project
Education Program of Environment Diplomatic Leader, Univ. Tsukuba
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Preface

UNESCO Chair Workshop on "International Strategy for Sustainable Groundwater Management: Transboundary Aquifers and Integrated Watershed Management" was held on 6 October, 2009 at the Laboratory of Advanced Research A, University of Tsukuba, Tsukuba City, Japan in conjunction with the JSPS-DGHE Joint Research Project Meeting. The workshop was hosted and organized by the Terrestrial Environment Research Center, University of Tsukuba, Japan and the Institute of Geo-ecology, Mongolian Academy of Sciences (MAS) for the UNESCO Chair, JSPS-DGHE Joint Research Project, Education Program of Environment Diplomatic Leader, University of Tsukuba, Japan, UNESCO Office Beijing and Japanese National Committee for UNESCO-IHP. The scientific workshop and meeting is also one of important activities within the framework of implementation of the UNESCO Chair on Sustainable Groundwater Management in Mongolia.

The workshop theme was selected in order to focus on a new wave for groundwater resources management occurred recently in the world. The aims and purpose of the workshop are to share and disseminate knowledge, information and experiences in groundwater resources and watershed management sciences and to promote cooperative and collaborative activities in several areas supporting the core themes of the UNESCO Chair.

At the workshop, 9 scientific papers were presented and published in this proceedings. The range of topics covered by the papers including groundwater initiatives in UNGA together with UNESCO-IHP, transboundary aquifer issues in Asia and neighbouring countries, water management and watershed management in Asian countries and new integrated capacity to solve global environmental issues.

We hope that this UNESCO Chair workshop and its deliberations will bring benefit to many of us and the Chair activities will be extended to continue the proceeding.

1 December, 2009

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Scope of the Workshop

Groundwater is the most important water resources on the Planet. Aquifers contain almost 96 % of the Planet's freshwater. Globally, 65 % of groundwater is devoted to irrigation, 25 % to the supply of drinking water and 10 % to industry. In many areas, most drinking water is groundwater that up to 80 % in Europe and Russia, and even more in North America and Middle East. Without groundwater which is the largest and more reliable of all freshwater resources, maintaining secure water supplies for drinking, industry and agriculture would be impossible.

Due to growing of population, economic activities and agricultural productions, the demand for water resources is rising up and more than 30 countries suffer from serious chronic water shortage and groundwater use is increasingly to cover the demand. It is reported that the groundwater production in the world has been reached more than 600,000 million tones in 2001 and this production is nearly 165 times larger than that of hard coal and oil productions. Those situations regarding groundwater resources have caused many social groundwater problems such as water level decline, salinization, land subsidence and groundwater pollution in all over the world.

To start the "International Year of Planet Earth 2007-2009", IUGS and UNESCO have listed up 10 Scientific Programs as a science program, which is concentrating on globally important issues facing all Nations, named "Earth Sciences for Society". In those programs, "Groundwater - reservoir for thirsty planet" has been ranked up the top (first) program among other 9 scientific programs such as Hazards, Earth and Health, Climate, Resources Issues, Mega Cities, Deep Earth, Ocean, Soil and Life. This means that the groundwater is the most serious and resolved subjects necessarily at the present time in the world. On the other hand, the 63rd UN General Assembly has adopted the resolution of the draft articles on the "Law of Transboundary Aquifers" in December, 2008. The draft articles of this resolution were prepared by the UN International Law Commission (ILC) cooperated with the UNESCO-IHP after 6 years works and discussions from 2003 and its special rapporteur is Ambassador Chusei Yamada, Special Assistant to the Minister for Foreign Affairs of Japan. The main concept of the law is depending on the fact that the groundwater is a shared natural resource as well as oil and natural gas. The American Society of International Law (ASIL) has evaluated the work by the ILC as constituting a "land mark event" for the protection and management of groundwater resources, which have been neglected as a subject of international law despite the social, economic, environmental and strategic importance of groundwater. For make the transition from the adoption of law policies to their implementation into practical, operational actions, the seminar on "Sharing an Invisible Water Resources for Common Good: How to Make Use of the UN General Assembly Resolution on the Law of Transboundary Aquifers" was held on 20 August, 2009 in Stockholm during the period of World Water Week in 2009. In the last October, the 36th IAH International Conference was held in Toyama, Japan and the main theme of the conference was "Integrated Groundwater Science and Human Well-being".

These recent new waves on groundwater occurred in the world indicate that the thought on groundwater is shifted from the development to the management and the management should be in mind that the groundwater is a shared natural resource. This concept is led and is based on the scientific knowledge that natural groundwater flow system depending on a aquifer system of which boundary does not coincide with National State boundaries. The idea of this concept will apply not only for the groundwater management but also for the management of surface water as an "Integrated Watershed Management" of which concept is widely marked up currently in the world.

Participants and paper presenters may as well come from International Organizations. It is hoped that this International Workshop is an opportunity for Japanese water professionals to communicate and share their knowledge and experiences with their foreign peers and counterparts. As world's water needs continue to graw, groundwater will become increasingly important, and effective planed activities and cooperation between Aquifer States will help ensure and adequate water supply for the future.

6 October, 2009

On Behalf of Organizers
Prof. Tadashi TANAKA
Co-Chairholder of UNESCO Chair in Mongolia
Director of Terrestrial Environment Research Center
University of Tsukuba
Japan

Greetings
On the Occasion of the UNESCO Chair Workshop 2009

Dr. Kazuko SHIOJIRI

Executive Director and Vice President, University of Tsukuba
Tsukuba City, Ibaraki 305-8577, Japan

Excellencies, Distinguished Guests, Professors, Dear Colleague Participants, and Ladies and Gentlemen

It is my great honour and pleasure to be here with you today on this auspicious occasion of the UNESCO Chair Workshp on International Strategy for Sustainable Groundwater Managenmet: Transboundary Aquifers and Integrated Watershed Management, in collaboration with JSPS-DGHE Joint Research Project Meeting.

First of all, on behalf of University of Tsukuba, I express my deepest gratitude and highest appreciation to all of the organizers and the persons in charge of UNESCO Offices, both in Mongolia and in Beijing, and Terrestrial Environment Research Center in University of Tsukuba, for their diligent labours and valuable efforts to materialize the opening of this meaningful Workshop.

The UNESCO Chair on Sustainable Groundwater Management in Mongolia was established under the Institute of Geo-ecology of MAS, in cooperation with University of Tsukuba. It is a good example of a successful research and international collaboration on sustainable management of water resources. We are much pleased that this collaboration has been facilitated and supported by UNESCO.

Here, my especial appreciation goes to every effort and support extended by His Excellency Ambassador Chusei Yamada, Special Assistant to the Foreign Minister of Japan.

I heard that in December 2008 last year, UN General Assembly adopted the resolution of the draft articles on the “Law of Transboundary Aquifers”. Ambassador Chusei Yamada was the Special Rapportuer of the articles. Thanks to His Excellency’s efforts, this adoption has become a notable new wave of the international law for the protection and management of groundwater resources, which had been neglected for a long time despite the social, economic, environmental and strategic importance to the whole world.

On this occasion, it is our great honour and pleasure to invite His Excellency Ambassador Chusei Yamada to this UNESCO Chair Workshop today. We will listen to his keynote presentation.

With your permission, let me tell you my small memory. It was around early 90s when I was in Cairo with my husband, who was working under Ambassador Yamada as Director of the Information and Culture Center at the Embassy of Japan in Egypt. We have many happy memories of those days.

Sometimes we enjoyed private excursions to the old Islamic area of Cairo, to the Coptic monasteries in the desert, half collapsed pyramids, etc. I planned those excursions for my friends and colleague wives of the Embassy to take them to historic sites and unknown spots in Cairo. I was very glad that almost every time His Excellency and Mrs. Yamada were kindly joined us.

Now, back to the subject. I would like to thank the UNESCO-IHP, UNESCO Office Beijing and Japanese National Committee for UNESCO-IHP for their active cooperation with this Workshop since the establishment of UNESCO Chair in 2007. I look forward to their more active cooperation in the future. The University of Tsukuba is very keen on the strong support for UNESCO Chair's activities.

This workshop program includes many interesting presentations, which will provide very useful information on groundwater issues in the world. I sincerely wish that this Workshop would be a most successful one through fruitful discussions and contribute to further development of the innovative academic activities and the international peace.

Finally, my special appreciation goes to every effort and support by the Organizing Institutions, the Local Organizing Committees, and to dedication of Professor Tadashi Tanaka of Terrestrial Environment Research Center in University of Tsukuba, for the arrangement and preparation of this UNESCO Chair Workshop.

Thanking for your kind attention. I wish all the best for everyone and all the success for the participants.

Opening Address

Prof. Teruo HIGASHI

Provost of Graduate School of Life and Environmental Sciences, University of Tsukuba
Tsukuba City, Ibaraki 305-8572, Japan

Good morning, Dear distinguished guests, participants, ladies and gentleman.

It is a great pleasure for me to make a welcome address on behalf of the Graduate School of Life and Environmental Sciences, University of Tsukuba, on the occasion of the UNESCO Chair Workshop titled with International Strategy for Sustainable Groundwater Management dealing with the Transboundary Aquifers and Integrated Watershed Management. My mane is Teruo HIGASHI, currently the provost of our Graduate School.

As all of you know, our university, UNESCO, and Mongolian Academy of Sciences officially made a mutual agreement to start UNESCO Chair from July, 2007. Professor Tanaka, Director of Terrestrial Environmental Research Center from our Graduate School has been the key and responsible person for this excellent and important activity. Today I am very pleased to meet many outstanding scientists from Institute of Geo-ecology, Mongolia, including Dr. Tsogtbaatar, Dr. Janchivdorj, and Prof. Hendrayanto, Prof. Pawitan, IBP Indonesia and UNESCO Chair Staffs, Dr. Jayakumar and Dr. Zandarayaa in addition to many Japanese Scientists involved UNESCO Chair Activities who are currently working under the framework UNESCO-IHP of sustainable groundwater management.

Groundwater is indispensable for human beings, since aquifers contain almost 96% of the Planets freshwater, and is the largest water sources as drinking water in the world. However, groundwater has been subjected to serious problems including water level decline, salinization, pollution caused by the greater groundwater consumption due to growing population, economic growth in all over the world.

On the other hand the 63rd United Nations General Assembly has adopted the resolution of draft articles on the Law of Transboundary Aquifers in December, 2008, which was prepared by International Law Commission cooperated with the UNESCO-IHP. As all of you know Ambassador Chusei Yamada, the former Ambassador in India, and currently the Special Assistant to the Ministry of foreign affairs of Japan contributed greatly to this International Law as special rapporteur. This law has clearly demonstrated that the groundwater is shared natural resources made from natural groundwater flow system that is depending on aquifer systems where the boundary does not coincide with National State Boundary. Groundwater will become increasingly important in 21st century, and effective planed activities and cooperation among aquifer states will help adequate water supply for the future.

I see many interesting presentations in the Workshop Program that will provide very useful information on groundwater issues related with transboundary aquifers and integrated watershed management. I wish successful workshop with a lot of valuable discussion to share the current knowledge and experiences.

Thank you for your attention.

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Keynote Presentation

International Law of Transboundary Aquifers: Aims and its Strategies

Chusei YAMADA[1]

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Mr. Chairman, Distinguished Participants,
It is indeed an honour for me to be given this opportunity to speak to you on the efforts of the United Nations to establish international legal regime for the appropriate management of the transboundary aquifers. I understand that most of you are scientific or administrative experts on groundwaters. I am a lawyer myself but will try my best to communicate to you in understandable languages. I will explain the UN DRAFT ARTICLES OF THE LAW OF TRANSBOUNDARY AQUIFERS* with the use of the power point presentation.

1. In order to secure justice and order and to settle any dispute among States by peaceful means, it is essential to establish the "rule of law" in the world society. Such law is the international law the sources of which are treaties and customary international law. The treaties bind their States parties. The customary international law is defined as "international custom, as evidence of a general practice accepted as law" in Article 38 of the Statute of the International Court of Justice. It binds all the States of the international community. In the absence of a world legislature, the international law has largely developed as customary law. However, it is sometimes difficult to define what the customary rules are and there also often exist differences of interpretation of such rules among States. Furthermore there exist many lacunae in customary law as they are not systemized. In order to remove ambiguity, there have been efforts for the restatement of existing customary rules to be agreed upon by States. This process is referred to as the codification of international law. The Charter of the United Nations, in Article 13, 1(a), provides that it is one of the important functions of the UN General Assembly to promote the codification of international law.
2. The UN International Law Commission (hereafter referred to as ILC) was established in 1947 as a subsidiary organ of the UN General Assembly whose mandate is to prepare the basic documents in the form of draft articles for such codification. The ILC consists of 34 members who have competence of international law and are elected by the UN General Assembly, bearing in mind that in the ILC as a whole representation of the main forms of civilization and of the principal legal systems of the world should be assured. The United Nations has so far adopted many important codification treaties on the basis of the works of the

∗ The draft articles are reproduced in the ANNEX.

ILC in such fields as Diplomatic and Consular Relations, Law of Treaties, Law of the Sea and Jurisdictional Immunity.

3. With respect to the waters, the world community was deeply involved in developing international law on the ocean which covers 70 % of the surface of the earth and we now have the comprehensive law in the form of the UN Convention on the Law of the Sea. As for freshwaters, the Rhine and the Danube were subject to international regulations as early as in the beginning of the 19th Century for free navigation. However the first time the United Nations dealt with transboundary freshwater resources was when it instructed the ILC in 1970 to take up the study of the law of the non-navigational uses of international watercourses. Since the mid-20th century, large projects have been undertaken in various parts of the world for construction of dams and other activities on the international rivers for the purposes of drinking, power generation, irrigation and others and they have posed the threat to cause adverse effects upon downstream States. To regulate these activities and to preserve international surface waters, the United Nations adopted in 1997 the Convention on the Law of the Non-Navigational Uses of International Watercourses on the basis of the work of the ILC.
4. While that convention covers theoretically such groundwaters as are physically linked to the international surface waters, it meant to regulate essentially the surface waters. In the preparation of that convention, the ILC did discuss the question of whether to include groundwaters in the project. Though it recognized the need to deal with the groundwaters, it decided that a separate study is required for that purpose. Meanwhile, the United Nations became aware of the rapidly expanding exploitation of groundwaters for portal, industrial and irrigation uses in both developed and developing countries and of the resulting critical overexploitation and pollution problems.
5. Accordingly, the United Nations instructed the ILC in 2001 to proceed with the work on "Shared Natural Resources" which were generally understood to include groundwaters, oil and natural gas. The ILC embarked on the work in 2002, appointing me as its Special Rapporteur of this new topic. Though there exist many similarities between the groundwaters on one hand and oil and natural gas on the other, there are also much dissimilarity between them. Upon my recommendation, the ILC chose to adopt the step by step approach by embarking first on the work on groundwaters as the follow up of the 1997 convention on international watercourses. However, the codification work on the law of transboundary aquifers required multi-disciplinary process. As stated before, the ILC is the body composed solely of lawyers of public international law. It does not possess scientific and technical knowledge of groundwaters and expertise for proper management of these aquifers. The United Nations Educational, Scientific and Cultural Organization (UNESCO), the coordinating agency of the UN organizations on the world water issue, mobilized a team of groundwater scientists, administrators and water lawyers to assist the ILC. Without their untiring and valuable support, the ILC would not have been able to formulate the draft articles.
6. It might be too obvious for you scientists but I would like to mention some scientific factors on which the lawyers built up the legal regime. The freshwaters is the life supporting resources for which no alternative resources exist. The

groundwaters are of high quality and nourishing. The groundwaters exist in most parts of the world and many of them are transboundary. They are fragile and particular care is necessary not to pollute. There exist many kinds of activities in addition to utilization of aquifers which would adversely affect the neighbouring States through tansboundary aquifers. The ILC found ample State practices and almost 400 relevant treaties, general, regional and bilateral, on the basis of which customary rules could be identified. The States have also shown keen interests in the ILC's work as aquifers exist in almost all States and the overwhelming majority of States possesses transboundary aquifers with their neighbouring States. Those States transmitted their valuable inputs and observations to the ILC.

7. Taking into account the advices of experts and observations from governments, the ILC formulated a final set of 19 draft articles on the law of transboundary aquifers in 2008. It is recalled that the ILC took 24 years to complete the formulation of draft articles on the law of the non-navigational uses of international watercourses. It was rather a rare case for the ILC that the codification work on transboundary aquifers was completed in such a short period of 6 years. It shows that the ILC was fully aware of the current critical situation of groundwaters and of the urgent need to establish legal framework for proper management of transboundary aquifers in order to achieve the objectives of equitable and reasonable utilization, protection of environment and international cooperation.
8. The UN General Assembly received the draft articles favourably. It recognized that the draft articles are not only scientifically and technically sound but also they incorporate the positions of the majority of the member States of the United Nations. It adopted the resolution 63/124 entitled "the Law of transboundary aquifers" by consensus on December 11, 2008. The copy of the resolution is also included in the ANNEX for your reference. The resolution took note of the draft articles the text of which is annexed to it. It encouraged the States concerned to make appropriate bilateral or regional arrangements for the proper management of their transboundary aquifers, taking into account the provisions of the draft articles. It further decided to include in the provisional agenda of its 66th session in 2011 an item entitled "the Law of transboundary aquifers" with a view to examining, *inter alia*, the question of the form that might be given to the draft articles.
9. The salient points of the draft articles are as follows;

(1) Article 1 Scope

The scope of the application of the draft articles is (a) utilization of transboundary aquifer, (b) other activities that have or are likely to have an impact upon such aquifers and (c) measures for the protection, preservation and management of such aquifers. The concept of the paragraph (b) was not included in the case of 1997 watercourses convention. In the case of aquifers, activities other than utilization above them such as those causing pollution to the aquifers or harmful to normal functioning of aquifers by blocking or destroying geological formation of the aquifers must be regulated. I might mention here that Kyoto has the huge aquifers underneath which supported the city as our old capital for one thousand years. The people there who lived on these aquifers found the lowering of the water table in 1960's. It was thought that the decline was partly due to the construction of subway networks.

(2) Article 2 Definition

There are various ways of defining aquifers. The definition of aquifer adopted here is for the purpose of applying the draft articles. It is in a sense a legal fiction. Aquifer means both a geological formation which serves as a container and the water contained in the saturated zone of the formation. Recharging and discharging zones and outlets are outside the aquifers. It is necessary to include the geological formation in the definition of aquifer in order to preserve proper functioning of aquifer. It is also necessary to include the geological formation in order to regulate its utilization such as storage, disposal of waste or a new experimental technique for carbon dioxide sequestration.

(3) Article 4 Equitable and Reasonable Utilization

One of the essential principles is equitable and reasonable utilization of aquifers. Factors relevant to such equitable and reasonable utilization are listed in Article 5. The principle of equitable utilization among the States sharing the same resources is identical as is in the case of the 1997 international watercourses convention. However the principle of reasonable utilization, though the same term is used, is quite different here. The principle of sustainable utilization can apply only to renewable resources. International law has developed the precise legal concept of sustainability in relation to marine living resources. You find the principle of the sustainable utilization in almost all the fisheries conventions. This principle is clearly defined as “to take measures, on the best scientific evidence, to maintain or restore populations of harvested species at levels which can produce the maximum sustainable yield (MSY)” in Article 119, 1 (a) of the UN Convention on the Law of the Sea (UNCLOS). What it means is to maintain the size of the population of a particular stock of fish that can produce the maximum catches year after year. Science tells us that such a level is somewhat below the maximum population of a particular fish stock which the nature can afford to hold. Now this principle could be applied to other renewable resources. The 1997 international watercourses convention applied this principle and defined it as “optimal and sustainable” utilization in its Article 5, 1. It meant that the watercourse States are obliged to limit the amount of use of water to that of recharge and keep the river flowing permanently. When we learnt the dynamics of aquifers, it became clear that this sustainability principle could not apply to both recharging and non-recharging aquifers. For non-recharging aquifers, there is no room whatsoever to apply this principle as any utilization would lead to depletion of the resources. Even for recharging aquifers, recharge is, in most cases, just a fraction of the large volume of waters accumulated over hundred and thousand years and States could not be deprived of the use of such accumulated resources while the States of non-recharging aquifers were free to use them. Accordingly Article 4 does not refer to sustainability at all and provides only for a recharging aquifer that a recharging aquifer shall not be utilized at a level that would prevent continuance of its effective functioning. Meanwhile, however, the term “sustainability” has become a sort of catch phrase for many environmentalists. Taking into account their positions, the term “sustainable development” is inserted in Article 7, General Obligation to Cooperate.

(4) Article 6 Obligation not to Cause Significant Harm

Another important principle is the obligation not to cause significant harm to other States. This is the cardinal principle of international law. This principle applies not only to adverse effect to other States caused by utilization of transboundary aquifers but also to adverse effect through transboundary aquifers to other States caused by activities other than utilization. Utilization of aquifers and other activities are activities necessary for the society and accordingly could not be prohibited. Other States therefore have obligation to bear certain harm unless such harm does not go beyond the level of significant harm. The concept of “significant” is relative and could not be defined in abstract. However, in view of fragility of aquifers and difficulty of removing pollutants from aquifers once affected, the threshold of “significant” would be much lower than in the case of surface waters.

(5) Article 7 International Cooperation

Yet another important principle is the international cooperation. The key to the proper management of aquifers is the international cooperation among aquifer States. The draft articles provide various measures beginning from regular exchange of data and information, monitoring and establishment of joint management mechanism. As the ILC meets in Geneva, it has been briefed by Franco-Swiss Genevois Aquifer Authority. This French-Swiss cooperation is one of the most successful joint mechanisms. There is also an article which provides consultation procedure for a planned activity which may affect a transboundary aquifer and thereby may have a significant adverse effect upon another State.

(6) Article 16 Technical Cooperation with Developing States

The draft articles also regulate non-aquifer States. In particular, all States are required to promote technical cooperation with developing States in the scientific, educational, technical, legal and other fields for the protection and management of aquifers in Article 16. I do believe that Japan, although non transboundary aquifer State, would be able to play a significant role in this field.

10. There have been some critical observations on the draft articles from international lawyers mainly on two points. One is the inclusion of sovereignty clause in Article 3 which might in their view diminish the value of the whole exercise. I do share some of their apprehension. However, we must squarely face the current state of affairs. It was the UN which passed the resolution “Permanent sovereign over natural resources” 1803(XVII) in 1962. Many aquifer States insisted the inclusion of sovereignty article. It is noted that the second sentence of Article 3 states that it [aquifer state] shall exercise its sovereignty in accordance with international law and the present draft articles. I do believe that the current draft Article 3 represents an appropriately balanced text. Another point is the overlap between the 1997 international watercourses convention and the present draft articles. The 1997 watercourses convention theoretically covered the groundwaters which are linked to international watercourses. The present draft articles cover all the transboundary aquifers regardless of whether they are linked or not to the international watercourses. The ILC considered that all the aquifers possess distinct characteristics different from those of surface waters. For instance, the Nubian Sandstone Aquifer System is linked to the River Nile south of Khartoum. However

the bulk of the Nubian system has only the characteristics of non-recharging aquifer. Accordingly, that aquifer system must be regulated by the present draft articles. The regulations of the present draft articles are generally much broader and stricter than 1997 international watercourses convention. Dual application of the two instruments to a particular aquifer would normally not cause any difficulty. However, if it does, we would have to draft a provision to regulate the relationship between the two instruments when the negotiation takes place to transform the draft articles to a convention.

11. There are two years to go before the UN General Assembly makes the final decision on the status of the draft articles. The best outcome would be to transform the draft articles to a UN convention as the case of the 1997 UN watercourses convention. If it turns out to be difficult, the second best would be for the UN General Assembly to adopt the draft articles as the guidelines. There are certain differences in legal effects between the two alternatives. However, that difference would not matter much. As long as the draft articles receive an official endorsement by the UN General Assembly, the States concerned could make full use of the draft articles in negotiating a bilateral or regional agreement with their neighbouring States in order to properly manage their transboundary aquifers.
12. Our task is twofold. First, the grave situation of many aquifers must be highlighted. Second, understanding and appreciation of the draft articles must be promoted. UNESCO-IHP will hold a series of regional and general meetings in this connection. Your valuable support as scientists and experts to this endeavour will be greatly appreciated.

ANNEX

RESOLUTION ADOPTED BY THE GENERAL AASSEMBLY
63/124. The law of transboundary aquifers

The General Assembly,

Having considered chapter IV of the report of the International Law Commission on the work of its sixtieth session, which contains the draft articles on the law of transboundary aquifers,

Noting that the Commission decided to recommend to the General Assembly (a) to take note of the draft articles on the law of transboundary aquifers in a resolution, and to annex the articles to the resolution; (b) to recommend to States concerned to make appropriate bilateral or regional arrangements for the proper management of their transboundary aquifers on the basis of the principles enunciated in the articles; and (c) to also consider, at a later stage, and in view of the importance of the topic, the elaboration of a convention on the basis of the draft articles,

Emphasizing the continuing importance of the codification and progressive development of international law, as referred to in Article 13, paragraph 1 (a), of the Charter of the United Nations,

Noting that the subject of the law of transboundary aquifers is of major importance in the relations of States,

Taking note of the comments of Governments and the discussion in the Sixth Committee at the sixty-third session of the General Assembly on this topic,

1. *Welcomes* the conclusion of the work of the International Law Commission on the law of transboundary aquifers and its adoption of the draft articles and a detailed commentary on the subject;
2. *Expresses* its appreciation to the Commission for its continuing contribution to the codification and progressive development of international law;
3. *Also expresses* its appreciation to the International Hydrological Programme of the United Nations Educational, Scientific and Cultural Organization and to other relevant organizations for the valuable scientific and technical assistance rendered to the International Law Commission;
4. *Takes note* of the draft articles on the law of transboundary aquifers, presented by the Commission, the text of which is annexed to the present resolution, and commends them to the attention of Governments without prejudice to the question of their future adoption or other appropriate action;
5. *Encourages* the States concerned to make appropriate bilateral or regional arrangements for the proper management of their transboundary aquifers, taking into account the provisions of these draft articles;
6. *Decides* to include in the provisional agenda of its sixty-sixth session an item entitled "The law of transboundary aquifers" with a view to examining, inter alia, the question of the form that might be given to the draft articles.

67th Plenary Meeting, 11 December 2008

ANNEX

The law of transboundary aquifers

Conscious of the importance for humankind of life-supporting groundwater resources in all regions of the world,

Bearing in mind Article 13, paragraph 1 (a), of the Charter of the United Nations, which provides that the General Assembly shall initiate studies and make recommendations for the purpose of encouraging the progressive development of international law and its codification,

Recalling General Assembly resolution 1803 (XVII) of 14 December 1962 on permanent sovereignty over natural resources,

Reaffirming the principles and recommendations adopted by the United Nations Conference on Environment and Development of 1992 in the Rio Declaration on Environment and Development and Agenda 21,

Taking into account increasing demands for freshwater and the need to protect groundwater resources,

Mindful of the particular problems posed by the vulnerability of aquifers to pollution,

Convinced of the need to ensure the development, utilization, conservation, management and protection of groundwater resources in the context of the promotion of the optimal and sustainable development of water resources for present and future generations,

Affirming the importance of international cooperation and good-neighbourliness in this field,

Emphasizing the need to take into account the special situation of developing countries,

Recognizing the necessity to promote international cooperation.

Part one
Introduction
Article 1
Scope

The present articles apply to:

(a) Utilization of transboundary aquifers or aquifer systems;

(b) Other activities that have or are likely to have an impact upon such aquifers or aquifer systems; and

(c) Measures for the protection, preservation and management of such aquifers or aquifer systems.

Article 2
Use of terms

For the purposes of the present articles:

(a) “aquifer” means a permeable water bearing geological formation underlain by a less permeable layer and the water contained in the saturated zone of the formation;

(b) “aquifer system” means a series of two or more aquifers that are hydraulically connected;

(c) “transboundary aquifer” or “transboundary aquifer system” means, respectively, an aquifer or aquifer system, parts of which are situated in different States;

(d) “aquifer State” means a State in whose territory any part of a transboundary aquifer or aquifer system is situated;

(e) “utilization of transboundary aquifers or aquifer systems” includes extraction of water, heat and minerals, and storage and disposal of any substance;

(f) “recharging aquifer” means an aquifer that receives a non-negligible amount of

contemporary water recharge;
(g) “recharge zone” means the zone which contributes water to an aquifer, consisting of the catchment area of rainfall water and the area where such water flows to an aquifer by run-off on the ground and infiltration through soil;
(h) “discharge zone” means the zone where water originating from an aquifer flows to its outlets, such as a watercourse, a lake, an oasis, a wetland or an ocean.

Part two
General principles
Article 3
Sovereignty of aquifer States

Each aquifer State has sovereignty over the portion of a transboundary aquifer or aquifer system located within its territory. It shall exercise its sovereignty in accordance with international law and the present articles.

Article 4
Equitable and reasonable utilization

Aquifer States shall utilize transboundary aquifers or aquifer systems according to the principle of equitable and reasonable utilization, as follows:
(a) They shall utilize transboundary aquifers or aquifer systems in a manner that is consistent with the equitable and reasonable accrual of benefits therefrom to the aquifer States concerned;
(b) They shall aim at maximizing the long-term benefits derived from the use of water contained therein;
(c) They shall establish individually or jointly a comprehensive utilization plan, taking into account present and future needs of, and alternative water sources for, the aquifer States; and
(d) They shall not utilize a recharging transboundary aquifer or aquifer system at a level that would prevent continuance of its effective functioning.

Article 5
Factors relevant to equitable and reasonable utilization

1. Utilization of a transboundary aquifer or aquifer system in an equitable and reasonable manner within the meaning of article 4 requires taking into account all relevant factors, including:
(a) The population dependent on the aquifer or aquifer system in each aquifer State;
(b) The social, economic and other needs, present and future, of the aquifer States concerned;
(c) The natural characteristics of the aquifer or aquifer system;
(d) The contribution to the formation and recharge of the aquifer or aquifer system;
(e) The existing and potential utilization of the aquifer or aquifer system;
(f) The actual and potential effects of the utilization of the aquifer or aquifer system in one aquifer State on other aquifer States concerned;
(g) The availability of alternatives to a particular existing and planned utilization of the aquifer or aquifer system;
(h) The development, protection and conservation of the aquifer or aquifer system and the costs of measures to be taken to that effect;
(i) The role of the aquifer or aquifer system in the related ecosystem.
2. The weight to be given to each factor is to be determined by its importance with regard to a specific transboundary aquifer or aquifer system in comparison with that of other relevant

factors. In determining what is equitable and reasonable utilization, all relevant factors are to be considered together and a conclusion reached on the basis of all the factors. However, in weighing different kinds of utilization of a transboundary aquifer or aquifer system, special regard shall be given to vital human needs.

Article 6
Obligation not to cause significant harm

1. Aquifer States shall, in utilizing transboundary aquifers or aquifer systems in their territories, take all appropriate measures to prevent the causing of significant harm to other aquifer States or other States in whose territory a discharge zone is located.
2. Aquifer States shall, in undertaking activities other than utilization of a transboundary aquifer or aquifer system that have, or are likely to have, an impact upon that transboundary aquifer or aquifer system, take all appropriate measures to prevent the causing of significant harm through that aquifer or aquifer system to other aquifer States or other States in whose territory a discharge zone is located.
3. Where significant harm nevertheless is caused to another aquifer State or a State in whose territory a discharge zone is located, the aquifer State whose activities cause such harm shall take, in consultation with the affected State, all appropriate response measures to eliminate or mitigate such harm, having due regard for the provisions of articles 4 and 5.

Article 7
General obligation to cooperate

1. Aquifer States shall cooperate on the basis of sovereign equality, territorial integrity, sustainable development, mutual benefit and good faith in order to attain equitable and reasonable utilization and appropriate protection of their transboundary aquifers or aquifer systems.
2. For the purpose of paragraph 1, aquifer States should establish joint mechanisms of cooperation.

Article 8
Regular exchange of data and information

1. Pursuant to article 7, aquifer States shall, on a regular basis, exchange readily available data and information on the condition of their transboundary aquifers or aquifer systems, in particular of a geological, hydrogeological, hydrological, meteorological and ecological nature and related to the hydrochemistry of the aquifers or aquifer systems, as well as related forecasts.
2. Where knowledge about the nature and extent of a transboundary aquifer or aquifer system is inadequate, aquifer States concerned shall employ their best efforts to collect and generate more complete data and information relating to such aquifer or aquifer system, taking into account current practices and standards. They shall take such action individually or jointly and, where appropriate, together with or through international organizations.
3. If an aquifer State is requested by another aquifer State to provide data and information relating to an aquifer or aquifer system that are not readily available, it shall employ its best efforts to comply with the request. The requested State 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 States shall, where appropriate, employ their best efforts to collect and process data

and information in a manner that facilitates their utilization by the other aquifer States to which such data and information are communicated.

Article 9
Bilateral and regional agreements and arrangements

For the purpose of managing a particular transboundary aquifer or aquifer system, aquifer States are encouraged to enter into bilateral or regional agreements or arrangements among themselves. Such agreements or arrangements may be entered into with respect to an entire aquifer or aquifer system or any part thereof or a particular project, programme or utilization except insofar as an agreement or arrangement adversely affects, to a significant extent, the utilization by one or more other aquifer States of the water in that aquifer or aquifer system, without their express consent.

Part three
Protection, preservation and management
Article 10
Protection and preservation of ecosystems

Aquifer States shall take all appropriate measures to protect and preserve ecosystems within, or dependent upon, their transboundary aquifers or aquifer systems, including measures to ensure that the quality and quantity of water retained in an aquifer or aquifer system, as well as that released through its discharge zones, are sufficient to protect and preserve such ecosystems.

Article 11
Recharge and discharge zones

1. Aquifer States shall identify the recharge and discharge zones of transboundary aquifers or aquifer systems that exist within their territory. They shall take appropriate measures to prevent and minimize detrimental impacts on the recharge and discharge processes.
2. All States in whose territory a recharge or discharge zone is located, in whole or in part, and which are not aquifer States with regard to that aquifer or aquifer system, shall cooperate with the aquifer States to protect the aquifer or aquifer system and related ecosystems.

Article 12
Prevention, reduction and control of pollution

Aquifer States shall, individually and, where appropriate, jointly, prevent, reduce and control pollution of their transboundary aquifers or aquifer systems, including through the recharge process, that may cause significant harm to other aquifer States. Aquifer States shall take a precautionary approach in view of uncertainty about the nature and extent of a transboundary aquifer or aquifer system and of its vulnerability to pollution.

Article 13
Monitoring

1. Aquifer States shall monitor their transboundary aquifers or aquifer systems. They shall, wherever possible, carry out these monitoring activities jointly with other aquifer States concerned and, where appropriate, in collaboration with competent international organizations. Where monitoring activities cannot be carried out jointly, the aquifer States shall exchange the

monitored data among themselves.
2. Aquifer States shall use agreed or harmonized standards and methodology for monitoring their transboundary aquifers or aquifer systems. They should identify key parameters that they will monitor based on an agreed conceptual model of the aquifers or aquifer systems. These parameters should include parameters on the condition of the aquifer or aquifer system as listed in article 8, paragraph 1, and also on the utilization of the aquifers or aquifer systems.

Article 14
Management

Aquifer States shall establish and implement plans for the proper management of their transboundary aquifers or aquifer systems. They shall, at the request of any of them, enter into consultations concerning the management of a transboundary aquifer or aquifer system. A joint management mechanism shall be established, wherever appropriate.

Article 15
Planned activities

1. When a State has reasonable grounds for believing that a particular planned activity in its territory may affect a transboundary aquifer or aquifer system and thereby may have a significant adverse effect upon another State, it shall, as far as practicable, assess the possible effects of such activity.
2. Before a State implements or permits the implementation of planned activities which may affect a transboundary aquifer or aquifer system and thereby may have a significant adverse effect upon another State, it shall provide that State with timely notification thereof. Such notification shall be accompanied by available technical data and information, including any environmental impact assessment, in order to enable the notified State to evaluate the possible effects of the planned activities.
3. If the notifying and the notified States disagree on the possible effect of the planned activities, they shall enter into consultations and, if necessary, negotiations with a view to arriving at an equitable resolution of the situation. They may utilize an independent fact-finding body to make an impartial assessment of the effect of the planned activities.

Part four
Miscellaneous provisions
Article 16
Technical cooperation with developing States

States shall, directly or through competent international organizations, promote scientific, educational, technical, legal and other cooperation with developing States for the protection and management of transboundary aquifers or aquifer systems, including, inter alia:
(a) Strengthening their capacity-building in scientific, technical and legal fields;
(b) Facilitating their participation in relevant international programmes;
(c) Supplying them with necessary equipment and facilities;
(d) Enhancing their capacity to manufacture such equipment;
(e) Providing advice on and developing facilities for research, monitoring, educational and other programmes;
(f) Providing advice on and developing facilities for minimizing the detrimental effects of major activities affecting their transboundary aquifer or aquifer system;
(g) Providing advice in the preparation of environmental impact assessments;
(h) Supporting the exchange of technical knowledge and experience among developing States

with a view to strengthening cooperation among them in managing the transboundary aquifer or aquifer system.

Article 17
Emergency situations

1. For the purpose of the present article, “emergency” means a situation, resulting suddenly from natural causes or from human conduct, that affects a transboundary aquifer or aquifer system and poses an imminent threat of causing serious harm to aquifer States or other States.
2. The State within whose territory the emergency originates shall:
(a) Without delay and by the most expeditious means available, notify other potentially affected States and competent international organizations of the emergency;
(b) In cooperation with potentially affected States and, where appropriate, competent international organizations, immediately take all practicable measures necessitated by the circumstances to prevent, mitigate and eliminate any harmful effect of the emergency.
3. Where an emergency poses a threat to vital human needs, aquifer States, notwithstanding articles 4 and 6, may take measures that are strictly necessary to meet such needs.
4. States shall provide scientific, technical, logistical and other cooperation to other States experiencing an emergency. Cooperation may include coordination of international emergency actions and communications, making available emergency response personnel, emergency response equipment and supplies, scientific and technical expertise and humanitarian assistance.

Article 18
Protection in time of armed conflict

Transboundary aquifers or aquifer systems and related installations, facilities and other works shall enjoy the protection accorded by the principles and rules of international law applicable in international and non-international armed conflict and shall not be used in violation of those principles and rules.

Article 19
Data and information vital to national defence or security

Nothing in the present articles obliges a State to provide data or information vital to its national defence or security. Nevertheless, that State shall cooperate in good faith with other States with a view to providing as much information as possible under the circumstances.

Transboundary Aquifers of Asia

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Abstract Water is humanity's most important natural resource. The availability of, and access to, freshwater is high on the agenda of politicians and planners. Groundwater makes up more than 95 percent of the global, unfrozen fresh water reserves (Icecaps 68.7%, Groundwater 30.1%, Surface water 0.3% and others 0.9%) and many of the aquifers are transboundary. It is the key to affordable, safe water supplies globally, but it must be managed responsibly. During the past decades the interest in groundwater increased considerably due to water shortage problems on local, regional and even global levels. The use of groundwater is considered an efficient solution to regional water crises caused by population growth and economic development but the knowledge of this hidden resource is still weak in many places and investments in groundwater management and protection are insufficient. UNESCO's International Hydrological Programme in collaboration with BGR, Germany started World Hydrogeological Mapping and Assessment Programme (WHYMAP) with the objective of summarizing global groundwater information during 2000. Subsequently, during 2002 UNESCO and IAH (International Association of Hydrogeologist) leading multi-agency efforts on Internationally Shared Aquifer Resources Management (ISARM) started to aim at improving the understanding of scientific, socio-economic, legal, institutional and environmental issues related to the management of transboundary aquifers. Since 2000, ISARM carried out various case studies in Africa, Americas, Arab, Asia and Europe. The outcomes of these case studies are used to build up scientific, socioeconomic and institutional guidelines and recommendations to manage transboundary aquifers. UNESCO, in cooperation with China Geological Survey and various other partners, carried out a regional inventory of transboundary aquifers of Asia which is currently been updated at sub-regional level.

INTRODUCTION

The transboundary nature of aquifers has long been recognized. However, its significance and function in environmental and human development have not received due attention. In an effort to remedy the gap, UNESCO, through its IHP programme (International Hydrological Programme), carried out the ISARM initiative, a joint effort with IAH (International Association of Hydrogeologists) and other international agencies. Specifically, the 5th phase of IHP (1996—2001) was set to stimulate a stronger interrelation among priority areas of scientific research, application, education, identified groundwater and arid and semi-arid zone hydrology. The emphasis was on environmentally sound integrated water resources management and planning, supported by a scientifically proven methodology within its overall theme. Its results continue to influence research and practice. The 5th phase of IHP also coincided with the TARM (Transboundary Aquifer Resource Management) initiative developed by IAH. On the 14th Session of the Inter Governmental Council of UNESCO, in 2000, joint activities were approved between TARM and UNESCO. In addition, these activities had also been carried out through cooperation with the Food and Agriculture Organization (FAO) and the United Nations Economic Commission for Europe (UN ECE). Such interagency action was defined in a framework document of ISARM (Internationally Shared Aquifer Resource Management).

Since its inception in 2000, ISARM, through the collaboration of multiple agencies, developed several regional initiatives, including ISARM-Americas Programme, the ISARM-Europe Programme and ISARM—Balkans programme, In addition, studies financed through the Global Environmental Facility (GEF) also commenced in Africa and the Caribbean. Nineteen articles, on the "Law of Transboundary Aquifers" prepared by UNESCO IHP and the UNILC have been endorsed by the United Nations (UN) General Assembly in New York at its 63rd session.

These 19 articles were drafted by a team of hydrogeologists and lawyers drawn from UNESCO's International Hydrological Programme (IHP) and the UN International Law Commission. The 6th Committee of UN General Assembly endorsed the articles and adopted a resolution on the Law of Transboundary Aquifers on Friday, 14 November 2008. The articles have been annexed to a UN resolution, which recommends that the States concerned make appropriate bilateral or regional arrangements for managing their transboundary aquifers on the basis of the principles enunciated in the articles. These principles include cooperation among States to prevent and control pollution of their shared aquifers. In view of the importance of these 'invisible resources', States are also invited to consider the elaboration of a convention on the basis of the draft articles.

GROUNDWATER IN ASIA

The Asian continent covers 44 million square kilometres with a population of 3.5 billion. It is world's largest continent both in size and population. There are 48 countries and regions in Asia with several countries with a population of more than 100 million such as China, India, Indonesia, Japan, Bangladesh and Pakistan. The combination of large populations and rapid growth leads to dramatic increasing demands for water resources.

Groundwater resources vary greatly across Asia. Some regions are underlined by aquifers extending over large areas, while the floodplain alluvial deposits usually accompany the largest rivers. The sedimentary rocks, especially Quaternary loose sediments, are very thick with good storage space. The deep fissure water is relatively abundant in confined aquifers. The Loess Plateau in central Asia has a specific topography. Continuous aquifers are only distributed in Loess tableland. The carbonate rocks are widely distributed in Southeast Asia. In southern China and on the Indochina peninsula, there is stratified limestone from the late Paleozoic and Mesozoic in which karst is considerably developed.

In mountainous regions, groundwater generally occurs in complexes of joint hard rocks. There is little rainfall but strong evaporation in the inland arid areas of central Asia. However, the thawing of glaciers and snow in the high mountains contribute to groundwater recharge. A lot of Quaternary volcanic rock is extensively distributed on the circum-Pacific islands, which forms asymmetrical ring aquifers. The piedmonts of volcanoes mostly contain spring water with a high water quality.

The development of groundwater in Asia has greatly increased over the past 30 years. In some arid regions of Asian countries, where sufficient renewable groundwater resources are not available, non-renewable groundwater is being exploited to support development, such as the coastal area of the north China plains. Since the 1970s, groundwater extraction has increased greatly in China, India, the Republic of Korea and other countries in South Asia. However, groundwater problems have increased rapidly over the last 20 years with higher salt content in arid and semi-arid zones, high levels of arsenic and fluoride, the encroachment of seawater in coastal areas and land subsidence due to overexploitation.

Asian Regional Transboundary Aquifers

There are several transboundary aquifers in Asia involving two or more countries and UNESCO's International Hydrology Program (IHP) in cooperation with China Geological Survey has identified 12 significant transboundary aquifers, primarily porous or fissured/fractured aquifer systems (Table 1 and Fig. 1). The successful management of these shared aquifers will contribute to peaceful relations between Asian states.

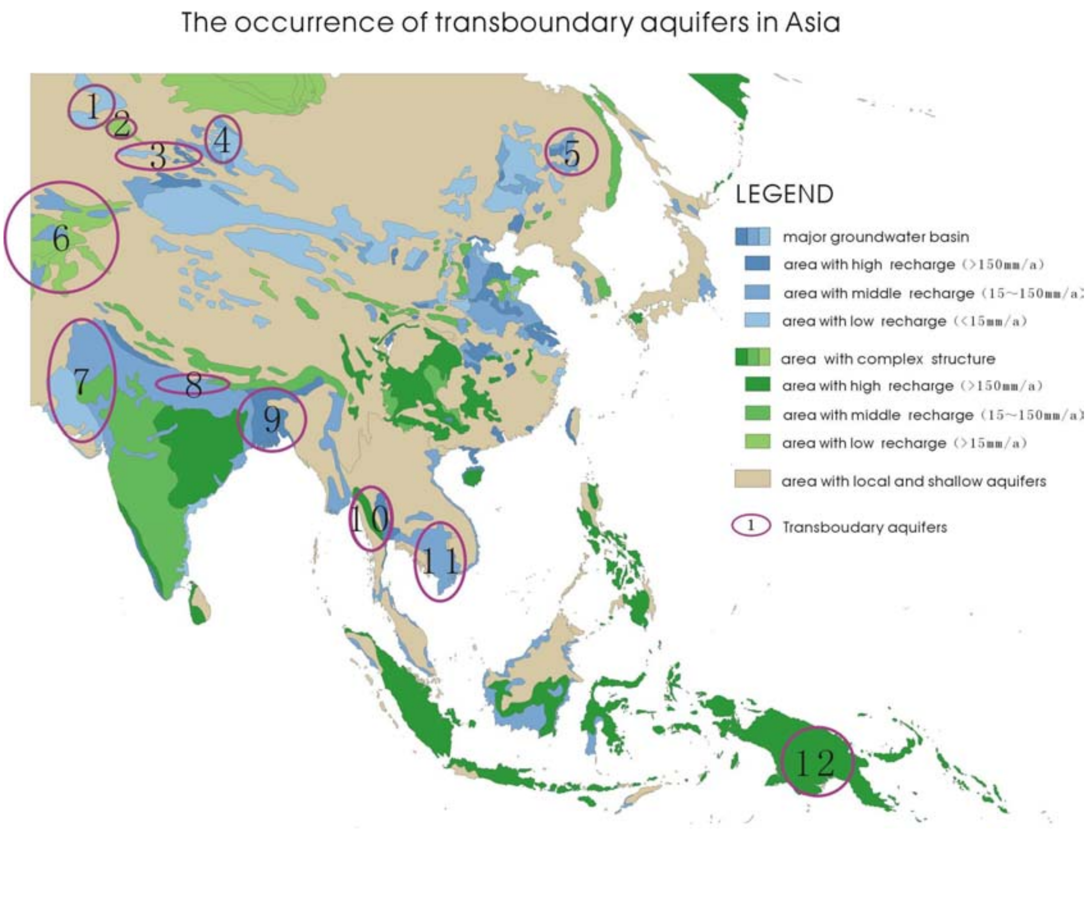

Fig. 1. Major transboundary aquifers of Asia.

Table 1. Transboundary aquifers in Asia.

No.	Name of transboundary aquifer system	Countries sharing this aquifer system	Type of aquifer system	Extension [km^2]
1	Ertix River Plain	Russia, Kazakhstan	1	120000
2	West Altai	Russia, Kazakhstan	1,2	40000
3	Ili River plain	China, Kazakhstan	1	53000
4	Yenisei upstream	Russia, Mongolia	1,2	60000
5	Heilongjiang River plain	China, Russia	1	100000
6	Central Asia	Kazakhstan,Kyrgyzstan, Uzbekistan, Tajikistan,Turkmenistan, Afghanistan	1,2	660000
7	India River plain	India, Pakistan	1	560000
8	Southern of Himalayas	Nepal, India	1	65000
9	Ganges River plain	Bangladesh, India	1	300000
10	South Burma	Burma, Thailand	2	53000
11	Mekong River plain	Thailand, Laos, Cambodia, Vietnam	1	220000
12	New Guinea Island	Indonesia, Papua New Guinea	2	870000

Type of aquifer system: 1 - porous, 2 - fissured/fractured, 3 – Karst.

Transboundary Aquifers of China: an Inventory

There are eight transboundary aquifers that China shares with other countries as is shown in Fig. 2 and also in Table 2. Their characteristics are elaborated in detail in this section.

Table 2. International transboundary aquifers in China.

No.	Name of transboundary aquifer system	Countries sharing this aquifer system	Extension in China [km^2]	Type of aquifer system
1	Ertix River Plain	China, Kazakhstan	16754	1
2	Tacheng Basin	China, Kazakhstan	11721	1
3	Ili River Valley	China, Kazakhstan	26000	1
4	Middle Heilongjiang-Amur River Basin	China, Russia	45000	1
5	Yalu River Valley	China, Korea	11210	2
6	Nu River Valley	China, Burma	35477	3
7	Upriver of Zuo River	China, Vietnam	32227	3
8	Beilun River Basin	China, Vietnam	30170	3

Type of aquifer system: 1 - porous, 2 - fissured/fractured, 3 – karst.

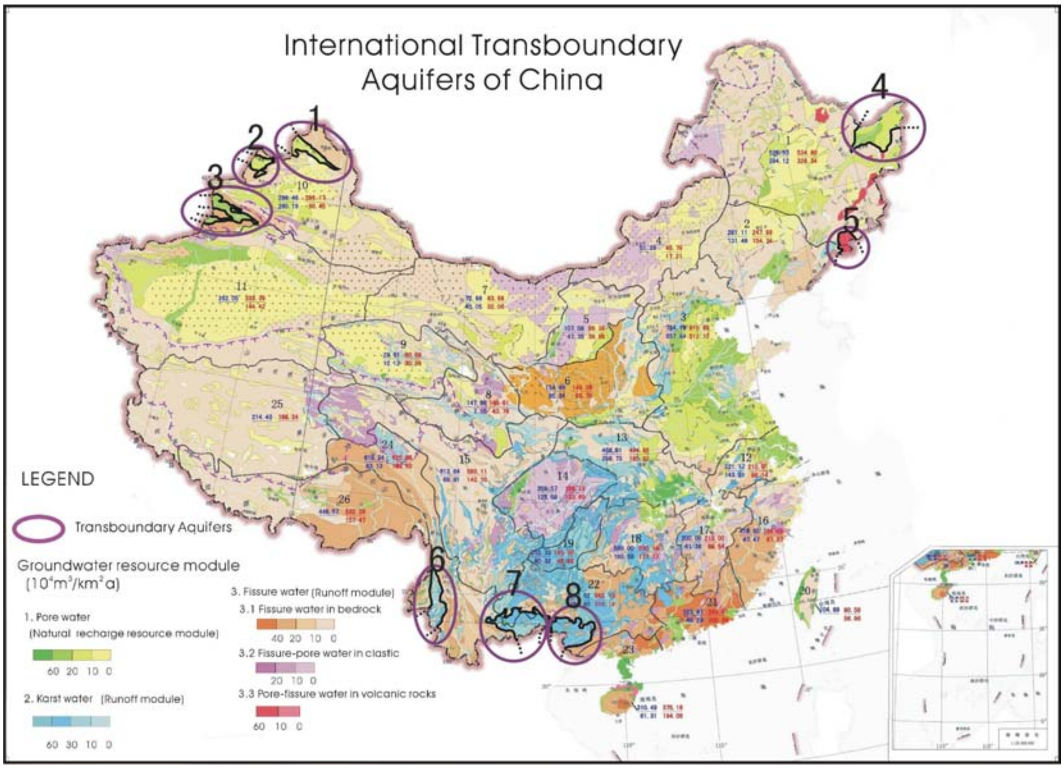

Fig. 2. International transboundary aquifers of China.

1. Ertix valley plain aquifer: This aquifer is a transboundary aquifer shared by China and Kazakhstan. The Ertix River originates from southern slope of the Altai Mountains, with a total length of 2,669 km and a drainage area of over 1,070,000 km^2. The length of this river within China is 546 km, and the drainage area is 57,000 km^2. After flowing out of the national boundary of China, the Ertix River flows into the Zhaisang lake of Kazakhstan that subsequently feeds into the E'Bi lake of Russia, and finally depletes into the Arctic Ocean. The valley plain aquifer is made up of Quaternary sand gravel, where steady cohesive soil sediment is almost absent. The area within China is 16,000 km^2 and the runoff module of natural recharge is about 150,000 m^3/(km^2 a).

2. Tacheng aquifer: Tacheng basin is a part of the valley plain of the Yimin River. This aquifer is also a transboundary aquifer shared by China and Kazakhstan. The Yimin River originates from southern slope of Harbahatai Mountains. After flowing out of China, the Yimin River flows into Lake Ala in Kazakhstan. The direction of groundwater flow is the same as that of the river. Average annual precipitation is 256 mm. The aquifer is composed of Quaternary sands and base rock fractures. The area within China of the Yimin River aquifer is 21,000 km^2, and the groundwater recharge is about 2.35 billion m^3/year.

3. Yili River valley plain aquifer: This aquifer is a transboundry aquifer shared by China and Kazakhstan. The total area of the aquifer is 53,000 km^2, and the area within China is 26,000 km^2. The water resources of Yili River mainly come from the thaw of Tianshan Mountain of China. The influx of the river water flowing into Kazakhstan is about 12 billion m^3/year, which subsequently flows into the Lake Balkhash. The valley

plain aquifer includes Quaternary pore water and fissure water of Mesozoic sandstone. Generally, the runoff direction of groundwater is consistent with the surface water. The groundwater flows into valley from the two sides of the piedmont, which is V shaped, and flows towards west into Kazakhstan from China. It is estimated that the influx of groundwater across the boundary between China and Kazakhstan is about 0.6 billion m^3/year. Groundwater and surface water of Yili River plain sustain the social and economic development of the Xinjiang province of China and the regions with large population in Kazakhstan. The aquifer is thus a valuable natural resource shared by these two counties.

4. Middle Heilongjiang-Amur River Basin: This aquifer is a transboundary aquifer shared by China and Russia. The total area is estimated to be 100,000 km^2, and the area of the Russian portion is 55,000 km^2. The southern part of the aquifer is called the Three River plain and is located in China with an area of 45,000 km^2. The flat and low-lying plains are formed due to the sand deposition of Heilongjiang-Amur River, Songhua River and River Wusuli. The annual average precipitation of this area is 500–650 mm. This aquifer is divided into Quaternary pore aquifer, Tertiary pore aquifer and Pre-Quaternary bedrock fissure aquifer. The groundwater flows from high elevation part of piedmont to low elevation part where the Heilongjiang-Amur River meets the Wusuli River. The monitoring data on groundwater of the middle Heilongjiang-Amur River Basin show that it is still in equilibrium, but with a much higher content of Fe and Mn.

5. Yalu River Valley: This is the transboundary aquifer shared by China and Korea D.P.R. The basalt fracture rock aquifers are the sources for water supply for both countries. The total dissolved solid of the groundwater is less than 0.2 g/L. Their chemical type is HCO_3–Mg_Ca.

6. Nu River Valley: This aquifer is a transboundary aquifer shared by China and Myanmar. The area of this shared aquifer in China is 35,477 km^2, and the runoff module of natural recharge is about 300,000 $m^3/(km^2a)$. The annual average precipitation of this area is 1,600–2,700 mm. Groundwater in the aquifer is mainly in the form of karst fissure water and subterranean stream and its chemical type is mainly HCO_3–Ca and HCO_3–Ca_Mg. Karst fissure groundwater in the aquifer is the main water source for local residents.

7 and 8. Karst aquifer of Upriver of Hong River and Zuojiang Valley: This aquifer is a transboundary aquifer shared by China and Vietnam. The area within China is 62,000 km^2. The annual average precipitation of this area is 1,500–1,800 mm and the runoff module of natural recharge is about 400,000 m^3/km^2 per year. The karst area is made up of solid thick-bedded limestone, dolomitize limestone, and calcareous dolomite. Geomorphologically, from northwest to southeast, there are valleys and plains in both riversides of Zuojiang Valley. The groundwater in the aquifer is mainly in form of karst fissure water and subterranean stream. The subterranean stream, in line with big karst valley and surface water subsystem, extend towards the northeast and northwest. With Heishuihe River being the boundary, the western subterranean stream flows towards southeast, and the eastern subterranean stream flows towards southwest. The catchment area of subterranean stream is about 25–120 km^2, and the outflow in the dry season is 50–500 L/s. Chemical type of groundwater in the aquifer is mainly HCO_3–Ca and HCO_3–Ca_Mg. The depth of groundwater is mostly less than

30 m and is even less than 10 m at some places. The annual variation of water level ranges within 10–20 m. The rate of karst cave and fractured of the underground limestone on volume is 33–50%. Groundwater in the aquifer of karst fissure and subterranean stream is the main water source for local residents.

Tranboundary Aquifers of Greater Mekong River Basin

UNESCO-IHP has started a new initiative to map major transboundary aquifers in the Greater Mekong River Basin with various partners. The 4,900 km long Mekong River is an international water body having its source in China's Qinghai province from where it flows southwards through the Tibet Autonomous region and Yunnan province of China, the eastern portion of Myanmar and the four countries of the Southeast Asian peninsula. It discharges to the South China Sea through the Mekong Delta to the south of Ho Chi Minh City in Vietnam. The Mekong River and its network of tributaries form the Mekong River Basin (MRB), draining parts of six countries: Cambodia, China, Lao PDR, Myanmar, Thailand, and Vietnam. The boundary of this region includes the entire Mekong River Basin and the coastal area surrounding the Mekong Delta.

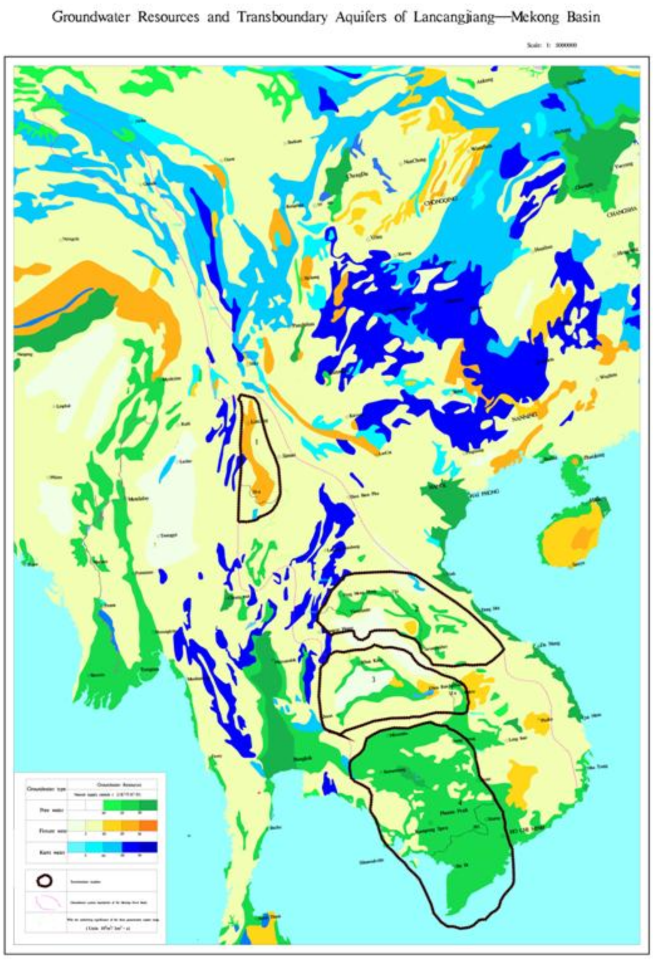

Fig. 3. Transboundary aquifers of Greater Mekong river basin.

Transboundary Aquifers of Caucasus and Central Asia*

For transboundary basins in Caucasus and Central Asia during the Soviet Union era, basin plans were developed by regional institutions and included inter-republic and multi-sectoral aspects, as well as allocation of water for various uses. Since independence more than a decade ago, Armenia, Azerbaijan and Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan (the countries of the CACENA region) have been striving to develop fair and rational bases for sharing and using their water resources.

This regional assessment covers transboundary groundwater aquifers from the eight CACENA countries. The assessment is based on current knowledge. Such knowledge is still incomplete and will need to be confirmed and completed by further studies. All together, 18 aquifers with significant resources were reported as transboundary, bordering or shared by two or more countries. However, only 16 of them were reported by two countries sharing them. The assessment has shown that

Table 3. Transboundary aquifers of Caucasas and Central Asia.

No.	Aquifer name	Countries	Type/link with surface water	Lithology/age	Thickness mean-max (m)	Extent (km^2)
1	Osh Aravoij	UZ/KG	n.a./shallow/deep /medium	Sandy gravel		
2	Almoe-Vorzin	UZ/KG	n.a./medium			
3	Moiansuv	UZ/KG	n.a./shallow-deep/ strong-medium	Boulders pebble, loams, sandy, loams	150 -300	1,760
4	Sokh	UZ/KG	n.a./probably shallow /strong			
5	Alazan-Agrichay	AZ/GE	3/shallow/medium	Gravel-pebble, sand, boulder	150 -320	3,050
6	Samur	AZ/RU	3/shallow/strong	Gravel-pebble, sand, boulder	50 -100	2,900
7	Middle and Lower Araks	AZ/IR	3/shallow/strong	Gravel-pebble, sand, boulder	60 -150	1,480
8	Pretashkent	KZ/UZ	4/deep/weak	Sand, clay	200 -320	20,000
9	Chu Basin	KG/KZ	4/deep/weak	Sand, clay, loams	200 -350	
10	Pambak-Debet	GE/AM	3/shallow strong	Sand, clay, loams		
11	Agstev-Tabuch	AM/AZ	1/2/shallow/mode-rate			500
12	Birata-Urgench	TM/UZ	3/shallow/strong	Sand, loams	10 -50	60,000
13	Karotog	TJ/UZ	2/shallow/moderate			328
14	Dalverzin	UZ/TJ	2/shallow/moderate			
15	Zaforoboi	TJ/UZ	2/shallow/moderate			
16	Zeravshan	TJ/UZ	2/shallow/moderate			88
17	Selepta-Batkin – Nai-Icfor	KG/TJ	2/shallow/moderate			891
18	Chatkal-Kurman	KZ/UZ	4/ deep/weak	Sand, clay		20,000

transboundary groundwaters play a significant role in the CACENA region. Different types, functions and uses can characterize aquifers. In general, all types of groundwaters can be found in the CACENA countries. However, there are young sediments in river basins as it was found from the available information. General information on the types, connection with surface water resources and geology of the aquifers is summarized in Table 3. Figure 4 shows locations of transboundary aquifers of Caucasus and Central Asia.

Fig. 4. Transboundary aquifers of Caucasus and Central Asia.

***** Adopted from "Our Waters: Joining Hands across Borders - First Assessment of Transboundary Rivers, Lakes and Groundwaters" published by Economic Commission for Europe Convention on the Protection and Use of transboundary Watercourses and International Lakes.

Transboundary Aquifers of India: an Inventory

Indian continent, bounded by the Himalayas to the North, stretches southwards and at the Tropic of Cancer, tapers off in the Indian Ocean between the Bay of Bengal on the

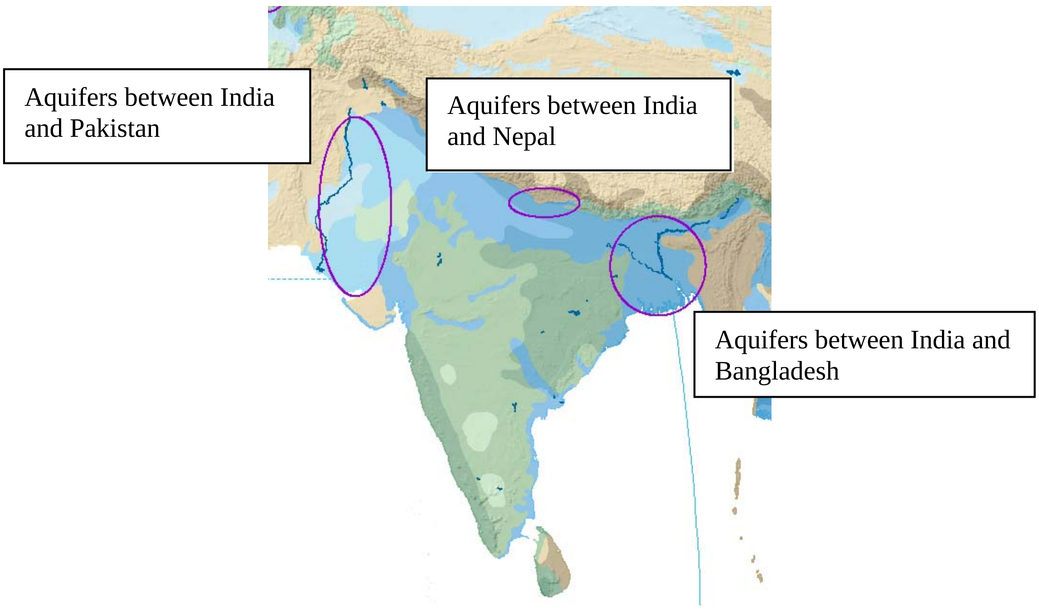

Fig. 5. Transboundary aquifers of India.

east and Arabian Sea to the west. The transboundary aquifers thus originate from Himalayas and pertain to the Indus and Ganges basins which share transboundary aquifers with China, Pakistan & Afghanistan and Nepal, Bangladesh & Myanmar respectively. The map shown in Fig. 5 depicting transboundary aquifers of India derived from World Hydrogoleogical Map.

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The Groundwater Problem in Mongolia

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Abstract Mongolia has limited water resources, especially when compared with other countries. Twenty percent of Mongolia's water consumption comes from surface water resources and 80 percent from groundwater resources. The specific aspect of groundwater resources of Mongolia is that the groundwater resources are unevenly distributed and groundwater resources are limited in many areas. Mongolia is using the groundwater resources for sources of urban water supply, industrial water supply, livestock water supply, agricultural water supply (irrigation systems and pasture watering) and the mining industry. In recent years, water consumption has been increasing rapidly, particularly due to industry development and population growth. The artificial recharge of groundwater resources is impossible in Mongolia for a range of reasons. There are limited groundwater resources and the groundwater recharge process is lengthy. There has also been a lack of investment in artificial recharge technologies. Moreover, the groundwater's ecology is sensitive and one of the parts of the frail environment ecosystem.

In Mongolia ecological–economical damages are becoming increasingly apparent in the environment. Environmental impacts in the natural environment are increasing and ecological change is appearing. A major cause of these changes is the utilization of groundwater resources for the rapidly growing mining industry, for instance gold, copper-molybdenum and spar. Water resource shortages and water pollution arise because Mongolia is utilizing its water resources without investigating the impacts or accounting for the amount of usage.

Global climate change and has also been influencing Mongolia in last decade. The scientific organization's scientists are forecasting that air temperature is rising and total evaporation is increasing. The trend of groundwater resources will therefore be that groundwater resources will be decrease.

Key words Groundwater resources, water utilization, groundwater problem, climate change, water shortage

BASIC ENVIRONMENTAL CONDITION OF MONGOLIA

Mongolia is a landlocked country located in Central Asia bordered by Russia and China. Mongolia covers a total area of 1,564,100 km^2. Most of the country is a high plateau ranging from 560 meters above sea level to 4,374 m, with an average altitude of 1,580 m.

Mongolia has severe climatic conditions. The average annual precipitation is 250 mm, ranges from 400 mm in the north, to less than 50 mm in the southern Gobi region.

In Mongolia, all natural zones such as high mountains, valleys between the

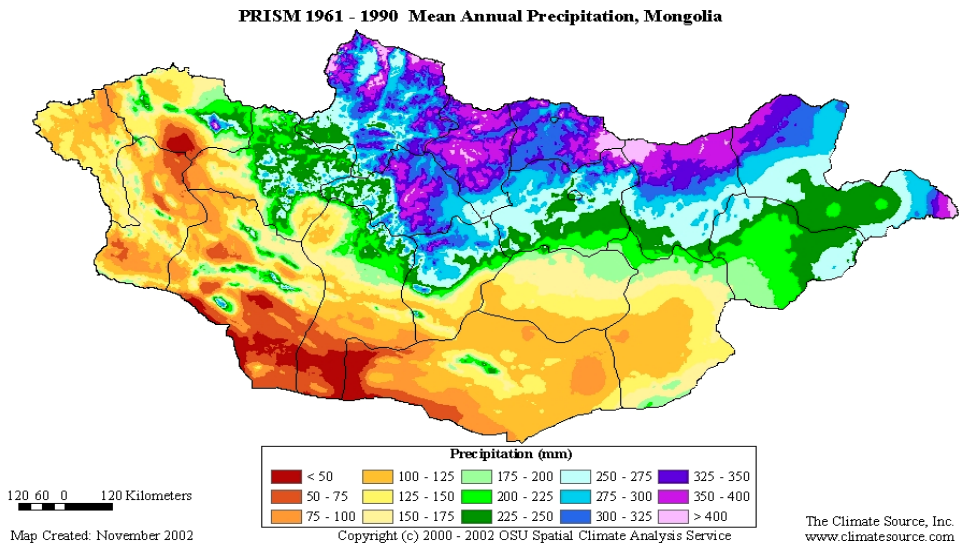

Fig. 1. Mean annual precipitation of Mongolia.

mountain ranges, wide steppe, desert and semi-desert zones are associated. Ecologically, Mongolia occupies a critical transition zone in Central Asia and Siberian taiga.

Southern part:

- Mezozoic sedimentary rock
- Precipitation 50-100 mm/year
- Discharge of spring Q=0.03-21 l/s
- Well specific yields 0.1-6.0 l/s
- TDS 500-600 mg/l, and more 1500 mg/l

Northern part:

- From Archezoic to Cenozoic magmatic metamorphic and sedimentary rock
- Precipitation 400-550 mm/ year
- Discharge of spring Q=0.2-50 l/s sometimes Q=100 l/s
- Well specific yields q=0.2-30 l/s
- TDS 200 mg/l

Almost 20 % of the country is steppe - vast grass-covered plains that include the Depression of Great Lakes and the Gobi Desert, a treeless, barren cold desert with some of the harshest climatic conditions on the planet. But the Gobi Desert also has some of the country's most valuable mineral deposits.

Annual precipitation for all country is 250 mm or 361 km^3.

- evapotranspiration – 90 %
- outstanding- 10 % (36.1 km^3 water)
    - infiltration 37 % (13.4 km^3)
    - overland flow 63 % (22.7 km^3)

Water resource depends on geological structure, climate, geomorphology and hydrogeological condition.

WATER RESOURCES

Mongolia is divided into three ocean basins in the Central and Eastern Asia, namely:

- Northern Arctic Ocean Basin
- Pacific Ocean Basin
- Central Asian Internal Drainage Basin

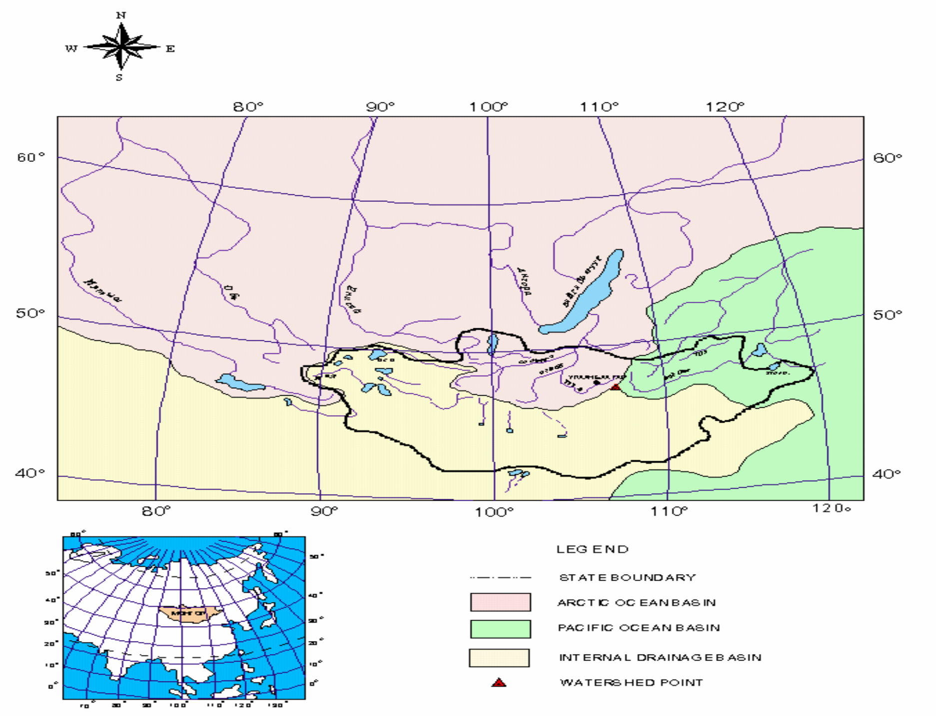

Fig. 2. The main basins in Mongolia.

The Central Asian Internal Drainage Basin occupies the greatest area of Mongolia (68 % of the national territory), however contains the smallest potential water resources of the three basins (refer to Table 1). Much of the area of this basin is occupied by the great Gobi Desert, which receives very little precipitation. However, both the Northern Arctic Ocean Basin (16.9 km^3) and the Pacific Ocean Basin (13.9 km^3) contain significant potential water resources.

Table 1. The basin area and volume of water resources.

Name of the basin	Area of basin (%)	Volume of water resources of basin (km^3)
Northern Arctic Ocean	20.5	16.9
Pacific Ocean	11.5	13.9
Central Asian Internal Drainage	68.0	3.8
Total	100	34.6

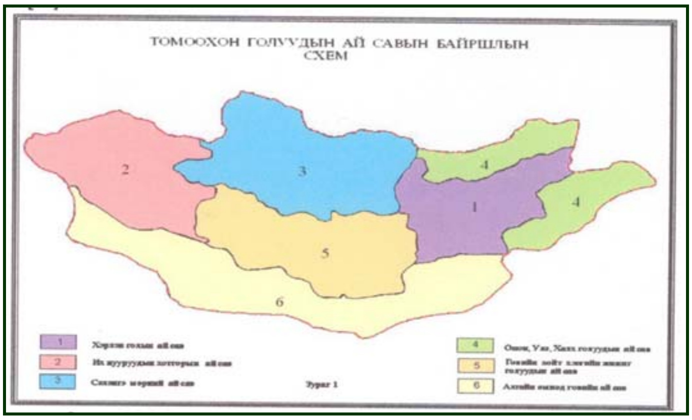

Fig. 3. Larger river basins in Mongolia.

The territory of Mongolia divided into six larger river basins based on economic and environmental significances, namely:

1. Kherlen River basin
2. Great-Lakes basin
3. Selenge River basin
4. Onon, Ulz, and Khalkh Rivers basin
5. Northern Gobi Rivers basin
6. Southern Gobi of Altai basin

The first comprehensive water resources evaluation was undertaken as part of the Master plan for the Complex utilization and Conservation of Water resources in Mongolia. Subsequently, six Regional Water Sub Plans were prepared between 1978 and 1991 and partially published by Institute of Water Economy (now the Institute of Geoecology). The product awarded the Parliament prize for scientific work of the XX century. The territory of Mongolia is also divided into 6 large water basins based on economic and environmental significances, namely it is:

-Selenge River basin
-Kherlen River basin
-Great-Lakes basin
-Onon, Ulz, and Khalkh River basin
-Northern Gobi Rivers basin
-Southern Gobi or Altai basin
-Tuul River basin
-Khubsugul Lake basin

Table 2. Water resources distribution.

World Basin	Regional Basin	Popn. (1000’s)	Area (km^2)	Popn. Dens. ($/km^2$)
Northern Arctic Ocean	Selenge	1,500.9	343.2	4.4
Pacific Ocean	Kherlen	240.0	180.7	1.3
	Onon, Ulz & Khalka	100.0	150.5	0.6
Central Asian Internal Drainage	Great Lake	393.7	288.5	1.3
	South Gobi	115.5	343.5	0.3
	North Gobi	143.9	257.7	0.6
Total		2,533.1	1,546.1	1.6

The Water Authority of Mongolia is performing regulations based on these water basins by the River Basin Committees on water resources and management, which is initiated by the Ministry of Nature and Environment.

SURFACE WATER RESOURCES

The total surface water resource of Mongolia is estimated as 599 km^3/year and is composed of water stored in lakes (500 km^3/year), glaciers (62.9 km^3/year) and rivers (34.6 km^3/year). Figure 4 shows water resources distribution in the country.

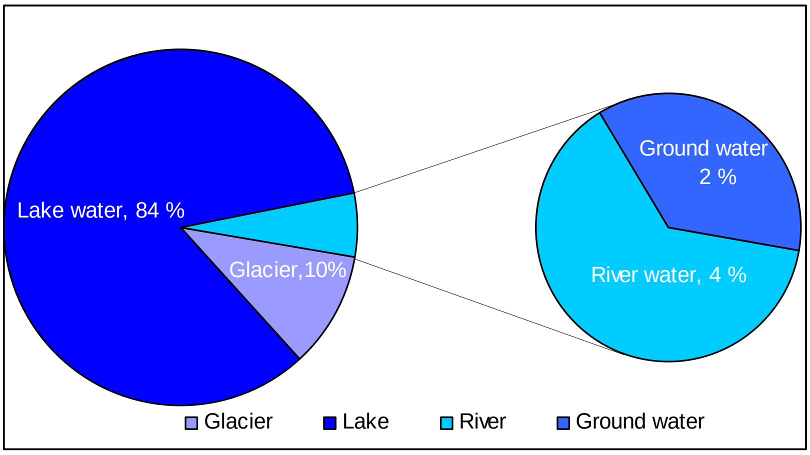

Fig. 4. Water resources distribution in the country.

Round 3,060 permanent lakes are in Mongolia, water surface area of which exceeds 10 hectares. Total lake area is estimated to be 16,003 km^2. 83.7 percent of total lakes are small lakes with surface area less than 1.0 km^2. Water surface area of small lakes composes only 5.6 percent of the country's total lake area (Tserensodnom, 2000). The biggest 4 lakes with surface area exceeding 1000 km^2 such as Khuvsugul, Uvs, Khyargas and Khar-Us lake contain more than 80 percent of the total water resources in the country.

Water bodies of dry or semidry climate region as my country are very sensitive to climate change and anthropogenic pressures. High evaporation rates and low precipitation easily respect this sensitiveness. As shown in Fig. 5, annual evaporation from open surface area of lakes exceeds annual precipitation in all areas except high mountainous region. Biggest lakes are concentrated in the Great Lake's hollow and in the Valley of Lakes located in western and southwestern Mongolia. However, there exists clearly defined climatic, and lake morphological distinguish between the hollow and the valley. The ratios of area of lake to average depth of lake decrease with increasing evaporation rate in the Great Lake Hollow. In other words, spatial distribution of water surface evaporation shows that the area per unit depth of lake decreases with increasing evaporation in the Hollow. While these ratios increase with increasing evaporation rate of lakes located in the Valley of lakes. Therefore, most of medium lakes as Orog, Taatsyin Tsagaan, Adgiin Tsagaan and Ulaan lakes in the Valley of lakes dry up 1-2 times per 11-12 years. These lakes are drying in last 4 series of drought years of 1999 to 2003, as well. This is very tragic period of ecological crisis.

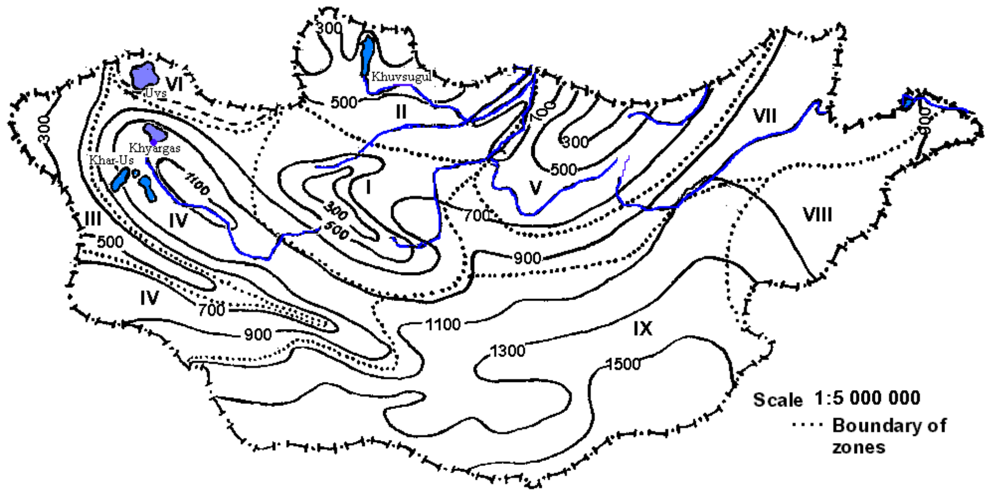

Fig. 5. Annual mean evaporation rate from open water surface.

When millions of fishes, aquatic plants and animals die concentrating in isolated spots of saline mud left by drying vast area of lake bottom.

Numbers of evaporating ponds and small lakes periodically dry up forming isolated saline water holes, salt, marsh and minerals at their bottom. Water surface evaporation reaches even 1.5 m and more in southern peripheries of the Gobi desert (Fig. 5). While annual precipitation amounts 50-100 mm. It severely limits existence of even evaporating ponds, springs and streams in these areas, especially in last years as shown in Fig. 6.

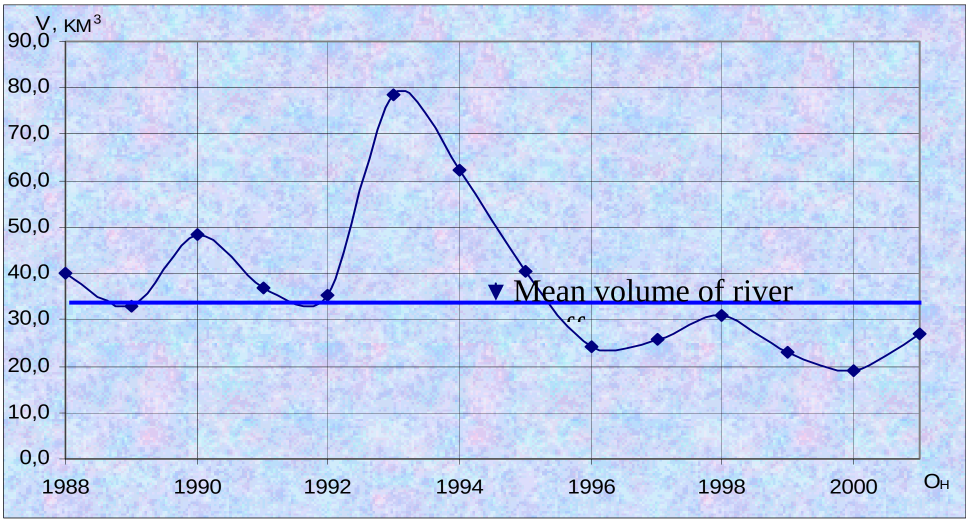

Fig. 6. Annual runoff volume series of rivers in Mongolia.

Natural belt, zones and their contrasts and unevenly distributed water exploitation figures in the country require locally own specific measures of water resources conservation. Simple reason, majority of lakes is located at the end of river drainage basins, forces to implement proper watershed management in the country.

WATER UTILIZATION

Actual water use is small compared to the water resources available, particularly in the southern part of Mongolia. Only 30.8 % of total population is provided with water from the centralized distribution systems, 24.8 % gets its water from tank distribution systems, 35.7 % from wells 9.1 % still uses rivers, stream, spring and other surface water. Nearly half of the population lives in rural area where people use river, spring and other surface waters for daily use. In addition to that the provincial centers have a rural character i.e. certain percentage of households grow crops and keep animals. Therefore, a water use urban household that grows crops and keeps animals and herdsman depends on availability of surface water nearby. Thus the surface freshwater is a finite and vulnerable resource.

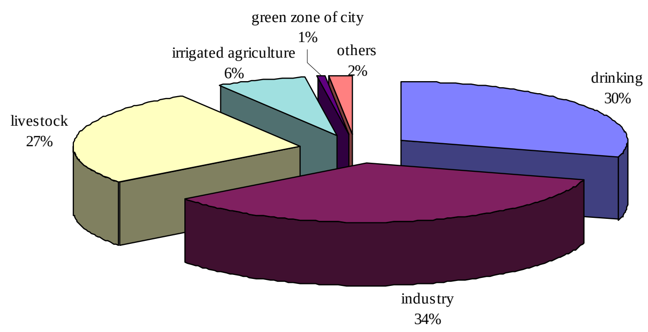

Fig. 7. The percentage of water utilization of Mongolia.

PASTURE WATER SUPPLY

The total water use is 0.5 km^3. The water availability is 10 time less than the world average, because of water resources are unequally distributed over the country. Before 1990s, there were over 48,000 wells mostly used for herders' water supply and livestock watering throughout the country. Today about 40 % of those wells are out of use due to lack of maintenance and absence of owners. A number of multi stage measures have been implemented over the last 20 years with the purposes of solving out the issues on water supply and expansion of service range in compliance with future outlook of cities and settlement's development. As a result of those measures capacity of water supply construction has been increased 6 times of water supply line. Water supply capacity reached 0.55 million m^3 per day while the capacity of water refining facility increased 4 times enabling about 0.4 million m^3 of waste water getting refined per day.

There is necessity to solve the problems of water supply 170 soums, however this issues was resolved only in 70 soums. In the future water resources exploration and survey should be undertaken in order to improve water supply in more than 100 soums.

The government of Mongolia have been pay attention for development of pasture water supply 1965-1990, and established 29,000 production wells with engineering construction and 14,000 shallow pit well for pasture water supply, agricultural water supply and drinking water supply of human and life stocks. Those wells utilized for pasture water supply and developed animal husbandry successfully. The result of this development work is that we irrigated 65.4 percent of total pasture area of Mongolia in 1989.

That development work of pasture water supply was satisfied for agricultural water in this time. Unfortunately, 2/3 percent of production wells destroyed in 1990-1998 due to social system changed to the market system and privatization process started in 1990.

Therefore, the livestock water supply decreased 2 times depending from 70 percent of unused production wells located in agricultural pasture area. Sixty percent of total water supply is industrial water supply and 40 percent is domestic water supply and livestock water supply.

Nowadays 11,223 production wells are working for agricultural pasture water supply of Mongolia. In addition 6,072 production wells of them have been reconstructed.

Fig. 8. The dug well in rural area.

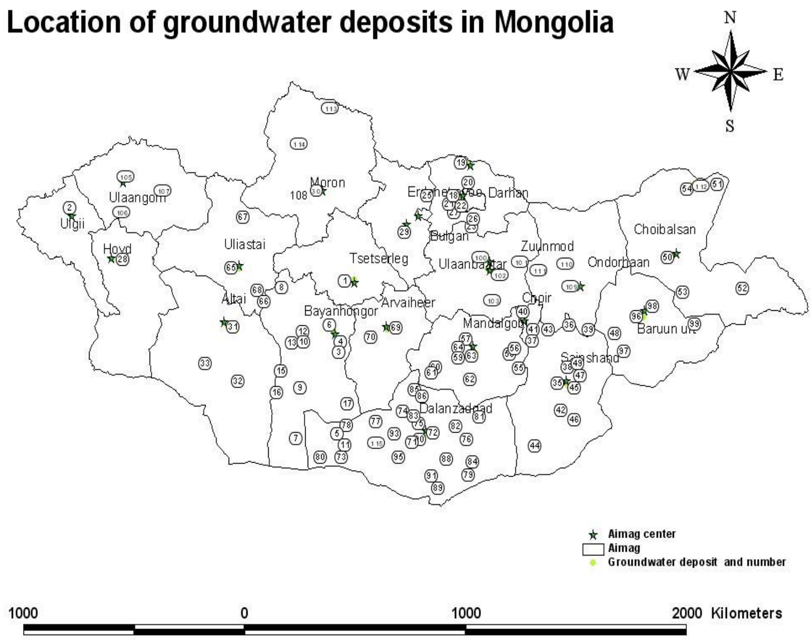

Fig. 9. Location of groundwater deposits of Mongolia.

In some area of the steppe and the Gobi ground water is only source for daily use. Different type of well whether it is artesian, pipe, tube or hand serve as water source for residential use as well as for livestock watering. In one word the rivers are the main source of water for resident of mountainous regions while people of steppe and Gobi depend on groundwater.

MAIN ENVIRONMENTAL PROBLEMS

The main environmental problems of Mongolia are deforestation, overgrazing, urbanization, water quality deterioration and lack of water resources management.

Groundwater Resources Problems

The groundwater resources are estimated as 12.6 km^3. The groundwater is main sources of domestic water supply for livestock and pasture water supply in dry steppe and desert areas.

In desert and semi arid areas water supply is often a problem. Particularly, no surface water is available except some oases. Groundwater is found to be highly mineralized and salted due to natural factors. This causes essential problems for drinking water supply, and its use often brings health problems to local people. The major problem of national water resources of Mongolia is following below:

- Depending on the geographic location frozen land in winter season dominate ground with a depth of approximately 3.5 m and rivers will be frozen for up to 7 months of a year. Because GW is the main source for household and drinking use, and watering points for animal husbandry and industrial consumption in Mongolia.
- The water resource in Gobi and steppe region is characterized by scarcity, fragile ecologically unsuitable for drinking purposes due to high mineral contents and hardness.
- More than 80 soums in 16 aimags have severe problems with water quality and water containing calcium, magnesium and chlorine which were exceed safe standards for drinking water.

Fig. 10. Transportation of drinking water from the long distance.

The users of Gobi desert region are transported drinking water from distance 10-20 km. Due to the surface water resources are very scarce in this region.

The pasture husbandry faces the movement to reconcile between water availability and grazing areas. Especially in Gobi a herdsman family moves 6-7 times a year and travels about 20 km depending on pastures and water source availability. In fact the movement around the water resources leads to more pressure on land through increased density of cattle. This in turn results to overgrazing, trampling erosion and sand movement. Accordingly water shortage

Climate Change in Mongolia

The climate of Mongolia characterizes by long lasting cold winter, cool summer, low precipitation, high temperature variability and relatively long duration of sunshine in a year. The January is the coldest month with average temperature of –15°C to –35°C that can fall till less than –50°C. The month of July is the warmest with average temperature of 15°C-25°C while the maximum can reach +35°C to +43°C. The July, 1999 was the hottest month since the last 60 years of instrumental observations.

Precipitation amount is low and varies both in time and space. Annual mean precipitation is 300-400 mm in the Khangai, Khentii and Khuvsgul mountain region, and 50-250 mm, 100-150 mm and 50-100 mm in the steppe, steppe-desert and the Gobi-desert areas respectively. About 85-90 per cent of total precipitation falls in summer months as rain. The mountain ranges are replaced by steppe and desert from north to south; accordingly the heat resource and wind speed increase while the precipitation and soil moisture decrease.

According to the records of the last 60 years, the annual air temperature increased an average by 1.56°C (Fig.11), this increase was greater in the winter (3.61°C), and smaller in the spring (1.4-1.5°C), but the summer temperature decreased by –0.3°C. If look for particular months, there is a rapid increase in months of May, September, and not much change in April. The summer temperature drop appears mainly in June and July. Changes in temperature have also spatial character: winter warming is more pronounced in the high mountain and concave between mountains, and less in the steppe and Gobi and desert. Summer cooling is not observed in the Gobi. There is not a significant change in annual precipitation amount (Dagvadorj et al., 1994, 1999).

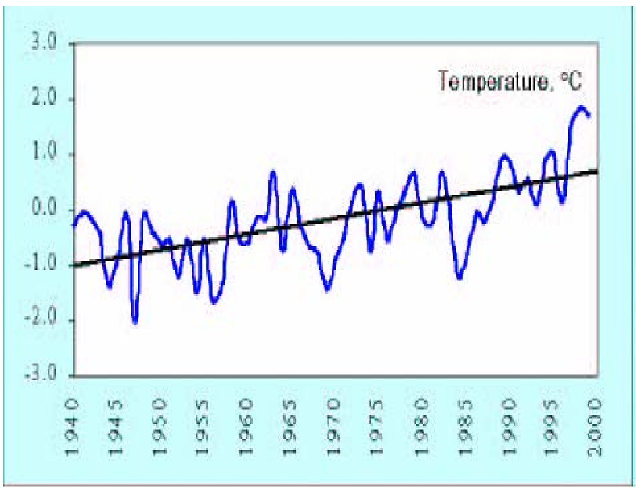

Fig. 11. Characterization of climate change in Mongolia.

Temperature in Mongolia has increased by 1.8°C since 1940. The occurrence of natural disasters like extreme hot and cold weather, drought, *dzud*, flood and sand storms in Mongolia has increased. Melting of high mountain glaciers has increased. Permafrost is melting intensively. Groundwater table is decreasing in arid regions 4 m. Desertification of the land due to shortage of water.

Fig. 12. Drought, *dzud* in Mongolia.

Groundwater Resources Problems -Water and Ecosystems

- Influences of growing urbanization and significant pollution of mining industry on ground ater resources.
- Overuse of groundwater resources and lowering of groundwater table.
- Degradation of river and lake ecosystems.
- High demand of livestock sector and impact of uncontrolled grazing practices on water ecosystems.

Mining also uses vast quantities of groundwater which reduces the groundwater table in the country.

Fig. 13. Groundwater resources problems - Mining industry.

Fig. 14. Mining industry in Tuv province Zaamar soum.

Fig. 15. Mining activity in Uvurkhangai province Ult.

Groundwater Pollution

The GW problem is pollution of mercury, the toxic substance that is used to process and separate gold from ore. "Mongolia is on the way to a mercury pollution" !!!

Figs. 16 and 17. Dundgobi province Ulziit soum In Buttai people used cyanide for gold washing by the well water (left) and that well almost polluted (right) (December, 2008) .

Umnugobi province Khanbogd soum In Nomgon people used cyanide for gold washing by the well water and around the production well there soil also polluted (Fig. 16, December, 2008). The content of heavy metal in production well water was higher than drinking water standard (Fig. 17, December, 2008) The heavy metal contents was very high in this well. For example:

- Pb-0.04 mg/l 4 time higher than drinking water standard
- As-0.06 mg/l 6 time higher than drinking water standard
- Cd-0.01 mg/l 3.3 time higher than drinking water standard

The content of heavy metal in production well water was higher than drinking water standard (Fig. 18, December, 2008). Pb-0.02 mg/l, it was 2 time higher than drinking water standard.

Fig. 18. Polluted area near the production well in Umnugobi province Khanbogd soum.

Fig. 19. Darkhan uul province Khongor soum production well.

Fig. 20. Umnugovi, Mandal-Ovoo soum, Goyo-ulaan well.

CONCLUSION

- Water scarcity and high human demand for water with required quantity and qualities.
- At the present time water pollution of groundwater is serious problem in Mongolia, especially in urban areas.

- Intensive effect of the human activities on the water environment including industrial pollution, mining exploitation and deforestation in river catchments area.
- Groundwater pollution is serious problem in urban areas and gold ore and placer mining.
- Mitigation measures of water pollution and improvement of water quality monitoring.
- Clear inter-sectoral linkage between institutions with regard to policy making, research, monitoring and managing.
- Adequate regulation and enforcement of laws and standards related to SGWM.
- Improvement of water management, coordination, research and monitoring activities throughout the country.
- Extension of groundwater monitoring network.
- Assessment and database on water resources and quality.
- Improvement of ecological and economical value of water resources.
- The quality of water is concerning issue. Every group of users requires water of different quality, and total demand is increasing. There is very important to separate users by group: high quality drinking water must not use for industry and agriculture needs or for this reason there was not unnecessary treatment of water for purposes which do not require it.
- Water quality degradation is an increasingly important issue. Water quality in Central and Northern part of Mongolia is heavily degraded, because of high population density, urbanization, comparatively high industrialization and the general lack of pollution control facilities.

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Legislation Related to Groundwater in the EU: Background and Current Status

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Abstract The paper describes the outline of the Water Framework Directive 2000/60/EC and the Groundwater Directive 2006/118/EC, giving priority to groundwater after first discussing the transition of the water environment legal system of the EU.

Key words Framework for the protection of groundwater, stream management, river basin district, combined approach, healthy chemical and ecological management

INTRODUCTION

Water environmental legislation and policy in the European Commission (EU) is one of the main policy tasks after the first Environment Action Programme of the EC adopted in 1973, and various EC directives have been enacted in this field. One of the approaches of water environmental legislation and policy in the EU is promotion of measures based on the setting of emission limit values. It has chiefly paid attention to the prevention of water pollution with a specific pollutant according to the ‘Dangerous Substances Directive: 76/464/EEC’ etc. Moreover, measures based on the setting of the level of environmental achievement are promoted. To ensure that the guidelines in ‘Surface Water for Drinking Water Abstraction Directive: 75/440/EEC’ are followed, measures to pay attention to the water utilization form have been strongly promoted.

Afterwards, these existing EC directives were reviewed. On the other hand, a new EC directive, the ‘Ecological Quality of Water Directive: COM(93)680final’, was enacted and the EC had proposed additional new directives. However, these have been only the narrowly focused corresponding allopathies for each individual problem; therefore, there has been a need for an inclusive water environmental legislation and policy since many years.

In 1995, ‘The Proposed Water Framework Directive (COM(97)49)’ proposed according to the fifth Environment Action Programme assumed that the development of a sustainable water policy was necessary. This directive inclusively provides for all water environment conservation. A matter of particular attention was to adopt the combined approach that integrated both the above-mentioned characteristics (an inclusive water environmental legislation and policy and a sustainable water policy) in ‘The Proposed Water Framework Directive (COM(97)49)’. The directive was adopted as an amendment bill (COM(98)76final) in June 1998.

In this amendment bill, the deregulation of the effects of flood water and water shortage was added to the objectives. Other additions were maintenance of the territorial water environment and achieving the target concerning the international treaty. In addition, regulations were amended, and the environmental quality standards achievement deadline was extended.

Moreover, in the declaration of the cabinet ministers seminar concerning groundwater, which was held in Hague for groundwater in 1991, the need for an action to prevent long-term deterioration of the quality and the amount of fresh water had been expressed, and the decision to execute the programme for sustainable management and the protection of freshwater resources by 2000 was made. In the council decision on 25 February 1992[1] and 20 February 1995[2], the Council requested the action programme concerning groundwater and the amendment of 'COUNCIL DIRECTIVE of 17 December 1979 on the protection of groundwater against pollution caused by certain dangerous substances (80/68/EEC)[3], which are part of the overall policy concerning fresh water maintenance.

In September 1996, the EU committee submitted the proposal[4] to the decision of the European Parliament and the Council concerning the action programme for integrated conservation of groundwater and management. In this proposal, the committee indicated the need to establish the procedure for obtaining water restrictions and monitoring of the quality and amounts of fresh water.

Thus, the Water Framework Directive 2000/60/EC based on the coherence and integration of the water policy was adopted on 23 October 2000 by the reviewers of the water environment directives of the EU since 1990, and it took effect on 22 December in the same year. The Groundwater Directive (Council Directive 2006/118/EEC of 12 December 2006 on the protection of groundwater against pollution and deterioration) was enacted in December 2006.

WATER FRAMEWORK DIRECTIVE 2000/60/EC

This instruction is a new attempt of the EU that aims at the execution of stream management that enables the purification and management of waters not delimited at an international border, but at the river basin, and treats the river chemically for a healthy ecological outcome[5].

Objective

The objective of this directive is to establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater, which
(a) prevents further deterioration and protects and enhances the status of aquatic ecosystems;
(b) promotes sustainable water use;
(c) aims at enhanced protection and improvement of the aquatic environment;
(d) ensures the progressive reduction of pollution of groundwater and
(e) contributes to mitigating the effects of floods and droughts.

The intention of this directive is to target land surface water and groundwater across national borders so that the river is not delimited by national administrative and political regulations, but rather the entire river basin is managed under the directive for geographical and hydrological elements of water quality. As this Water Framework Directive did not provide for prevention and limitation of pollution input to groundwater, 'DIRECTIVE 2006/118/EC OF THE EUROPEAN PARLIAMENT AND THE COUNCIL of 12 December 2006 on the protection of groundwater against pollution and deterioration (2006/118/EC)' was passed in December 2006 (following description).

Water Quality Target

In the Water Framework Directive, a main objective is to achieve the water quality target of excellence by 2015. For the first time, ecological evaluation joined chemical water quality evaluation in this water quality target.

Both the ecological and chemical states of surface waters are evaluated, and a quantitative, chemical state of groundwater is evaluated. Because the ecological state varies from place to place, the EU has not set a common standard. Therefore, the ecological state of surface waters is measured by a complex system based on the state with minimum human influence. The chemical state of surface waters is evaluated by the EU-established qualitative standards for the chemical.

On the other hand, absence of pollution is a pre-condition in groundwater so that the setting of a chemical quality standard is not the best approach. Therefore, the combined approach uses both prohibition of direct discharge and monitoring to cover the influence of an indirect discharge to groundwater.

Because a constant amount of water is discharged every year and some volume of water is needed to maintain the ecosystem, abstraction of groundwater is controlled. When you take the measures necessary to deregulate the adverse effect, temporary deterioration of the waters such as floods and water shortages is not considered as a failure of the achievement of the environmental target.

Priority Substances

The EU proposed 32 types of specification 'Priority Substance' lists as the first control subjects of the EU Water Framework Directive in January 2001, and these were adopted to achieve the water quality target in November 2001. A specific hazardous substance described in a 'Priority Substance' list requires the exhaust to the waters to be prohibited gradually within 20 years. Eleven types of 'top priority hazardous substances' in that list become subject to all aspects of the exhaust prohibition within 20 years. In addition, some chemicals are added to the list of top priority hazardous substances after investigation. Because the use of top priority hazardous substances will be prohibited within 20 years, one focus of the project is to determine whether a given chemical substance described in the list remains as 'a priority hazardous substance' or becomes classified as a more dangerous 'top priority hazardous substance'[6]. However, whether the priority substance list of the Water Framework Directive applies directly or indirectly to groundwater has not yet been determined.

Recovery of Costs for Water Services

It is assumed that water-pricing policies (cost-recovery pricing) provide adequate incentives for users to use water resources efficiently, and thereby contribute to the environmental objectives of this directive. For a different water supply for industrial, household and agricultural use, member states will take into account the principle of recovery of the water services' costs, including environmental and resource costs, the economic analysis conducted according to Annex III, and in accordance, in particular, with the 'polluter pays' principle. When the costs for water are recovered, member states can consider the social, environmental and economic effects of the recovery as well as the geographic and climatic conditions of the affected region or regions.

Features

The Water Framework Directive promotes the following three features:
(a) approach by both environmental quality standards and emission limit values,
(b) promotion of the integrated countermeasure by river basin management plan and
(c) monitoring.
Member states are required to convert and bring into force domestic laws, regulations and administrative provisions necessary to comply with the Water Framework Directive and fulfil the obligation of this directive. The Water Framework Directive has a fundamental law character, and the mechanism of a concrete restriction relies heavily upon an individual EC directive and the domestic laws in the member states.

Approach using Both Environmental Quality Standards and Emission Limit Values（Combined Approach）

In Japan, although promotion of both environmental quality standards and emission limit values was the original approach, the EU strategies initially centred on either the approach that decides restricted content centring on environmental quality standards according to the situation in an individual region or the approach of enforcing uniform emission limit values. In 1976, when the 'Dangerous Substances Directive: 76/464/EEC' was enacted, Britain targeted environmental quality standards and the continental nations targeted emission limit values. In the end, the selection system of both the approaches was adopted as a result of a compromise.

However, this selection system was abolished, and the combined approach was adopted in the Water Framework Directive, obligating member states to promote the surface water measures by both emission limit values and environmental quality standards (Article 10 of the Directive).

Concretely, it obligates member states to provide other measures necessary to achieve environmental quality standards in addition to measures by uniform emission limit values in a 'programme of measures', and to execute this programme (Article 11 of the Directive).

Promotion of Integrated Countermeasures by River Basin Management Plan

Each member state must aim to achieve the state of an excellent aquatic environment of the public water area and groundwater within 15 years at latest after this directive comes into effect (the achievement of environmental quality standard） (refer to Article 2 clause 18, 34 and 35, and Article 4 clause 1 of the Directive). Furthermore, each member state should establish a 'river basin district' that groups each river basin in the area severally, and settle on a 'river basin management plan' of each river basin. In addition, it is necessary to provide a 'programme of measures' including a concrete content of measures in the programme, and to execute this programme (Article 4, 5, 11 and 13 of the Directive).

The execution of the analysis of the state of water, an impact assessment of the state of surface water and groundwater by human activity and economical analysis for the water supply is requested in the river basin district (Article 5 of the Directive, and Annex II and III). Moreover, member states will ensure the establishment of a register or registers of all areas lying within each river basin district, which have been designated as requiring special protection under specific community legislation for the protection of their surface water and groundwater or for the conservation of habitats and species directly depending on water (Article 6 of the Directive). Therefore, member states will identify, within each river basin district, all water bodies used for the abstraction of water intended for human consumption providing more than 10 m^3 per day as an average, and may establish safeguard zones for those water bodies (Article 7 of the Directive).

Promotion of Monitoring of Surface Water Status, Groundwater Status and Protected Areas

Member states will ensure the establishment of programmes for the monitoring of water status to establish a coherent and comprehensive overview of water status within each river basin district. It is necessary to monitor the public water area ecologically and chemically. Moreover, it is necessary to monitor groundwater concerning the chemistry and the volume of water (Article 8 and 11 of the Directive, and Annex V). The Regulatory Committee shall adopt rules of details of monitoring procedure (Article 21 of the Directive).

Regulations Related to Groundwater

In the Water Framework Directive, quantitative status and chemical status are used as an index that shows the status of groundwater. According to the definition, ‘Available groundwater resource’ means the long-term annual average rate of overall recharge of the body of groundwater less the long-term annual rate of flow required to achieve the ecological quality objectives for associated surface waters (Article 2, Paragraph 27), and ‘Good groundwater chemical status’ is the chemical status of a body of groundwater, which meets the conditions that the chloride and other substances do not elute and the contaminant density does not exceed the quality standard applied under the other relating community legislation. Article 17 provides for strategies to prevent and control pollution of groundwater. Finally, it was requested that the Groundwater Directive be adopted by the European Parliament and the Council quickly in the hope of the most timely achievement of ‘Good groundwater chemical status’. In that case, the criteria must be established for assessing ‘Good groundwater chemical status’ according to section 2.2 of Annex Ⅱ, and section 2.3.2 and 2.4.5 of Annex V.

CONTENT OF THE ANNEX AND TIME SCHEDULE FOR THE FUTURE

Each member state should confirm all rivers in the domestic territory by 22 December 2003 and specify the river basin district. The river across the area in one or more member states is specified for the international river basin district. Each member state appoints the competent authority of each river basin district. Furthermore, according to the Annex I, ‘INFORMATION REQUIRED FOR THE LIST OF COMPETENT

AUTHORITIES', this list is submitted to the committee. The time schedule after the directive comes into effect is as follows.

— After the Water Framework Directive comes into effect, within 4 years…analysis of character of each river basin, review of influence of activity of person to water, an economical analysis for the water use are completed.

—The waters where special protection is needed for maintenance of habitat and seed, the waters used for drinking and bathing and the nitrate sensitive area are registered as a preservation district.

—After this Directive comes into effect, within 6 years…the status of surface water and groundwater and the preservation district are monitored.

—The excellent, good and appropriate state of surface water and groundwater is defined, and it provides for the target and the procedure of monitoring, considering the target of the Directive 'good status' being achieved by December 2015.

—After this Directive comes into effect, within 7 years…directives as follows are abolished: 'Council Directive 75/440/EEC of 16 June 1975 concerning the quality required of surface water intended for the abstraction of drinking water in the Member States', 'Council Decision 77/795/EEC of 12 December 1977 establishing a common procedure for the exchange of information on the quality of surface fresh water in the Community' and 'Council Directive 79/869/EEC of 9 October 1979 concerning the methods of measurement and frequencies of sampling and analysis of surface water intended for the abstraction of drinking water in the member states'.

— After this Directive comes into effect, within 9 years…the river basin management plan is settled on and made public. This plan is updated within 15 years after the Directive comes into effect, and updated every six years thereafter.

— After this Directive comes into effect, within 12 years…to achieve the environmental quality standards, a programme of measures is established and operated.

—Member States shall ensure that all discharges from point and diffuse sources into surface waters are controlled according to the combined approach, using control of pollution at source through the setting of emission limit values and environmental quality standards. In addition, the Commission shall publish a report on the implementation of this directive within 12 years.

—After this Directive comes into effect, within 13 years…directives as follows are abolished: 'Council Directive 78/659/EEC of 18 July 1978 on the quality of fresh waters needing protection or improvement in order to support fish life', 'Council Directive 79/923/EEC of 30 October 1979 on the quality required of shellfish waters' and 'Council Directive 76/464/EEC of 4 May 1976 on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community'.

—After this Directive comes into effect, within 15 years…the programmes of measures shall be reviewed, and if necessary, updated at latest 15 years after the directive comes into effect, and every six years thereafter. Any new or revised measures established under an updated programme shall be made operational within three years of their establishment.

—The environmental quality standards are achieved. However, when exceptional situations such as floods and water shortages are generated, this deadline can be extended.

GROUNDWATER DIRECTIVE

Directive 2006/118/EC of the European Parliament and the Council of 12 December 2006 on the Protection of Groundwater against Pollution and Deterioration

The Groundwater Directive was proposed according to Article 17 of the Water Framework Directive by the EU in September 2003. After the European Parliament reading, the European Parliament and Council of Ministers were divided in opinion on the Groundwater Directive proposal for the pollution control regulation of nitrates and the requirement for the water quality deterioration prevention of groundwater. Therefore, the Conciliation Commission was held, and mutual agreement was achieved between the European Parliament and the Council of Ministers in October 2006. Then the Council of Ministers approved the Groundwater Directive and it was passed.

The Groundwater Directive (2006/118/EC) consists of the following 14 Articles. In addition, it is composed of Article 1 (Purpose), Article 2 (Definitions), Article 3 (Criteria for assessing groundwater chemical status), Article 4 (Procedure for assessing groundwater chemical status), Article 5 (Identification of significant and sustained upward trends and the definition of starting points for trend reversals), Article 6 (Measures to prevent or limit inputs of pollutants into groundwater), Article 7 (Transitional arrangements), Article 8 (Technical adaptations), Article 9 (Committee procedure), Article 10 (Review), Article 11 (Evaluation), Article 12 (Implementation), Article 13 (Entry into force) and Article 14 (Addressees).

The Groundwater Directive makes concrete the content required by Article 17 clauses 1 and 2 of the Water Framework Directive (2000/60/EC). In addition, the Water Framework Directive regulations concerning the prevention and limitation of pollution input to groundwater are supplemented by

(a) Criteria for good groundwater chemical status,

(b) Criteria for identification of significant and sustained upward trends and trend reversals and

(c) Definition of starting points for trend reversals.

The Water Framework Directive obligates member states to establish threshold values for mercury, ammonium and lead by 22 December 2008, and applies a common emission limit value in which the nitrate content in groundwater is restricted to 50 mg/l for the entire EU.

Member states will ensure that ‘all measures necessary’ are established to prevent the input of any hazardous substances into groundwater along with the enforcement of the Groundwater Directive. In addition, member states will identify ‘significant and sustained upward trends’ to the groundwater pollution judged dangerous by 2009. Moreover, when the density of the contaminant reaches 75% of the threshold values, member states will introduce measures to reverse the upward trends of the contaminant density. Member states will adapt the Groundwater Directive into their domestic laws, regulations and administrative provisions necessary to comply with this directive before 16 January 2009. Thus, it can be said that a basic framework of the Groundwater Conservation System of Europe has been constructed.

CONCLUSIONS

Europe has entered a new stage in managing the waters in each river basin across national boundaries with the aim of healthy chemical and ecological management. In Europe, where countries share boundaries, purification and management of the waters will not be delimited at the international border, but will be managed as an international river basin. This approach is indispensable from an environmental viewpoint.

The deadline for beginning the ‘programme of measures’ for the river basin management plan in Britain is December 2012, although the deadline for achieving the water quality target of having all water at excellent quality status is 2015. Therefore, one must question the feasibility of reaching that ambitious objective in three years.

At the same time, all member states must address the following issues for future sustainable development:

(a) Achievement of a sustainable development index,
(b) Water pollution prevention measures for nitrate originating in agriculture,
(c) A farming groundwater fee system for groundwater regulation and
(d) Sewage disposal restrictions in municipalities.

All these matters should be attended to promptly, preferably before the required deadline for beginning the ‘programme of measures’ or the present ‘Water quality improvement programme’ is enhanced, to achieve the targeted level improvement by the time of the succession in 2012.

Finally, the measures for adapting the directive into domestic laws will be added to the schedule in the future based on the Groundwater Directive enacted in December 2006.

Table 1. Research on recent foreign cases (structural classification of the groundwater/ground environment management system) Country/territory EU (Yanagi, 2009).

Research Item			Contents of the System
Characteristics of the use of groundwater (land characteristics, change, present use condition etc.)			Hydrocarbon, having been disposed with chlorine, is distributed into aquifers of groundwater in the countries of Western Europe, while in the countries of Eastern Europe, hydrocarbon and especially mineral oil are the cause of serious problems. Percentage of the groundwater within the fresh water necessary for the entire demand is 9%–99%. In some areas, the level of abstracting groundwater has exceeded the limit of cultivation (excessive abstraction). However, in many countries, the annual gross volume of abstracted groundwater is decreasing since 1990.
(1) Condition of public participation in the advanced system	① Classification of concepts (basic approach regarding management)	• position of groundwater	With regard to groundwater, because the [volume] of groundwater is affected by the ecological [quality] of the ecosystem of the land bordering with groundwater and surface water, a common definition about the condition of water shall be regulated with regard to [quality] and [volume].
		• background of system establishment	Deterioration of the quality and decrease of the volume of water in aquifers and the substance of groundwater that has occurred as a result of different artificial pressures of human activity.
		• basis of management based on public participation • priority measures in the use of groundwater	No description.

	② Classifica-tion of management purposes	・hindrance of groundwater ・appropriate form of underwater/ground environment	Deterioration of the quality of water caused by nitrate brought about by the use of nitrogenous fertilizers, use of agricultural chemicals, pollution in a certain area(for example, area of a factory, garbage dumping place and inferior storage facilities), decrease of the volume of water caused by the excessive abstraction for public and industrial needs, a serious problem of chloride (concentration > 100 mg C/l.) caused by permeation of salt water, which is a result of excessive abstraction, acidification of groundwater occurring mainly in the countries of Northern Europe, disappearance of the length of rivers and swamps caused by drying due to excessive abstraction, pollution of groundwater caused by heavy metals due to permeations from the garbage dumping places, activity of mining industry and industrial emissions. With regard to groundwater, there is a necessity to keep it in a good condition, and with regard to concentration of pollutants, it is necessary to determine and improve large and constant contamination trends. In principle, it is a recyclable natural resource and, in particular, the duty of preserving groundwater in a good condition requires fast actions and reliable, long-term plans of preserving measures because of a natural time lag in creation and regeneration.

(2) Classification of elements for proper management	① Classification of regulatory methods for management	• objects of permissions and notices (pumping facilities) • zones that are objects of regulation • technological standards and a concept of their establishment	Subjects of the notion of zoning are those with the purpose of protection of water sources. The purpose of setting up groundwater preservation zones has three aspects: (a) to manage in order to put a source of pollution outside the zone of abstracting groundwater. (b) until pollution reaches zones of abstracting groundwater, measures such as physical mechanisms, biochemical mechanisms and dilution should be taken to reduce pollution up to admissible concentration. (c) registration of a zone requiring special protection for the preservation of groundwater. Zoning is usually carried out in the way of setting up two- or five-level conservation zones around the areas of abstracting groundwater. The size of zoning is decided on the basis of the standard of securing the distance and the time necessary for bacteria and chemical materials to decrease until groundwater reaches a well up to the concentration where a human body is not affected (by actions of filtration, adsorption, decomposition, dilution etc.). Combined approach based on the combination of effluent standards and environment standards. Common [standard on the quality of environment] and [emission threshold value] concerning certain pollutants shall be regulated as a minimum requirement in the legal system of the community. According to the Water Framework Directive, at the time of the settlement of the river basin management planning, every country is required to set up environmental standards.

	② Classification of watching methods of the groundwater level, etc. (present system)	• system of watching hindrance of groundwater • position in the system of watching item (level of groundwater/condition of groundwater use) • administration, sharing roles of parties (system of implementation, expenditures)	According to the Water Framework Directive, monitoring with regard to a scientific condition of groundwater and its volume shall be implemented. Most monitoring planning projects are unified by a single state body and carried out together with local territories or prefectures.
	③ Method of achieving management goals (policy, costs/effect of the method)	• method of restraining groundwater use • method of promoting water resource cultivation • method of water resource conversion	Regulation concerning registration of water abstraction, requirements to preliminary permission of water abstraction and water storage, surface fresh water abstraction and surface groundwater abstraction and storage of fresh surface water. These regulations shall be periodically reviewed and where necessary renewed. Regulation concerning requirements for prior authorization of artificial recharge or augmentation of groundwater bodies. There is no fund regarding recovery of polluted groundwater. According to the principle of a polluter burden, the principle of collection of costs for water services including environmental and resource connected costs shall be deliberated. The EU Regulation 797/85 (1985) regulates that the government of each country in environmentally sensitive areas can compensate farmers who have promised environmentally protective methods of agriculture.

(3) Classification of methods of using information regarding groundwater/ground environment	• types of information collected	Review of the effect of activity of people on groundwater- Position of the spot of a groundwater zone, which is used for abstracting water except the following spots: Water abstraction spot providing 10 m^3 per day on an average or water abstraction spot providing for human consumption 10 m^3 per day on an average or to less than 50 people; Scientific structure of water abstraction from groundwater bodies. Position of spots of groundwater bodies where water is released directly; Release percentage of such spots; Scientific structure of release into groundwater bodies and Use of river basin land recharged by groundwater including pollutant's inputs and changes of human causes towards characteristics of recharging such as changes of streams of rainwater and streaming water caused by pavements of land, artificial recharges, dam or drainage.
	• method of collection, data base	Collection of information concerning groundwater veins is the common work of the member states and the European Environment Agency (EEA). However, EEA does not have the power to collect information. It can only demand the member states to provide information.
	• method of using related information	Information network such as EEA and EIONET.

REFERENCES AND NOTES

1 Official Journal, C 59, 6.3. (1992), p.2.
2 Official Journal, C 49, 28.2. (1995), p.1.
3 Official Journal, L 20, 26.1. (1980), p.43. Amended by the Directive 91/692/EEC (Official Journal, L 377, 31.12. (1991), p.48.
4 Official Journal, C 355, 25.11. (1996), p.1.
5 Directive 2000/60/EC of the European Parliament and the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, Official Journal, L 327, 22/12/2000, p.0001–0073. This EU Directive was adopted in October 2000. The objective of this Directive is to be able to make sustainable use of the EU waters (groundwater is contained) and maintain a healthy ecological status. The intention is to introduce purification and management of each river in a manner similar to that of the rivers that transcend national borders. The main objective of this directive is to achieve the water quality target of excellence by 2015. The list of the water quality regulation substances is being made public by the EC to achieve this target in 2000. The water quality standard and the emission restriction plan are settled on after this list is adopted, and there are regulations of proper water rate setting, industrial activity and pollution management from agriculture and the city region and the requesting NGO and the local populace to participate from water quality management activity.
6 Official Journal, L 331,15.12. (2001), Annex X, List of Priority Substances in The Field of Water Policy. The list of the priority substance is as follows:

(1)Top priority hazardous material (Eleven-types): ①Brominated diphenyethers, ② Hexachlorobenzene, ③Mercury and its compounds, ④Polyaromatic hydrocarbons, ⑤ Cadmium and its compounds,⑥Hexachlorobutadiene, ⑦Nonylphenols, ⑧Tributyltin compounds, ⑨C10-13-chloroalkanes, ⑩Hexachlorocyclohexane and ⑪Pentachloro-benzene.

(2) Investigated priority substance (‘Schedule it to the priority hazardous material’, Eleven-types): ①Anthracene, ②Di (2-ethylhexyl) phthalate (DEHP), ③Naphthalene, ④ Trichlorobenzenes, ⑤Atrazine, ⑥Endosulfan, ⑦Octylphenols, ⑧Trifluralin, ⑨ Chlorpyrifos, ⑩Lead and its compounds and ⑪Pentachlorophenol.

(3) Priority material (Ten-types): ①Alachlor, ②1,2-Dichloroethane, ③Isoproturon, ④ Trichloromethane (Chloroform), ⑤Benzene, ⑥Dichloromethane, ⑦Nickel and its compounds, ⑧Chlorfenvinphos, ⑨Diuron and ⑩Simazine.

Water-resource Management and International Relations in Central Asia*

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Abstract This paper attempts to demonstrate that the present situation with regard to the availability of water resources in Central Asia is misbalanced, with some states finding themselves in a less favorable situation than others. In order to demonstrate this, several levels of disparities between two groups of regional states – upstream states with excessive supplies of water, and mid- and downstream states with water shortages – are discussed. It is suggested that the major problem in the way of setting up an effective water-management mechanism in the region is the drastic differences in perceptions amongst parties involved over how cooperation should be planned. After analyzing selected arrangements and agreements on water management in the region, attention is drawn to the weaknesses of institutional frameworks that have prevented fully fledged, constructive regional cooperation over water-related issues. Finally, an effort will be made to suggest what can be done to further develop inter-state cooperation in this field.

Key words Water management, regional cooperation, inter-state relations, Central Asia

INTRODUCTION

Before the collapse of the USSR, all decisions regarding water issues in Central Asian region were made through the centralized system in Moscow and the voices of union republics, Afghanistan and Iran in those issues were unheard or were neglected to a great extent. New geopolitical realities resulted in the creation of five newly independent states, each with its own interests, economic situation and water-management policies. The 'eco-nationalism' of the end of the 1980s turned into 'eco-centrism' and furthermore into 'eco-egoism' in the 1990s.** Issues that had largely fallen under the coordinated water-management policy of just one state, the USSR, were internationalized. This has exposed the reality that a new cooperative approach is required to prevent, mitigate, administer, and solve problems arising from the use of trans-boundary waters.

The main questions that the present paper aims to address are the following: What is lacking in present water-management cooperation in the region? What can be done to prevent and resolve water disputes in Central Asia? What are the main dilemmas and challenges in inter-state water consumption in Central Asia?

The article demonstrates that the present situation with regard to the availability of water resources in Central Asia is misbalanced, with some states finding themselves in

∗ This article is shortened and updated version of the articles published in 2004 and 2005.
∗∗ The term 'eco-nationalism' in a Central Asian context is borrowed from Weinthal (2002), pp. 106-109.

a less favorable situation than others. In order to demonstrate this, several levels of disparities between two groups of regional states – upstream states with excessive supplies of water, and mid- and downstream states with water shortages – will be discussed. It is suggested that the major problem in the way of setting up an effective water-management mechanism in the region is the drastic differences in perceptions amongst parties involved over how cooperation should be planned. After analyzing selected arrangements and agreements on water management in the region, attention will be drawn to the weaknesses of institutional frameworks that have prevented fully fledged, constructive regional cooperation over water-related issues. Finally, an effort will be made to suggest what can be done to further develop inter-state cooperation in this field.

GEOGRAPHY AND POLITICS OF WATER IN CENTRAL ASIA

The Trans-Boundary Nature of Central Asian Water Resources

The largest water basin in the Central Asia region is the Aral Sea Basin, which comprises the Amu Darya and Syr Darya trans-boundary river basins, and a network of smaller rivers.

The Amu Darya headwaters are formed in the Pamirs, at the tri-junction of the territories of Tajikistan, China and Afghanistan (Polat, 2002:124). The river Pyandj flows between Tajikistan and Afghanistan, creating a natural border between the two countries. The Pyandj then becomes the Amu Darya. Therefore, further downstream, the Amu Darya serves as a border delimiting Tajikistan and Afghanistan. The flow of the Amu Darya River is augmented by the Afghan Kundus River and the Tajik Kafirnihan River. The latter, in its upper course, also forms a part of the border between Uzbekistan and Tajikistan.

Besides forming the border between Uzbekistan and Afghanistan, the Amu Darya River further delineates the Turkmen-Afghan border and the Uzbek-Turkmen border. It finally enters the Khorezm region and then flows through the Karakalpak region of Uzbekistan and into the Aral Sea. There are also a number of canals and water reservoirs on the river (Polat, 2002: 125-128).

The trans-boundary nature of the Amu Darya Basin can be clearly understood by analyzing the nature of several rivers that constitute its basin. For instance, the rivers Murgab and Tejen are shared between Turkmenistan and Afghanistan, and the river Atrek forms a section of a common boundary between Turkmenistan and Iran (For other smaller rivers, see Polat, 2002: 125-128).

The situation in the Syr Darya River Basin is very similar. The headwaters of the Syr Darya are formed in the Tian Shan Mountains of Kyrgyzstan, and several tributaries cross into Kazakhstan. One of the most significant rivers of Kyrgyzstan – the Naryn – also crosses the border into the Namangan region of Uzbekistan. The Naryn is controlled by Kyrgyzstan using a system of several dams, one of which is the Toktoqul Dam. Once in Uzbekistan, the waters of the Naryn are first stored near the town of Uchqurgon and then join the Karadarya River. The Karadarya, too, originates in Kyrgyzstan and flows into the Andijan reservoir. Eventually, these rivers flow into and constitute the Syr Darya River. The Syr Darya flows through Uzbekistan into Tajikistan only to re-enter Uzbekistan later, flowing towards the Aral Sea. The Syr

Darya terminates in Kazakhstan.

Inter-connection of water resources in the region should not be seen as a problem per se. This issue becomes problematic because it is further complicated by the imbalance of, and consequent disputes over, water contribution, withdrawals and compensation for supplied water in this region.

Imbalances in Water Availability: Contribution vs. Withdrawals

'Imbalance' is a salient feature of characterizes the present situation with regard to water consumption in the Central Asia region. This imbalance is mainly predetermined by the geography and demography of the region. Uzbekistan, with a population density of about 53 inhabitants per km^2, seems to be the largest demographic entity in the basin. The second most densely populated country in the region is Tajikistan, with a population density of 42 inhabitants per km^2. Kyrgyzstan has about 20 inhabitants per km^2, Turkmenistan has 10 per km^2, and the least dense is that of Kazakhstan, which has 8 inhabitants per km^2 in the basin (Polat, 2002: 142-143).

However, most of the water supply is concentrated in mountainous areas, from which all the major and lesser rivers emanate. Four-fifths of this water network are located in Kyrgyzstan and Tajikistan, which have small land areas. Uzbekistan, Kazakhstan and Turkmenistan, which occupy approximately three-fourths of the region's land area and most of its arable land, have only one-fifth of the region's water (Rumer, 1989: 77).

According to Micklin (2000), considerable disparities exist in water generation and consumption in the region between upstream and downstream countries. Upstream countries Kyrgyzstan and Tajikistan, which constitute 20 per cent of the regional territory, generate 90 per cent of the river flow. In contrast, downstream states Uzbekistan and Turkmenistan occupy 80 per cent of the geographical territory but contribute just 10 per cent of the river flow (Micklin, 2000: 8).

The figures for water contribution and withdrawals in the region also show that there exists a disparity in water consumption. Thus, according to Micklin (2000), the composition of the Amu Darya River flow comprises 80 per cent from Tajikistan, 8 per cent from Afghanistan, 6 per cent from Uzbekistan, 3 per cent from Kyrgyzstan and 3 per cent from Turkmenistan and Iran altogether. According to other region-based information sources, the figures for the water composition of the Amu Darya River stand at 74 per cent from Tajikistan, 8.5 per cent from Uzbekistan, 2.0 per cent from Kyrgyzstan, 1.9 per cent from Turkmenistan and 13.6 per cent from Afghanistan and Iran taken together (Tsentral'naia Aziia: problemy opustynivaniia', 2002). The composition of the Syr Darya is as follows: 74 per cent from Kyrgyzstan, 12 per cent from Kazakhstan, 11 per cent from Uzbekistan and 3 per cent from Tajikistan. Region-based figures for contribution to the Syr Darya, stand at 75.2 per cent from Kyrgyzstan, 15.2 per cent from Uzbekistan, 6.9 per cent from Kazakhstan and 2.7 per cent from Tajikistan (Tsentral'naia Aziia: problemy opustynivaniia', 2002).

The comparative data for water withdrawals and contribution show that Kyrgyzstan and Tajikistan contribute 25 per cent and 55 per cent, respectively, of the average annual river flow in the basin, but withdraw just 16 per cent altogether. Afghanistan contributes nearly 4 per cent of the Aral Sea Basin river flow but withdraws just below 1 per cent (Micklin, 2000: 9).

In contrast, Uzbekistan, Kazakhstan and Turkmenistan contribute only 14 per cent of the Aral Sea Basin river flow (Micklin, 2000: 9). Yet they withdraw around 83 per cent of the flow altogether (Micklin, 2000: 9). Moreover, with foreseeable stabilization of the political situation in Afghanistan, it is anticipated that Afghanistan could potentially claim 6 to 15 billion m^3 from the Amu Darya River annually because of forecast growth of agricultural and industrial production (Trushin, 1998: 268). Country-by-country data show that Uzbekistan contributes 8 per cent of the water but withdraws 52 per cent, Turkmenistan contributes no water to the Aral Sea Basin but withdraws around 20 per cent, and Kazakhstan contributes 4 per cent of the basin's water but withdraws 13 per cent.

The importance of dealing with regional imbalances in water supply can be felt with a higher degree of urgency during the drought years. For instance, during the dry season of 2001, the upstream area of Uzbekistan and Turkmenistan withdrew 85 per cent to 100 per cent of their shares while downstream areas such as Karakalpakstan in Uzbekistan and Tashaus in Turkmenistan received minimal, paltry and seriously inadequate amounts (Moigne, 2003: 7).

These disparities in water contribution and withdrawals between upstream donor-states (Kyrgyzstan, Tajikistan and Afghanistan) and downstream consumer-states (Uzbekistan and Turkmenistan) are predetermined by the geographical position of these states. However, the lack of regional cooperation to coordinate the water policies of regional states exacerbates the existing imbalances, placing a heavy burden on all Central Asian states.

REGIONAL COOPERATION ON WATER ISSUES

Institutionalization vs. Eco-Egoism

As many experts suggest, it is a relatively easy matter to propose and set requirements for efficient water-resources management or the technical standards corresponding to the 'most reasonable' regime of water-resource management (Caponera, 1985: 563). Yet the real difficulty concerns practical enforcement of those standards. There are several factors to take into account in order to make this cooperation in Central Asia possible.

There are two human-factor determinants that facilitate the smoother emergence of cooperation over water resources in this region: firstly, the very firm political will of the various presidents to avoid water-related conflicts, based on their awareness of a complicated situation; and secondly, personal linkages and contacts among hydro-bureaucrats of the Central Asian republics.

Some skeptics ironically observe that these water-management specialists mentioned as a second driving force for cooperation are in most cases exactly those people who served for decades within the water-management institutions that designed or at least implemented disastrous water-management policies under the Soviet regime. In addition, skeptics insist that, since former central Moscow-based officials find themselves made irrelevant, there exists no mid-level political structures that can provide a forum for equitable conflict management (Buck et al., 1993: 624). Yet these arguments are misleading and destructive as far as the immediate work on crisis alleviation in the region is concerned. There is no alternative to engaging these water specialists in regional water ministries who are currently in a position to deal with this problematic water situation.

Significantly enough, it has been the active support of these water experts in the Post-Soviet period, which has been instrumental in securing a well-informed consensus amongst and support from the heads of states and setting up a smooth institutional mode of cooperation in the immediate aftermath of the collapse of the USSR. In most cases, these water-management specialists were educated in the same university classes or worked together in the same region for decades, which created a consensus among them for cooperative work even after they found themselves on different sides of the borders and negotiation tables.

Even before the collapse of the USSR, the leaders of the five Central Asian republics signed a joint declaration on June 23, 1990, expressing their concern over water shortages and water pollution as the major factors in the Aral Sea Basin ecological catastrophe. It was both an appeal to Moscow to pay closer attention to the environmental needs of the region and call for joint action in the region. Remarkably, this was one of the earliest and clearest attempts by Central Asian republics to voice their concerns from a joint stance.

The primary concern of Central Asian states in the early 1990s was to maintain a stable supply of water to the agricultural sector. Therefore, on 18 February, 1992, the heads of states of five Central Asian nations signed an agreement 'On Cooperation in the Management, Utilization and Protection of the Water of Inter-state Sources' (Soglashenie o sotrudnichestve v sfere sovmestnogo upravleniia ispol'zovaniem i okhranoy vodnykh resursov mezhgosudarstvennykh istochnikov: February, 1992). Accordingly, the Central Asian states agreed to follow the norms of water supply set in the Soviet Union (Soglashenie o sotrudnichestve v sfere sovmestnogo upravleniia ispol'zovaniem i okhranoy vodnykh resursov mezhgosudarstvennykh istochnikov: February, 1992: article 2). This agreement also stipulates that each party to the agreement accepts the obligation to prevent application of measures in water management within their territory that would compromise the interests of other parties or result in water pollution(Soglashenie o sotrudnichestve v sfere sovmestnogo upravleniia ispol'zovaniem i okhranoy vodnykh resursov mezhgosudarstvennykh istochnikov: February, 1992: article 3). However, certain states, Kyrgyzstan in particular, have repeatedly violated this article of the agreement by releasing larger volumes than set limits of water during the winter months for electricity generation (Micklin, 2000: 46).

Nevertheless, this agreement served the important purposes of, firstly, not compromising the status quo which had existed in the region, and secondly, coordinating further policies on water management of the states after the collapse of the integrated system of shared water management.

The agreement of 1992, mentioned above, established the International Committee on Water (Management) Coordination (ICWC) with powers to define and develop water-management policies and approve of annual water allocation limits for each state (Soglashenie February, 1992: articles 7 and article 8).

The executive body of the ICWC consists of the Secretariat, which is based in Khodjent (Tajikistan) in the Ferghana Valley. There is a Scientific Center, which is located in Tashkent (Uzbekistan) with regional branches in the other four Central Asian states. The two Basin Water Management Organizations (Basseinoe Vodnoe

Ob'edinenie) were also established at this time: BVO Amu Darya (based in Urgench) and BVO Syr Darya (based in Tashkent), the facilities and structures of which constitute the shared property of all parties to the agreement and shall be considered as transferred for their temporary use without the right of further transfer or privatization of that property (Soglashenie February, 1992: articles 7 and article 9).

In addition to the above, the agreement on the 'Joint Activities to Address Problems in the Aral Sea and its Surrounding Area' was signed in March 1993. This agreement established the International Council on Aral Sea Basin Problems (ICAS) and the International Fund for the Aral Sea (IFAS). ICAS was designed to set policy, provide inter-sector coordination and review the projects and activities conducted in the basin. IFAS was entrusted with the coordination of financial resources provided by member states, donors and international organizations (Vinogradov and Langford, 2002: 347, 351).

In January, 1994, the 'Program of Specific Measures to Improve the Ecological, Social and Economic Situation in the Aral Sea Basin for 3-5 Years' was adopted. During their March 1994 meeting in Dashkhous (Turkmenistan), the heads of states approved the ICWC annual report and considered the Aral Sea Basin Program.

In September, 1995, the Declaration on the Sustainable Development of the Aral Sea Basin was adopted in Nukus (Uzbekistan). Parties affirmed their financial obligations to the ICAS and IFAS. The subsequent draft agreement concluded in 1996 set out the composition and functions of the ICAS in highly general terms (Vinogradov and Langford, 2002: 352).

In 1997, ICAS and IFAS were merged into IFAS. The new structure has a board composed of the Deputy Prime Ministers of Central Asian states concerned with agriculture, water and environment. The Executive Committee (EC) is the permanent working body of IFAS.

The Internationalization of Water Issues in Central Asia: Conflict vs. Cooperation

All the Central Asian states support regional ownership of the water, that they say cannot be considered a property of any one state. At the same time, each of the countries solemnly enshrined in its constitution and other legislative acts that the water within their territory is an integral property of the state and that water policy is its sovereign entitlement (Water Law, 2001: article 4; Usubaliev, T. U, 2002). Inevitably, disputes must thus arise and often competition replaces cooperation, and angry noises emanate from all the capitals (Villiers, 1999: 138). These disputes are exemplified by the following cases.

In addition to the geographic imbalances mentioned above, the economic needs of the Central Asian states with respect to water are in direct conflict. For instance, natural resources of Kyrgyzstan and Tajikistan insufficient to satisfy their energy needs. They compensate for this by power generation using hydro-electric dams. Therefore, it is profitable for them to release a large portion of water during the winter months when the demand for electricity is at its highest. Storage of water in Kyrgyzstan's Toktokul Dam (gross capacity: 19.5 km^3) and Tajikistan's Nurek Dam (gross capacity: 10.5 km^3) in the winter months is hence counter-productive to their immediate energy needs.

On the other hand, storage of water in these dams mentioned above during winter months is vital for the downstream states of Kazakhstan, Uzbekistan and Turkmenistan, since they need adequate water for their water-intensive agricultural sectors during the summer months. This kind of water-policy dilemma creates water shortages in downstream states in the summer and also causes annual floods in immense areas in the downstream territories during the winter, with lethal effect on the newly planted crops.

In order to resolve this energy dilemma with mutual benefit, an agreement was concluded in 1994 between Kyrgyzstan, on the one hand, and Uzbekistan and Kazakhstan, on the other, to supply Kyrgyzstan with coal and gas as a compensation for water storage and supply. Unfortunately, this agreement and others like it (see below) were not implemented due to disagreements on the quota of energy resources to be delivered, or simply due to the inability of one side to deliver on the agreement (Mainguet and Letolle, 2001). This in turn led to a number of complications, the latest of which occurred in February 2004.

The Commercialization of Water and Unilateralism of Water Policy in Central Asia

The upstream states consider the schemes mentioned above to be temporary and ineffective. They also view these energy-swap schemes as a tool of pressure from the downstream states. What they suggest instead can be referred to as the 'commercialization of water'. For instance, Deputy of the Kyrgyz Parliament T. U. Usubaliyev calls for introducing payments from downstream states for water emanating from Kyrgyzstan, by arguing that annual losses to the Kyrgyz economy amount to 61.5 million USD due to water collection in winter months (Olimov and Kamollidinov, 1999).

The water commercialization paradigm has dominated the Kyrgyz leadership's thinking on water policy, and this led in March, 2001 to a unilateral declaration by Kyrgyzstan that it would provide just 750 million m^3 of water to downstream states instead of the previously agreed 2.3 billion m^3, dramatically affecting the agriculture of Uzbekistan (Slim, 2002: 500). Water-commercialization rhetoric further translated into the June 29, 2001 'Law on the Interstate Use of Water Objects, Water Resources and Water Management Installations', which states that all water in the territory of the country belongs to the state, and demands that downstream states pay for water coming out of Kyrgyzstan.

The downstream states of Uzbekistan and Kazakhstan categorically dismissed such Kyrgyz claims and cited international norms and the 1992 inter-state agreements in support of their arguments. Uzbekistan and Kazakhstan also questioned the practicality of the Kyrgyz approach. Certain officials in downstream states indicate that, should Kyrgyzstan enforce its stance on selling water as a product, downstream states would hit back with the imposition of high value added taxes on Kyrgyz water during the winter months.[***] Such an imposition would threaten the hydrogen-water generation of upstream states, making it very expensive, and none of the states would benefit.

Eventually, compromises were sought. Kyrgyzstan also rephrased its demand for

*** Personal communication with a high-ranking official at the Ministry of Water Management of Uzbekistan, August 2003.

compensation from downstream states. It currently insists that these states pay only for water passing through Kyrgyz reservoirs and canals – in other words, that they share the maintenance costs of water supply installations ('Central Asia: Water and Conflict', May, 2002: 16). Kazakhstan has favored such an approach, stating that it should not pay for water but for services provided to deliver that water('Central Asia: Water and Conflict', May, 2002: 16). Kazakhstan agreed to pay 100,000 USD a year for the maintenance of those facilities('Central Asia: Water and Conflict', May, 2002: 16). A similar agreement was concluded with Uzbekistan in March of 2002.[****]

In a different development, the Director of the Kyrgyz Institute of Water Problems and Hydro-Energy, Mamatkanov has suggested constructing regionally- and World Bank-funded additional dams (the Kambarta dams N 1 and N 2) in the upper stretches of the Syr Darya, which would serve for Kyrgyz energy generation. The water would then be released into the Toktokul reservoir for storage (Weinthal, 2002: 192-193). Deputy Prime Minister of Kyrgyzstan Djoomart Otorbaev shares this vision, arguing that such a project would benefit both upstream and downstream states (Taksanov, 2003). Kazakhstan has agreed to consider providing a portion of the required overall costs of 1 billion USD for Dam-1 and 210-230 million USD for Dam-2, if Kyrgyzstan issues stock shares of the two dams ('Kazakhstan gotov stroit' GEA v Kyrgyzii esli emu dadut chast' aktsii', 2002).

In a related development, in August of 2004, Head of the Governing Board of Russian Energy Company "EES Rossiia" A.B. Chubais signed an agreement with Prime Minister of Kyrgyzstan H.T. Tanaev on coordinated actions on implementation of construction of Kambarta Dam 1 and 2 indicating Russian interest in the project ("A. Chubais podpisal memorandum o dostroike Kambartinskih GES 1 i GES 2 v Kigizii", 2004). While Russian involvement in this project might be associated by some as a part of Chubais's controversial idea on creation of "liberal empire" in Russia and surrounding areas (through uniting energy systems and creating integrated economies, at the later stage), which he still strongly supports, undoubtedly, the construction of Kambarta Dams means a positive step towards resolution of the most acute water supply problems not only for Kyrgyzstan but also for the remaining Central Asian states. As a substitute or even alternative to the Russian involvement in the construction of water-related facilities, in September, 2004, the President of Kyrgyzstan discussed feasibility of possible Chinese participation in the construction of Dams in Kyrgyzstan ('Kyrgiziia predlagaet Kitaiu sovmestno dostroit' kaskad Narynskih GES', Kabar, 22.09.2004; Moigne, 2003: 6; Dukhovny, 2003: 1).

In addition to all the logistic problems mentioned above, donor-community representatives and local specialists have concluded that there is currently a lack of willingness in the Central Asian region to ensure sustainable and equitable development of the shared water resources and that the present policy climate on this issue promotes only selfish interests, resulting in a very unstable water supply for everyone (Moigne, 2003: 6; Dukhovny, 2003: 1).

**** Ibid., p. 16. Trushin (1993), advocates the idea of payments for delivery of water to the delivering states as compensation for amortization and modernization of facilities rather than for water as a product. He insists that water in Central Asia should be considered regional property rather than national property.

Trans-Boundary Water Issues in the Region

Tajikistan, like Kyrgyzstan, is an upstream state, poor in energy resources and forced to use dams for generating hydro-electricity. Tajikistan is an integral part of the two river basins. The total capacity of dams situated in Tajikistan is lower than that of Toqtokul Dam in Kyrgyzstan. Eighty-five per cent of the energy supply to Tajikistan's northern part is maintained mainly through the Wahsh system of dams. The energy supply to the remaining part of Tajikistan is still a problematic issue. In addition, there is an energy-swap agreement between Uzbekistan and Tajikistan on mutual supply of energy, which is also irregular because of the capacities of the Tajik dam.

In order to increase its energy-generation capacity, Tajikistan is considering the possibility of reviving the Rogun Dam project. This project was planned under the Soviet government. After gaining its independence, the government of Tajikistan attempted to implement the plan, but due to financial problems and instability in the country the project came to a halt in 1992. The Tajik government returned to its implementation after the end of the civil war. The governments of Uzbekistan and Turkmenistan were cautious in their assessment of this project, since they feared that the new dam could potentially divert more water from the Wahsh River for Tajikistan's agriculture, damaging interests downstream ('Tajiks, Uzbeks to Sign Agreement on Power Engineering, Water Use', 2002).

Uzbekistan, Turkmenistan and Afghanistan constitute the Amu Darya River Basin. The situation with regard to water in the relations between Uzbekistan and Turkmenistan is less dramatic though no less tense. Both Uzbekistan and Turkmenistan are downstream countries with the highest consumption of water in the region. Their economies depend heavily on water supply. Initially, both states divided the river's water flow equally and so relations between them did not seem to contain any potential tension. However, there are three alarming issues.

First, the water-sharing between the two countries remains problematic. Disparities exist in both the demography and amount of withdrawals between the states. For instance, the more densely populated and territorially larger Uzbekistan is allocated the same amount of water as the smaller Turkmenistan. There is a substantial discrepancy between the quotas allocated and the real amount of withdrawals. While both countries are allocated 22 km^3 of water, Turkmenistan, for instance is thought to use as much as 30 km^3 of water due to water-use inefficiency ('Central Asia: Water and Conflict', 2002: 21).

Second, relations between Uzbekistan and Turkmenistan have also been affected by the announcement of Turkmenistan's intention to extend the Kara Kum Canal. This canal already carries twice as much water as it did in Soviet times and the projected increase in its capacity threatens not just to leave the Amu Darya with an extremely limited water flow, but also endangers the downstream territories of Uzbekistan, in particular the Karakalpak region, with a deficit of water for both agricultural and household usage (Weinthal, 2002: 118-119).

Third, Turkmenistan announced in 2000 that it intended to consolidate the drainage water of territories surrounding a dry area into one lake, the Golden Age Lake ('Nastupaet vodenoe protivostoianie?', 2000). The project site is 500 kilometer from Ashgabat, and the overall size of the new lake is to be 3,460 km^2. According to Turkmen specialists, this would allow Turkmenistan to grow an additional 500 thousand tons of cotton, 300 thousand tons of grain and several thousand tons of fruit annually (Insarova, 2002). However, this clearly leaves the question of whether the Golden Age Lake's suggestion sustainability would be guaranteed through drainage resources alone and whether Turkmenistan would eventually be forced to withdraw water from the Amu Darya to support the Lake. This in turn would result in water crises in the downstream Urgench Province and in the Karakalpak region of Uzbekistan and would consequently have a disastrous impact on the whole Amu Darya Basin.

These issues are likely to affect not only Uzbekistan and Turkmenistan but also Afghanistan. With the expected reconstruction of Afghanistan, the water issue is going to turn into one of the most disputed issues in the region. Naturally, the reconstruction of Afghanistan would require additional amounts of water to expand agricultural and industrial production. During the Tokyo conference on the reconstruction of Afghanistan, Western and Japanese experts supported larger water allocations for Afghanistan even if it meant draining the Aral Sea (Jumagulov, 2002). Central Asian delegates voiced their concern over these plans and warned that drying the Aral Sea and the artificial creation of three lakes in the area would lead to a catastrophe affecting the whole region (Jumagulov, 2002).

The Siberian River-Diversion Project

Many leaders and water specialists still regard the Siberian river-diversion project as the only way to compensate for the shortage of regional water from external sources. Over 150 Soviet research institutes developed a plan according to which the Siberian waters would be directed into Central Asia. The plan was rejected by the Communist Party in 1986 ('Pokupat' sibirskuiu vodu gosudarstva Azii vsio ravno ne smogut – deneg net', 2003).

Attention to the rejected plan re-emerged in April of 2002. ECOSAN (International Fund of Ecology and Health "ECOSAN" name of which was constructed from words Ecology and Sanitation) an environmental NGO, held a conference in Tashkent during which the Russian Presidential Adviser on Agriculture and Water Management Zhurabekov voiced his support for a revival of the Siberia–Central Asia canal plan, possibly in reflection of the President's views. Specifically, the plan involves diversion of the Siberian rivers Ob and Irtish, so that they would connect to the Central Asian water resources (Evropa tolkaet Rossiiu na razvorot sibirskikh rek', 2004).

The story developed further when Mayor of Moscow Luzhkov addressed a confidential letter to President Putin in 2002, in which he strongly supported the project and suggested that Russia consider the project to be of strategic and commercial value. Luzhkov considered water to be a sustainable product that can be sold without damaging Russian interests. The essence of Luzhkov's idea was to divert 5-7 per cent of water from the Ob through a 200m x 2,500m long canal to Central Asia (Luzhkov zaimiotsia problemoi Arala, January, 2003). This water is supposed to return into Russia as a result of evaporation, therefore representing a sustainable and reusable 'product'. A number of influential persons, such as the Russian Minister of Natural Resources Miheev, also expressed their interest but President Putin chose not to comment on the issue (Interview with Nikolai Miheev, 9 January, 2003: available at http://www.news.ferghana.ru). Supporters of this project argue that regional institutions such as the CIS should take leading roles in its implementation

(See *"Smisl"– Zhazhda v Tsentral'noi Azii. U proektapovorota sibirskih rek poyavlya-yutsya novie storonniki*, January, 2003).

At the same time, one of the most prominent regional experts, Rim Giniiatullin, who heads the International Fund for Saving the Aral Sea, warns that the first stage of the project alone would require 15-16 billion USD, whereas the second stage would require another 30 billion USD (Taksanov, 2003). Other opponents of this project suggest that there are alternatives, such as water conservation, improvement of irrigation techniques and diversification of crops – all are supposed to decrease the demand for water (Buck et al., 1993: 605).

Agriculture, Dam Construction and Water Crisis

In January 2004, the government representatives of Kazakhstan, Kyrgyzstan and Uzbekistan met in the southern Kazakh city of Chimkent to tackle the issues of excessive water discharges from the Toktokul Dam and the problems connected to seasonal flooding: both factors trouble regional downstream states every spring. The Chimkent Agreement (signed on 4 January, 2004), which arose from the meeting stipulated that Kyrgyzstan was to cut water discharge into Kazakhstan's Chardara water reservoir from the Kyrgyzstan-owned Toktokul Dam to the level of 500 m^3 per second. Kazakhstan pledged to compensate for potential Kyrgyz energy losses resulting from such a cut, by providing fuel oil to Kyrgyzstan. In addition, Uzbekistan agreed to allow the excess water (around 350 m^3 per second) from the Kazakhstan-owned Chardara Reservoir to the Uzbekistan-owned Arnasay Reservoir, bordering the Chardara and separated by a dam. These measures were supposed to keep the water volumes at the projected level and decrease the threat of over-flooding at the Chardara Reservoir.

However, by the beginning of February, it became obvious that the agreement was not respected by either party. Water from the Kyrgyz Toktokul Dam kept flowing at levels higher than 500 m^3 per second peaking at 560 m^3 per second. Uzbekistan was unable to facilitate the water discharge from Chardara beyond levels of 200-220 m^3 per second, substantially short of the levels agreed upon during the January meeting in Chimkent (Syrdarya Floods Due to Lack of Regional Coordination, February, 2004). This situation was pregnant with further complications since by that time the water had filled the Chardara reservoir to the limit leaving no emergency spare-capacity for dealing with potential spring floods. In addition to these problems, Tajikistan kept discharging a considerable amount of water from its Kayrakkum dam, which it uses for energy generation. At certain times, Tajik discharges reached levels as high as 1,200-1,400 m^3 per second, which further complicated the situation in the downstream states of Kazakhstan and Uzbekistan. The environmental and inter-state crisis appeared imminent.

Kazakhstan appealed to its neighbors, and several emergency meetings of the government representatives were called at the beginning of February 2004. During one of those meetings in Tashkent on 7 February, Kazakhstan and Uzbekistan provisionally agreed that Uzbekistan would complete the construction of additional reservoirs within 10 days and increase discharge of water from Chardara Reservoir to Arsanai. This meeting was followed by a multilateral meeting of the Deputy-Prime Ministers of regional states in Bishkek on 11 February, to attempt to coordinate water discharge policies between upstream and downstream regional states ('Kak ostanovit' potop?

Vitse-Prem'ery Kazakhstana, Uzbekistana i Kirgizii srochno sobralis' v Bishkeke', February, 2004).

The Bishkek meeting ended in a clear stalemate, with re-registered stances and mutual demands by the states. As a compromise solution, however temporary, the parties signed a protocol that stipulated that Kyrgyzstan would reduce the water discharge from Toktokul to the Chardara Dam to a level of 500 m^3 per second from 12 February, 2004. Uzbekistan, in its turn, agreed to allow water discharges from Chardara to Arsanay at the rate of 550 m^3 per second from 20 February, 2004. And for its part, Tajikistan pledged to discharge no more than 950 m^3 per second from its Karakkum reservoir ("Kyrgyzstan priznal svoi ozhibki v sbrose vody" – uvereny v Kazakhstane', February, 2004).

While the agreements mentioned above decreased the level of water in the Chardara Reservoir and alleviated the problems of flooding for the time being, they still represented temporary measures that did not set up a reliable mechanism for transboundary water management in the Central Asian region. The water crisis of February, 2004 again saw mutual recriminations from all regional states (for instance, 'Kazakhstan obviniaet v potope – Uzbekistan i Kirgiziia razorvali Shymkentskii dogovor ot 04.01.2004', February, 2004. Also, see Kamilov, 2004). Kyrgyzstan and Tajikistan blamed downstream states for ignoring their energy needs. Both downstream states of Kazakhstan and Uzbekistan remain displeased with Kyrgyz and Tajik energy generation policy, because annual excessive spring water discharges from Kyrgyz and Tajik dams and recurrent threat of flooding affect the lives of 800,000 residents in Kazakhstan and 3 major regions in Uzbekistan (Zarudnaya, 2004. Cf. 'Uzbek President Accuses Kyrgyzstan of Raising Flood Risks', February, 2004).

Although the crisis of February, 2004 was dealt with properly and a catastrophe was avoided, this situation again stressed the differences that exist between regional states, and the importance of establishing a single sustainable system of water management that will meet the needs and concerns of all regional states on an ongoing basis.

The situation further makes relations among regional states tense, which forebodes new water crises on an annual basis. For instance, as indicated above, winter of 2004, as any other previous post-independence year, witnessed excessive water discharges causing both inter-state and ecological crises. In addition, in May of 2004, the water management agency of Kazakhstan, warned that the water collected at the Chardara and Toktokul reservoirs will most likely be short of agricultural needs in down-stream states in summer of 2004 ('Zapasov vlagi v Shardarinskom vodohranilishche ne khvatit na poliv', May, 2004). According to these data, the water inflows into the Chardara Reservoir, as of May, 2004, amounted to 566 m^3 per second, while water discharges run at 755 m^3 per second. Under the projected water collection capacity of 5.2 billion m^3, the Chardara Reservoir had 4.77 billion m^3 (as of May, 2004), with no additional large water flows expected. Fortunately for agricultural sectors of Central Asian states, these warnings did not materialize and major water shortage was avoided. Yet, likely excessive water discharges in the coming winter of 2005 keep Central Asian leadership and water specialists concerned. As an indication of such concern, in 2004 water ministry officials of Central Asian states commenced the new round of negotiations on winter water discharges and energy exchange between them earlier than in previous years. In particular, on 16 September of 2004 representatives of ministries of water management of Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan met to discuss the issues of discharges of water along Syr Darya and energy swaps between concerned states. While this meeting did not produce any sensible outcomes, it symbolizes understanding of the urgency of the water-related issues in Central Asia among member-states. This might become a basis for collective actions of Central Asian states in order to alleviate and resolve the existing problems.

CONCLUSION: FROM ABSOLUTE SOVEREIGNTY TOWARDS LIMITED SOVEREIGNTY?

One of the cornerstones of establishing cooperation in water-related issues in Central Asia is the issue of the sovereignty of each member state. It is obvious that in water management, Central Asian states cannot practice and apply absolute sovereignty, as their internal policies would have an adverse impact on all the states in the region. In view of these circumstances, the assumption on limited sovereignty is their only viable option in dealing with shared water resources.

For these states, it is important to proceed on the basis that all issues regarding inter-state water consumption be perceived as the subject of collective decision making. Regional knowledge and expertise should be consolidated in a single transnational institution designed to enhance the region's capacity to deal with environmental hazards. Regional institutions in different parts of the world have proved more effective than those operating at the universal level (see Caponera, 1985, p. 579). This factor merits due consideration by the Central Asian states.

Accordingly, the notion of absolute national sovereignty with particular respect to water resources should be attenuated, while the importance of the collective or regional sovereignty of the Central Asian region as a whole merits reinforcement at policy level. The establishment of a Central Asian Water Consortium, if successfully realized, might serve as a case of successful regional sovereignty application. The formation of the consortium is based on 17 March, 1998 Bishkek agreements, which were also ratified by Tajikistan on 7 May, 1999. The consortium brought together states from the delta of the Syr Darya River in order to form a system of water and energy swaps between these states. At this stage, the idea seems to enjoy the understanding and support of the Central Asian leadership, which revives hope that eco-nationalism, exemplified in the commercialization of water and other unilateral actions, will change into a multilateral mechanism to coordinate management of water and energy resources in the region.

What remains to be done is to make these institutional arrangements efficient and productive mechanisms for coordinating the policies of all member-states in order to secure water supplies and environmental sustainability in the region.

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Integrated Watershed Management: From Concept to Implementation; Indonesia Case

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Abstract The natural phenomena of watershed, atmosphere-soil-geological structure-water interrelationship give an understanding of the important of comprehension, inter disciplines approaches, and an integrated approach of those resources management. The integrated watershed or resources management in a watershed then requires the understanding of that bio-physic-chemical processes.

The authority or jurisdiction boundary on resources management almost not always coincide with the watershed boundaries, therefore integrated resources management needs not only technical cooperation among resources management authority, but also public policies integration among related autonomous governments.

The critical and crucial things toward integrated watershed management in Indonesia are: strong public policy to drive and increase institutional capacity on integrated program, land tenure (access right to land), human resources development on integrated resource management, as well as scientific development on process understanding in a watershed.

The watershed management when it is viewed as resources management, it is not only beneficial for local and regional, but also international, linked to global climate change. International collaboration to rise the global awareness and reward, award, as beneficiary to producer of benefits is necessary not only in the case of transboundary watersheds, but also to other parties who success to produce global benefit, these is the kinds of enabling incentives for better watershed management.

Key words Watershed, forestry, institution, incentive

INTRODUCTION

Watershed as a land unit bordered by natural boundaries, i.e topographical water divide gives knowledge the interrelated land aspects, included resources inside. Through the water flow-cycle properties, interrelated among atmosphere, soil, geological structure, and water in a certain level could be understood and or predicted. The natural phenomena of watershed, i.e. atmosphere-soil-geological structure-water interrelationship give an understanding of the important of comprehension, inter disciplines approaches, and an integrated approach of those resources management.

Comprehension, inter disciplines approach to understand the bio-physic-chemical processes give a clear understanding in a certain level, but still debatable, unknown (unclear) in other levels. The integrated watershed or resources management in a watershed requires the understanding of that bio-physic-chemical processes by the planning authority agency and stake holder on that resources management.

The authority or jurisdiction boundary on resources management almost not always coincide with the watershed boundaries, therefore integrated resources management needs not only technical cooperation among resources management authority, but also public policies integration among related autonomous governments.

The term of “watershed base” resources management in Indonesia was first to start when the first 5 years development plan, in 1969, launched a project called watershed, critical land rehabilitation and reforestation, and in 1971, FAO allocated a grant for a project called “Upper Solo Watershed Management and Upland Development Project”. In 1976, President of Indonesia issued Presidential Instruction No 8/76 to support Reforestation and Afforastation Program, and a project institution under Directorate General of Forestry, Ministry of Agriculture was Developed named Watershed Reforestation and Afforestation Planning and Development Project (P3RPDAS).

The main activities of those watershed management projects were upper stream land rehabilitation through three years period planting, soil and water conservation measures and those maintenances, that called reforestation and aforestation.

The reforestation and aforestation activities them self have been started to be conducted since the pre-independence of Indonesia, i.e since 1930 when Coster was inaugurated as the head of reforestation agency. He issued the ordinances, such as minimum forest area of a region, and since that, soil conservation structures, terraces as well as green fertilizer had been introduced.

Forest and land rehabilitation in watershed management project is driven by land degradation especially forest degradation and deforestation and inappropriate agricultural land management which occurred since the mid of 19th century, especially in Jawa. The project directly address the situation by replanting for reforestation and afforestation and soil and water conservation measures for agricultural land management improvement. The project did not recognized first the underlying causes of forest degradation and deforestation as well as inappropriate land management.

The project also less involve sectors development, only limited to forestry and agricultural sectors, other sectors, such as education, health, public, economic infrastructure, land tenure did not specifically involved to the projects.

This paper presents the research challenges in watershed management especially in forest and land management and problems in good practices implementation in watershed management in Indonesia.

RESEACRHS CHALLANGES

Watershed management needs comprehension knowledge of sciences and technologies, not only limited to the bio-physical sciences and technology, but also social, institutional arrangement as well as politics.

In term of land use especially forest influences on hydrological behaviors, Bruijnzeel (2004) has reviewed a wide range of available scientific evidence with respect to the influence exerted by the presence or absence of a good forest cover on regional climate (rainfall), total and seasonal water yield (floods, low flows), as well as on different forms of erosion and catchment sediment yield under humid tropical conditions in general and in southeast Asia in particular.

Bruijnzeel (2004) concludes that : 1) effects of forest disturbance and conversion on rainfall will be smaller in southeast Asia than the average decrease of 8% predicted for complete conversion to grassland because the radiative properties of secondary regrowth quickly resemble those of original forest, and, under ‘maritime’ climatic conditions, effects of land-cover change on climate will likely be less pronounced than those of changes in sea-surface temperatures, 2) total annual water yield appears to increase with the percentage of forest biomass removed, but actual amounts differ between sites and years due to differences in rainfall and degree of surface disturbance. If surface disturbance remains limited, most of the water yield increase occurs as base flow (low flows), but in the longer term rainfall infiltration is often reduced to the extent that insufficient rainy season replenishment of groundwater reserves results in strong declines in dry season flows, 3) although reforestation and soil conservation measures can reduce enhanced peak flows and stormflows associated with soil degradation, there is no well-documented case of a corresponding increase in low flows. While this may reflect higher water use of newly planted trees, cumulative soil erosion during the post-clearing phase may have reduced soil water storage opportunities too much for remediation to have a net positive effect in particularly bad cases, 4) a good plant cover can generally prevent surface erosion, and a well-developed tree cover may also reduce shallow land sliding, but more deep-seated (>3 m) slides are determined rather by geology and climate. Catchment sediment yield studies in southeast Asia demonstrate very considerable effects of such common forest disturbances as selective logging and clearing for agriculture or plantations, and, above all, urbanization, mining and road construction.

Further Bruijnzeel (2004) states that the ‘low flow problem’ is the single most important ‘watershed’ issue requiring further research, along with evaluation of the time lag between upland soil conservation measures and any resulting changes in sediment yield at increasingly large distances downstream. Such research should be conducted within the context of the traditional paired catchment approach, complemented with process-based measuring and modeling techniques. More attention should also be paid to underlying geological controls of catchment hydrological behavior when analyzing the effect of land use change on (low) flows or sediment production.

Bruijnzeel’s review (2004) shows the trend of the influences of existence, reducing or absence of forest on rainfall, total water yield, peak flow or storm flow is known but there are variations in the actual amount or magnitude influences due the differences of site characteristics, such as rainfall, susceptibility of soil and geological structures. Therefore, characterization of site, and documented as a database system for information management are important for better watershed management.

The recent critical issues in watershed management are not limited only on water scarcity, but also related aspects of water, such as food, energy, and atmospheric quality which are interrelated in local to global scale. Integrated, comprehension researches to optimize the needs are the big challenges.

A better knowledge of nature behavior resulted from scientific researches often do not support enough for better practices in watershed resources management and public policy. The socio-economy aspects include institution, and governmental politics usually affect strongly on natural resources management practices. Researches of these aspects related to implement the known bio-physical behavior of natural resources also become bigger challenges.

WATERSHED MANAGEMENT AND PROBLEMS FACED

Watershed base resources management in Indonesia is driven mostly by rapid land degradation that influences the water yield. The watershed management activities are dominated by land rehabilitation to improve land functions for water yield especially through vegetative and civil techniques on soil and water conservation measures.

Land degradation in Indonesia significantly occurred since mid 19 century, especially in Jawa island. Until mid 19 century, forest covered 85% of Jawa island or about 11.5 million ha. Montane and low land and hill natural forest started to be deforested as agricultural lands and settlement. In 1989, the rest of forest was only ± 3 million ha, most of them was teak forest plantation. The natural forest was only ± 1 million ha as shown in Fig. 1 (Smiet, 1990).

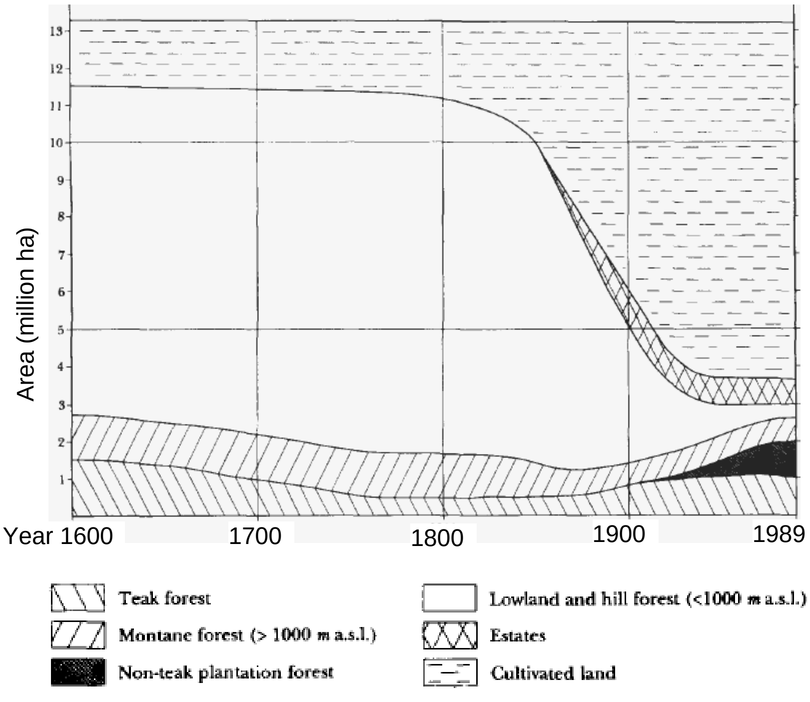

Fig. 1. Forest decreased 1600-1989 (after Smiet, 1990).

Those deforestation caused severe erosion, sedimentation and flood such as in Solo in the mid and at the end 19 century. Sedimentation in Ciltung River increased 1 mm per year in the 6 years period, from 0.9 (1911) to 1.9 mm per year (1917) (Haryanto et al., 2003).

Coster an observer of sediment, in 1930, was inaugurated as the head of reforestation agency. He issued the ordinances, such as minimum forest area of a region, and since that, soil conservation structures, terraces as well as green fertilizer had been introduced.

Land and forest degradation still continuing, critical lands increased. After independence of Indonesia (1945), in 1951-1955, The Ministry of Welfare issued a Plan, called Special Welfare Program, where some activities were terracing, aforestation of home garden, as well as Pilot Project of Dry Land Agriculture.

Forestry Congress in Bandung,1956, proclaimed *Arbor Day*, and Government of Indonesia in 1961 issued the *Afforestation Movement* through the first National Afforestation Week, where the ceremony was conducted in Tea Plantation of Gunung Mas, Bogor.

Land rehabilitation activities until 1969 were not specifically related to watershed or stated as watershed rehabilitation. In 1967, the Forestry Acts No.5 was issued, and as a part of the first 5 years development plan, in 1969, a project called Watershed, Critical Land Rehabilitation and Reforestation were launched.

FAO, in 1971 give a grant for a project called “Upper Solo Watershed Management and Upland Development Project”. In 1976, President of Indonesia issued Presidential Instruction No 8/76 to support Reforestation and Afforastation Program, and a project institution under Directorate General of Forestry, Ministry of Agriculture was developed named Watershed Reforestation and Afforestation Planning and Development Project (P3RPDAS). The project followed by several watershed development projects in Jawa as well as outside Jawa. These projects mostly funded by International donors, through grant or soft loans. The institution for planning and development of reforestation and afforastation of watershed was internalized in the Ministry of Agriculture, under the Directorate General of Forestry, namely: Directorate of Reforestation and Rehabilitation.

Implementation of national policy on forest and land rehabilitation was delegated to Land Rehabilitation and Soil Conservation Agency (BRLKT) as a Technical Implementation Unit of Directorate of Reforestation and Rehabilitation.

Watershed quality during 30 years period (1970-1999) decrease continually, where the number of first priority critical watersheds increased from 22 to 60 watersheds (Ministry of Forestry, 2008). This indicates that watershed management fails to improve watershed quality.

Inline with the National Development Program in the 4th five years National Development, the institutional capacity to manage the forest land, and land rehabilitation was increased where the Directorate General of Forestry was separated from the Ministry of Agriculture and became the Ministry of Forestry, and Directorate Reforestation and Rehabilitation became Directorate General of Reforestation and Rehabilitation.

In the era of governmental reformation preparation, the Forestry Act No. 5/1967 was revised and became Forestry Act No 41/1999. In this revised Forestry Act, the important of watershed as a basis for resources management and the important of the existence of forest minimal 30% in a watershed is clearly stated. Just after revision of the forestry act, the autonomous government was implemented in 2000. In this era, organization of Ministry of Forestry is restructured, and Directorate General of Reforestation and Afforestation became Directorate General of Land Rehabilitation and Social Forestry, and watershed management directorate is one of directorates under this Directorate General. The function of Technical Implementation Unit of BRLKT and its name change become Watershed Management Agency (Ministry of Forestry Decree No.665/Kpts-II/2003; March, 2003).

In 2003, three coordinative ministers, i.e public welfare, economy, and politic and security established the Coordinator Team for Environmental Improvement through National Rehabilitation and Reforestation. Team declared the National movement for Land and Forest Rehabilitation, and recently, in the last three years, the government advocate “a program” called “one man one tree”.

Those current programs, National movement for land and forest rehabilitation as well as the advocating “one man one tree” are not supported by required pre conditions sufficiently to give a change the trees to grow up to achieve the objectives of the program. Securing plantation land, and its management units, right to the yields are some aspects to secure the program objectives achievement. Notes that more than 70% of land in Indonesia is govern by government, and of about 90% of them as forest land is governed by the Ministry of Forestry.

A lot of recommendations to address issues on watershed management and climate change mostly, but mostly the technical aspects to solve the direct factors cause issues, such as the alternatives optimal land use, necessary soil and water conservation measure etc. These recommendations are believed (if success) could solve the issues. The question is, why these recommendations are never (rarely) implemented?

Case study in Jawa Island resource management especially study on flood accurance in the Capitol of Indonesia, Jakarta, shows that most recommendations actually do not addressing the real (actual) problem in the “field”.

Evaluations conducting by several parties and the result of National Congress for Resources Management summarize the “real problems” generally occur in resource management failure as presented in Fig. 2 (Kartodihardjo, 2006).

Figure 2 explains the main problem in resource management is the national development paradigm, which emphasize sector, incomprehension and exploitative paradigm, which cause problems of incomprehension policy, high cost economy, less beneficial allocation for local community, and limited resource information. Those are factors cause the weak of resources and environmental management; further it causes low performance of social and environmental in resource utilization which is indicated by marginalized local community, over resources exploitation, resource utilization conflicts, as well as the area and species conservation problems.

Approaching the issue by direct approach on “symptom”, such as by planting and soil and water conservation measures implementations without conditioning factors that underlie the symptom (land degradation), and single actor action are far to solve the problem. The problem may be solved just for a while. This case is shown by a case in the watershed management project, where during the 3 first years period all activities planting, soil and water conservation measures, 3 years maintenances are conducted, but after 3 years, after the project finished, the situation almost back to the origin, degraded land.

Up to now, the watershed management approach and development paradigm do not change significantly, still dominated by physical works, direct incentive, less focused on institutional, land tenure improvements, capacity building on resource management, creating enabling incentives, and strengthening the institutional coordination.

There are two institutions that govern land, i.e. the Ministry of Forestry, govern almost 60% of Indonesian lands, and National Land Board. There are also two institutions claim that they manage (at least in planning stage) resource base on

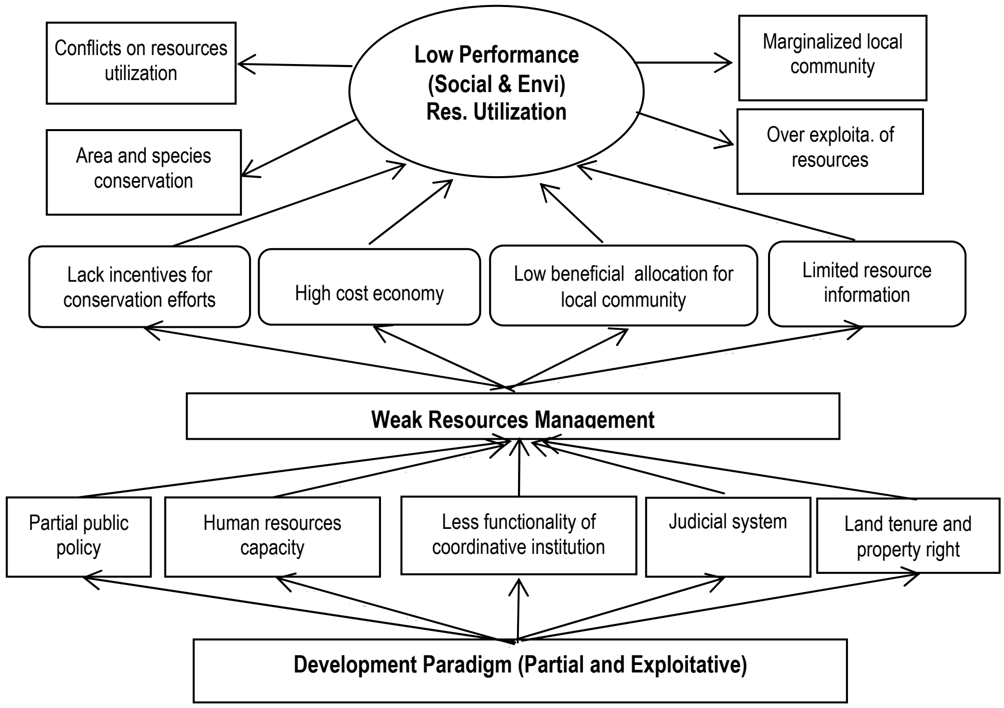

Fig. 2. Problem tree in watershed management (after Kartodihardjo, 2006).

watershed, i.e. Directorate of Watershed Management under the Directorate General of Land Rehabilitation and Community Forest, Ministry of Forestry, and Directorate General of Water Resource, Ministry of Public Works. The 2 institutions govern land, do not have an integrated policy in national land management, and 2 institutions that claim works base on watershed have "Integrated Watershed Management Plan" of almost the same watershed, but different approach and content. The Ministry of Forestry more focus on land rehabilitation, and mostly in upper stream, and the Ministry of Public Works more focus on water management. The existence of two "Integrated Watershed Management Plan" indicates the institutional problem in integration, and coordination. Sector superiority (ego sector) and regional governments remain dominated in resource management.

The critical and crucial things toward integrated watershed management in Indonesia are strong public policy to drive and increase institutional capacity on integrated program, land tenure (access right to land), human resources development on integrated resource management, as well as scientific development on process understanding in a watershed.

The watershed management when it viewed as resources management, then it is not only beneficial for local and regional, but also international, linked to global climate change. International collaboration to rise the global awareness and reward, award, as beneficiary to producer of benefits, necessary not only in the case of transboundary watersheds but also to other cases who successfully to produce global benefit, these are a kind of enabling incentives for better watershed management.

CONCLUSIONS

Need strong commitment from government and parliament to correct and improve public policy on sustainable resource management.

Researches for science and technology development for sustainable resources management to address water and climate change issues are important and necessary but not enough; the enabling incentives, and institutional capacity building to implement better technology, science, and knowledge findings need to be developed.

Multi disciplines researches and actions (implementation) of existing technology, science, and knowledge in a watershed as a pilot project on integrated watershed management toward sustainable water use in response to Climate Change is necessary.

The watershed management when it is viewed as resources management, then it is not only beneficial for local and regional, but also international, linked to global climate change. International collaboration to rise the global awareness and reward, award, as beneficiary to producer of benefits is necessary not only in the case of transboundary watersheds but also to every case (individual, community, government) who produce global benefit successfully. These are kinds of enabling incentive for better watershed management.

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Linking Environment and Livelihoods in Watershed Management: Experiences in Indonesia

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Abstract Indonesia is rich in natural resources consist of 144 million ha forest area of 191 million ha the total land resources. However, high population growth and development in the past decades caused degradation of forest and agricultural land that lead to degradation of watershed functions and change hydrologic regime. That is indicated by increasing of floods, landslides, draughts, sedimentation, and water pollution. This paper describes the integrated watershed rehabilitation programs through linking environment to livelihood in watershed community. The programs, such as Gerhan and GNKPA mainly consist of planting trees, soil and water conservation measures by involving many sectors, government institutions, private companies and participation of local community in degraded watersheds. The successful of implementation of watershed rehabilitation programs need institutional set up for coordination not only at national, regional/provincial and district level, but also very important at local level that can effectively deliver services linking the environment to community livelihoods as can be seen in the Lake Singkarak watershed, North Sumatera.

Key words Watershed, Gerhan, Singkarak

INTRODUCTION AND SOME BACKGROUND

Indonesia is rich in environmental resources as can be recognized from features of the land and water resources, however the national development in the past decades that stressed more on physical and economic aspects has left much social and environmental problems. The past few years had been characterized by natural disasters, many were water related such as floods, landslides, droughts and forest fires.

These are believed due to excessive human interventions, such as forest land conversion to agriculture and other uses, deforestation by legal and illegal logging, followed by pollutions in the downstream that have competed as new users of more limited natural resource and push the land hungry people moved more to the upstream.

Pockets of poverties on densely populated areas can be recognized around the country that very much overlaps with degraded land and forest resources with much reduced carrying capacity. Therefore, there is an obvious vicious relationship between poverty and degraded environmental resources, and the ideas of linking environment with community livelihoods have become of much concerns for some times in Indonesia that need government interventions, and many programs have been initiated ever since in the wide economic sectors to improve community welfares. This paper will limit the discussions of the environment to land and water resources related aspects, especially forest resources and land conversion to agricultural and other uses.

The linking of environment and livelihoods will be discussed from parts of the programs that relate to land and water, either in the forms of national movements adopting broad guidelines of sustainable development and integrated resources management, with multi-sectorals and coordinated implementations hierarchically around the country, such as: (i) GN-KPA – the national movement on partnership for safeguarding of soils and water resources; (ii) GN-RHL – national movement for land and forest rehabilitation, also known as Gerhan; and (iii) National Program on Integrated Agricultural Management Field School, or from more sectoral programs, such as: (i) ESP – Environmental Support Program, a project under Department of Forestry supported by US Agency for International Development; (ii) SCBFWM - Strengthening Community-Based Forest and Watershed Management In Indonesia, a pilot project under Department of Forestry supported by UN Development Program; and (iii) P4MI – Poor Farmers Income Improvement through Innovation Program, a pilot project under Department of Agriculture that is supported by Asian Development Bank. Brief introduction to Indonesia watershed and forest resources will be given first, followed by description of some case study areas, some forms of activities that link the environment and community livelihoods, necessary institutional set up, and lessons learned.

INDONESIA ENVIRONMENTAL RESOURCES AND THEIR MANAGEMENT

Indonesia forest resources consist of 144 Mha (approximately 74 % of total land of the country) with 109 Mha forest cover; 18.8 Mha conservation forest; 30.3 Mha protection forest; 64.4 Mha production forest; and 30.5 Mha conversion forest. The total land resources are 1.91 Mkm^2 with 17,000 islands (1.3 % of world's land surface) that contains about 10 % of global water resources, 10 % of world's plant species, 12 % of mammal species, 16 % of reptiles and amphibians, and 17 % of bird species. The abundance of water resources as characterized by components of runoff cycles with annual rainfall averaged at about 2,790 mm that ranges from 600 mm to well above 6,000 mm/annum. Land use and cover changes that follow the national development apparently have changed the hydrologic regime, that may be interfered with global climate change. Recent estimate of degraded forest land was 59.62 million ha with deforestation rate averaged at 1.09 million ha/year (2000-2006). Land degradation was severe and un-controllable, especially during reformation/autonomous era in the last decade, as permits or restrictions were not acknowledged, illegal logging, forest encroachment and conversion to other uses were rampaging.

The management of these environmental resources (air, water, wetlands, wildlife, aesthetics, as well as toxic and hazardous wastes) follows the broad principles of sustainable development and integrated resources management. Knowledge resources with appropriate science and technology were planned and implemented, but the effectiveness is still in questions, including the role of local/traditional wisdoms. Therefore, many efforts are still required to be pursued with the establishment of integrated watershed management for sustainable water resources development through decision making process based on academic research, governance and capacity building (Tanaka, 2009). A new paradigm in watershed management is the one that adopt broad principles of sustainable development and integrated resource management and also consider water quality parameters as indicators of watershed status and its carrying capacity to reflect the level of anthropogenic interventions.

DESCRIPTION OF STUDY AREAS

Several study areas were available implementing the different programs, each with its own characteristics, in terms of environmental resources conditions as well as its socio-economic conditions, range from North Sumatra to Indonesia eastern regions. For illustration purposes, the case of Singkarak lake basin of West Sumatra and of Way Besai basin in Lampung province are as described below.

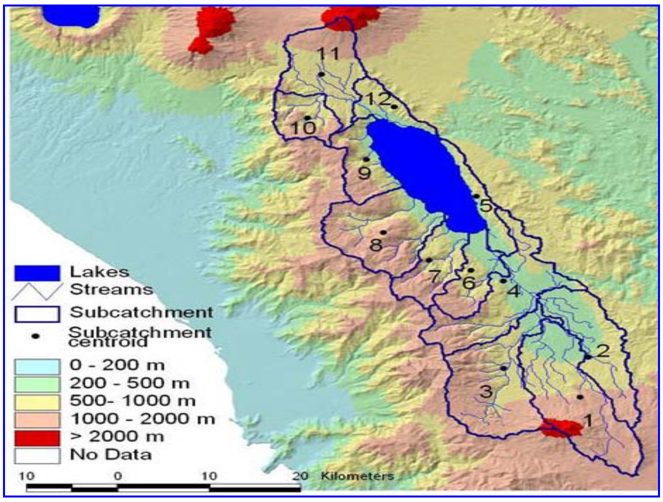

Fig. 1. Singkarak lake basin.

Singkarak is the largest lake in West Sumatra province with water surface area 112 km^2 at 363 m asl, maximum lake depth 268 m, catchment area 1,076 km^2 and water storage capacity 16.1 billion m^3.

Geologically the lake is considered as a volcanic lake with inlets from several rivers, and outlet at Batang Ombilin with a hydropower station of generating capacity of 175 MW. The lake basin is divided into two districts: Solok and Tanah Datar, and is famous for recreation, for agriculture land irrigation of 215,000 hectares, and for domestic water supply that in the past decades has been characterized by extensive critical land of 35,000 hectares on the catchment area with significant impacts to the lake waters.

Reduction of 'bilih' fish stocks in the lake was not only due to over fishing, but also due to domestic waste and sedimentation. Since 1999 during dry seasons, lake water drops 1.50 m that reduced capacity of the hydropower by 50 %, and during wet seasons damaging fish ponds, paddy fields and agricultural crops around the lake. Erosion and sedimentation are also occurring due to degraded land conditions of the lake catchment area. These critical conditions were believed due to forest logging many years ago that increase soil erosion and caused severe land degradation, and all the negative impacts, including depletion of indigenous endemic fish known as ‘bilih fish’ (*Mystacoleucus Padangensis*), measured 6-12 cm, only found at Singkarak lake. In the past 20 years, the fish population has been declining due to over fishing, deterioration of lake ecosystems, and lack of local people knowledge on nature conservation.

Another study area of interests is the Way Besai basin of 44,720 ha located in Lampung province, the southern part of Sumatra that is characterized by decreasing forest cover and being replaced with coffee plantations. Protected forest represents 30.53 % and national parks another 11.9 % of basin area, and the rests are other land uses, however critical land conditions were extensive as indicated by present forest cover at less than 10 %, and soil erosion rate at 21 mm/year that caused sedimentation to downstream reservoir at 8.4 million m^3/year with serious consequences to hydropower station.

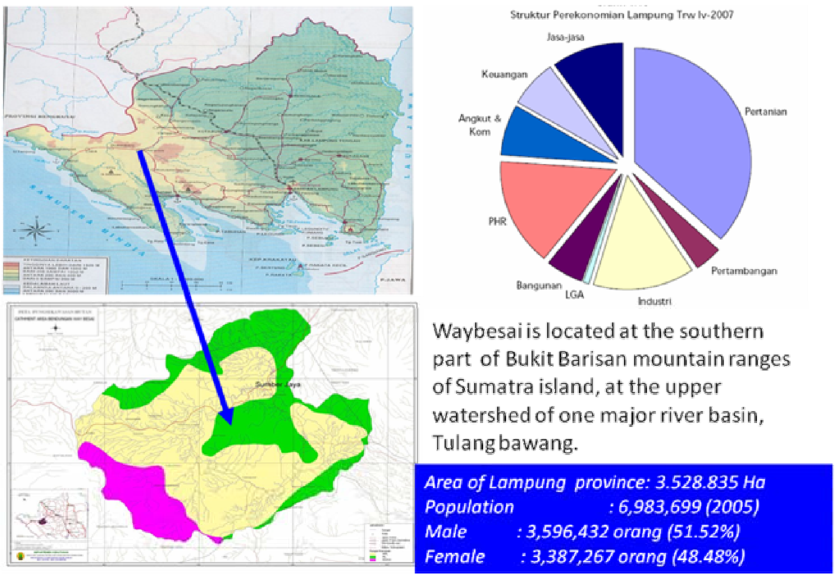

Fig. 2. Way Besai basin.

LINKING ENVIRONMENT AND LIVELIHOOD IN WATERSHED COMMUNITY

In the past five years, a series of activities has been implemented at community level within the Singkarak lake basin with the goals to eradicate poverty and improve environmental conditions. These include: (i) GN RHL activities through government agencies at district level with source of funding from Department of Forestry, and in the past five years succeeded to reforest 8,000 ha out of 35,000 ha critical land; (ii) regreening activities by Singkarak Hydropower Plant; (iii) JIFRO Revegetation Project since 2005 that succeeded to reforest 255 ha at 5.5 million Rp/ha; (iv) CDM Project from Dutch Government in 2009 reforests 28 ha at 10 million Rp/ha; (v) support activity from Ministry of the Environment; (vi) support activity from Environmental Management Office for Sumatra region in Pekanbaru; and (vii) Kemiri tree planting activity on sloping land and dalu-dalu trees on lake coast by local community. The activity was the practice of traditional value of ‘gotong royong’ where people in the community are working voluntarily, included by school children, NGOs, and support by Singkarak Hydropower Plant. To recognize this local initiative, in 2009 Mr. Kasmir of Nagari Padang Laweh received Kalpataru Award from the Government.

At national scale with implementation down to village level are activities under the GN-RHL (Gerhan) and GN KPA Programs with the planning at district government involving all the technical agencies. The activities under GNKPA ranges under three general categories: (i) improve vegetation cover through tree planting; (ii) civil technique activities to improve soil infiltration capacity; and (iii) community development activities.

Gerhan is basically a moral movement aimed at stimulating various parties to participate in combating forest and land degradation in order to grow the culture to cultivate trees within the Indonesians as a nation. The goal of Gerhan is to conduct an integrated approach in combating various hazards such as water flooding, landslides, drought, and forest fires through participation of various parties. The program also aims at securing water reservoirs and lakes. These improved environments were believed would give positive impacts and outcomes to community livelihoods. The main activities of Gerhan are rehabilitation of degraded forest and critical lands in priority watersheds through planting trees and soil and water conservation measures (structural measures). The activities of Gerhan during period of 2003 up to 2007 is presented in Table 1.

Table 1. Activities related to forest and watershed rehabilitation/conservation in Indonesia (Gerhan, 2003-2007).

No	Activities	Unit	Volume
1	Reforestation	ha	745,650
2	Private forest	ha	955,186
3	Agroforestry	ha	215,321
4	Bamboo garden	ha	160
5	City Forest	ha	6,670
6	Environmental regreening	seeds	124,000,000
7	Mangrove rehabilitation	ha	70,185
8	Riparian regreening	km	1,565
9	Community forest replanting	ha	245,456
10	Pilot areas of Private forest	ha	12,915
11	Embungs/small reservoirs	unit	912
12	Gully plug	unit	2,607
13	Sediment trap dam	unit	2,692
14	Chek dam	unit	530
15	Infiltration wells	unit	16,359
16	Streambank structures	km	434

Source : Statistik Pembangunan Ditjen RLPS th 2007 (Ditjen RLPS, sept 2008).

Gerhan as one of forestry national program in the field has given opportunity for people to increase their livelihoods. The people become subject of the program, starting from preparing the seedlings, planning stage, implementing and monitoring.

Participation of the people is organized in the form of forest farmer groups. Beginning in 2003 up to 2007 there were about 71,129 forest farmer groups nationally that consist of 25-50 farmer households per group. Total absorbed labors during 5 year activities of Gerhan program were about of 1,442,585 man days and involved 10,669 extension workers as field facilitators.

Projected economic benefit from the results of Gerhan program that could be received directly by the people inside the forest and its surrounding in 5 years is presented in Table 2, assuming that: a) average successful plantation is 50 %, b) average yield to be projected for 2 ha each 100 m^3, and c) average selling price is Rp 200,000 for each m^3, with the projected yield of 21,338,- billion IDR or equivalent to 2.27 billion USD or annually equivalent to 454 million USD as direct economic benefit the community from forestry related productions.

Table 2. Projection of Gerhan Economic Benefit.

No	Year	Progress		Projection	
		%	Area (Ha)	Vol (m^3)	Million IDR
1	2003	50%	147,755	14,755,450	2,955,090,-
2	2003	50%	200,410	20,040,950	4,008,190,-
3	2005	50%	128,302	12,830,200	2,566,040,-
4	2006	50%	258,332	25,833,189	5,166,638,-
5	2007	50%	332,141	33,214,100	6,642,820,-
	Total		1,066,939	106,693,889	21,338,778,-

Remarks : US $ 1 = Rp 9,400,-.

NECESSARY INSTITUTIONAL SET UP

Fortunately recent political change has returned to autonomous local government as mandated by national law, that in West Sumatra was based on local wisdoms known as 'nagari' governance. Nagari is a local government unit based on democratic principles and the West Sumatra province consists of twelve nagaris. This autonomous local government system shows that local communities practice traditional rules that relate to potential uses of the Singkarak lake, such as those regulate biodiversities and management of the lake, restriction to use 'jaring lingkar', a kind of fish net, and to share the catch to those who own the fish net or not. In 2003 it was recorded that active fishermen were 1202 people with low education level. Another regulation which now exist is prohibition to throw garbage to the lake, supported by the construction of garbage shelters and the set up of Agency for Environmental Management at Nagari level.

At national level, several institutional set up were formed, such as: (i) Coordination Board of Spatial Planning chaired by Coordination Minister of Economic Affairs with members across departments; (ii) National Water Resources Board, also chaired by Coordination Minister of Economic Affairs with members across departments and daily activities chaired by Minister of Public Works; (iii) National Energy Coordination Board with daily activities chaired by Minister of Energy and Mineral Resources; (iv) National Watershed Management Forum chaired by Minister of

Forestry; (v) Regional Offices of Water Resources and Watershed Management at provincial level; and (vi) Water Resources Authorities at national river basin level. However at the practical operational and implementation level, most of the good concepts and plans are not working, so that obviously there is still an urgent need of organizational set up that can effectively deliver services linking the environment and community livelihoods, may be by adopting .the basic principles of human-environment system (HES) approach recognizing the regulatory and feedback mechanisms (Scholz and Binder, 2004).

LESSONS LEARNED

Obviously there are lessons learned from project implementation that could be obtained from common experiences in different areas, that include: (i) technical level cooperation could enhance improvement in information sharing and provided impulse to building trust; (ii) power of community level participation to the improvement of livelihood of participating communities; (iii) planning and implementation of community based actions can be successfully shared between sectors as well as between communities across boundaries; (iv) Local knowledge and self-motivation made up for limited financial resources by working on existing farmers groups and what they are familiar with; and (v) the multi stakeholder/participatory approach is slow, expensive and time consuming, however, help to mobilize partnership with departmental Ministries, and decentralized local government, NGOs and civil society.

Farmer-groups are hungry for new skills and technology that are friendly to the watershed and the environment. They all have stories and experiences on how the use of chemicals pollute their water system, affect their health and tie them to high interest rates with banks or loan sharks/ijon. They have also seen how converting critical slopes or improper cultivation of land can bring flash flood, erode the topsoil and promote leaner harvests due to loss of soil fertility and diminishing carrying capacity. Moreover, they have some confirmations on the influences and role of climate and water related aspects (Pawitan, 2009).

CONCLUSINS

1. Linking the environment and livelihoods of the people very much interdependent on the existing land and water resources of the watershed, and the socio-cultural of the people. Sustainable management of watershed resources as it was targeted in the National Program to Safeguard the Water Resources (GN KPA) is only possible through the success of soil conservation efforts, and these could be achieved only through effective reforestation and land rehabilitation program (Gerhan) with the support and benefit of the people as key stakeholder.
2. The reforestation, regreening and revegetation efforts were a long term, multi-generation program that require necessary supports from every stakeholder in an effective institutional set up.

3. The champions for successful implementation were available at local scene that only needs recognition, though in practice hard to realize.

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Groundwater Monitoring System in Tuul River Basin, Mongolia

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Abstract This paper presents details on all procedures of groundwater monitoring activities in the Tuul river basin and the conclusion of the research study which was implemented in 2008 and 2009. UNESCO Chair activities started in Mongolia on Sustainable Groundwater Management in 2008. The host Institute is the Institute of Geo-ecology, MAS, Mongolia and the partner institution is the University of Tsukuba, Japan. According to the work plan of the UNESCO chair activities we have established a groundwater monitoring network along the Tuul river basin.

Groundwater monitoring plays an important role in the management of water resources. The groundwater monitoring program needed for particular area depends on the type of water quality problem faced, sources of contamination, hydro-geological conditions and the extent of groundwater use. We established 4 groundwater monitoring points along the Tuul river as follows:

1. Upper source of urban water supply
2. Central source of urban water supply
3. Third thermo power plant's water supply production well
4. Fourth thermo power plant's water supply production well

We established a 5th groundwater monitoring point in Dornogobi province Sainshand soum. The main goal of establishing this 5th monitoring point is as a control point on groundwater level change and its draw down in Gobi-desert area of Mongolia.

The objective of establishing the groundwater monitoring network are to collect data on groundwater levels and to interpret this data for a study on the determination of groundwater flow direction, interaction of surface water and groundwater.

The selection of monitoring point based on retro research study document and report for Ulaanbaatar city's source of water supply area and old data of groundwater level measurement and implemented itinerary (route) observation on it. We installed tools for groundwater level measurement on selection point of groundwater monitoring and therefore installed data logger on the production well of power plant–III. Nowadays we are doing regular observation on monitoring points and doing statistic analysis on tape inscription based on comparison method by graph and table of groundwater level.

The main effects of monitoring activities are as following below:

- to describe the condition that the sources of Ulaanbaatar city's urban water supply perhaps to enter groundwater resources deficit.
- to describe capability of utilization of groundwater resources by ecological (balance) parity.
- to describe basic information and documents for rational management of water utilization and its protection.

Key words Groundwater, groundwater monitoring, groundwater level, flow direction, hydro-geological condition

INTRODUCTION

Since 2008, we started to implement UNESCO Chair project on Sustainable Groundwater Management of Mongolia. According to frame work of this project we established groundwater monitoring network along the Tuul river basin. The Partner Institution is University of Tsukuba, Japan. The Co-Chairholder is Prof. Tadashi TANAKA, Director of Terrestrial Environment Research Centre, Graduate School of Life and Environmental Sciences, University of Tsukuba.

The purpose of the UNESCO Chair activities is to promote an integrated system of research, training and documentation in the field of groundwater management. It will serve as a means of facilitating collaboration between high-level, internationally recognized researchers and teaching staff of the university and other institutions in Mongolia and Japan and neigh boring East Asian countries.

The research/education/training, conference/meeting and documentation activities were conducted in 2008-2009.

THE METHODS OF RESEARCH STUDY

Groundwater monitoring plays an important role in the management of water resources. The groundwater monitoring program needed for particular area depends on the type of water quality problem faced, sources of contamination, hydro-geological conditions and the extent of groundwater use. We established 4 groundwater monitoring points along the Tuul River as follows:

- Upper source of urban water supply
- Central source of urban water supply
- 3rd thermo power plant’s water supply production well
- 4th thermo power plant’s water supply production well

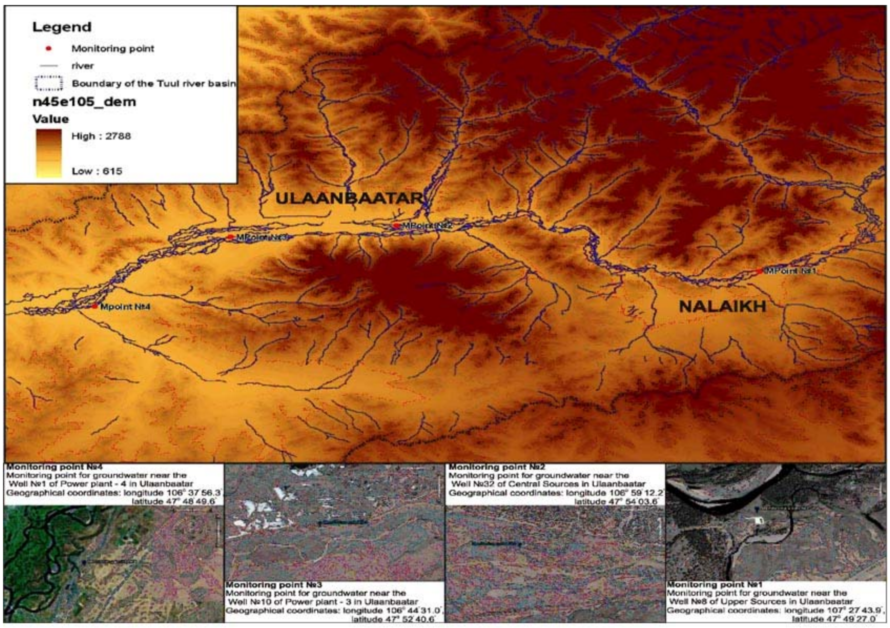

Fig. 1. The location of monitoring points in Tuul river basin.

We established a 5th groundwater monitoring point in Dornogobi province Sainshand soum. The main goal of establishing this 5th monitoring point is as a control point on groundwater level change and its draw down in Gobi-desert area of Mongolia.

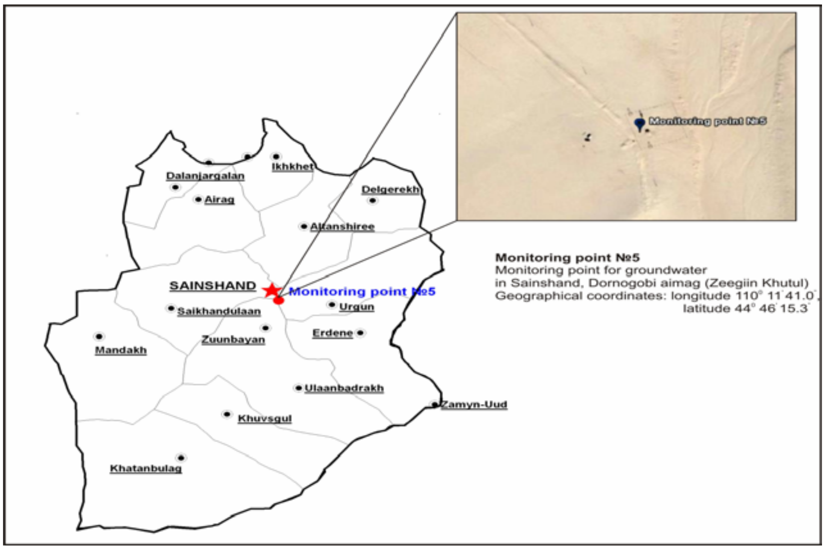

Fig. 2. Monitoring point in Gobi region**-** Sources of water supply for Sainshand city in Zeegiin khutul.

ESTABLISHMENT ACTIVITIES OF GROUNDWATER MONITORING NETWORK

We collected retro data for groundwater resources research study data of urban water supply UB city as following:

- The reports for survey work of U B city's groundwater resources (1979, 1987)
- Long term data of precipitation near UB city (1940-2007)
- Data of river discharge on observation points which locate Zaisan bridge of UB city
- Data of exploited water per day in sources of UB city's water supply (1996-2007)
- Data of groundwater level fluctuation on central water sources of urban water supply's production well which is working in techno-jenic activity (1987, 1991, 1993, 1996, 1997, 2000-2007)
- Database of borehole locate along the Tuul river basin (Hydro-geological data and hydrochemistry data)
- Geographical map of Tuul river basin with scale 1:25,000, 1:1,000,000
- Some data of bore hole and research study which implemented project on "Development of UB city's water supplly" by JICA organization's supporting fund
- Data of groundwater level measurement which implemented in August , 2009

The groundwater resources in Tuul river basin recharged by groundwater which coming from Tuul river valley and small streams. Because of bigger source of groundwater locate in aquifer of quaternary alluvial sediments. The Ulaanbaatar city is one of the biggest consumers in Tuul river basin. The water consumption of UB city is 168,000 m^3/day-216,000 m^3 /day.

Fast population growth and expanding urban area and industries, has resulted in a rapid increase in water demand. Urbanization and industrialization has reduced groundwater recharge as a result of over exploitation. This reduction in aquifer recharge depletes and change hydraulic gradients. Most important question of Mongolian researcher is the source of groundwater resource which locates in quaternary aquifer are enough or not enough for consumption of UB city. Due to Future Development of Urban Water Supply will increase by 40,000 family apartments. Groundwater pollution is caused by a variety of substances originating from many different activities. Many of them originate from man's use of water and others from undesirable constituent into groundwater, directly or indirectly. Groundwater monitoring plays an important role in the management of water resources. The groundwater monitoring program needed for a particular area depends on the type of water quality problem faced, sources of contamination, hydro-geological conditions and extent of groundwater use. Monitoring activities can help identify and solve problem in time.

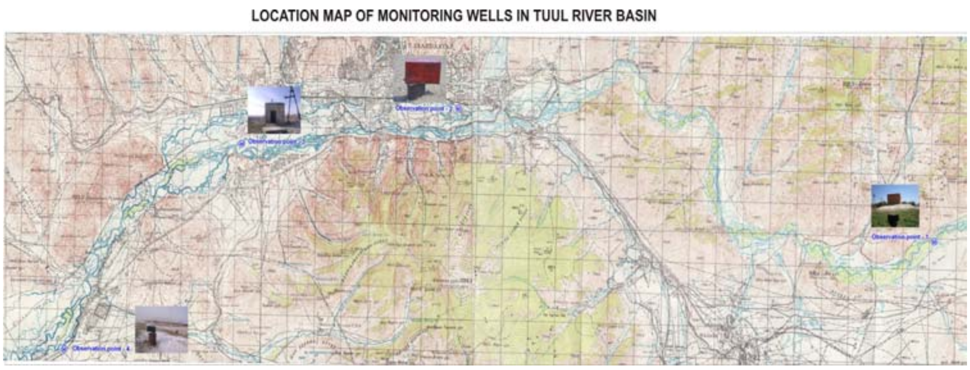

Fig. 3. Monitoring points along Tuul river in UB city.

Monitoring Points along Tuul River in Ulaanbaatar City

Monitoring Point 1

Monitoring point 1 is locates North West part of Ulaanbaatar city in Tuul river basin and distance is 45 km from UB city in upper sources of water supply Ulaanbaatar city.

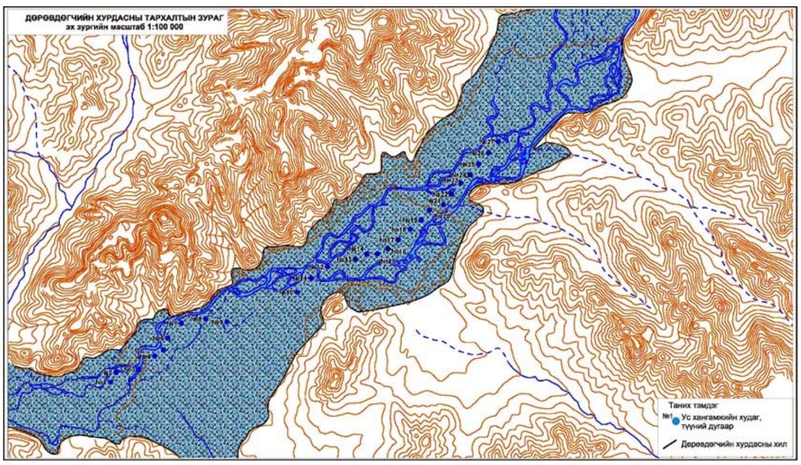

Fig. 4. The location of production wells in upper source of urban water supply.

The monitoring point 1 located near the production well No.8 for upper source's water supply.

Fig. 5. Location of monitoring point 1 in upper sources of water supply UB city.

The Geological Structure of Upper Source of Water Supply

Groundwater is abstracted from 4 main water sources area in territory of Ulaanbaatar. The groundwater resources are located in alluvial sediment quaternary aquifer along the Tuul river valley. The alluvial sediment divided in 2 main aquifer layer as following:

- Upper late (modern) quaternary aquifer
- Middle upper quaternary aquifer

Upper late (modern) quaternary aquifer consist sandy loam, pebble and gravel with clay loam. The production well's yield is 20-40 l/sec in 8-10 m drawdown.

Middle upper quaternary aquifer: sandy loam, gravel cores exist in II and III terrace of Tuul river valley. The yield is 24 l/sec in 1.6 m drawdown. The minimum yield is 0.9 l/sec.

Hydrogeological Condition in Upper Source of Water Supply

The groundwater distributed in alluvial sediment along Tuul river valley and has hydraulic interaction with river water. The lithology of aquifer is gravel pebble. The filtration coefficient is 50-200 m/day.

The geological and hydro geological longitudinal cross section of production wells in upper source of water supply UB city.

We established monitoring point 1 depends on survey work of the well which locates near the production well 8 of upper sources of UB city's water supply and installed instruments for measurement of groundwater level. The coordinate of this point is 107 ° 18' 18.1" and 47 ° 49' 38.3".

Table 1. Hydro geological parameter of upper source of water supply UB city.

Hydro-geological parameter	Near the upper source of urban water supply UB
Thickness of aquifer (m)	2.5-32.0
Yield (l/sec)	2.5-55.0
Drawdown (m)	2.9-5.89
Infiltration coefficient (m^2/ day)	4.2-103.7
Average depth of the wells (m)	25-35.0
Conductivity of change of water level (m/day)	$1.4*10^3$- $6.2*10^4$
Depth of the aquifer (m)	0.5-26.5

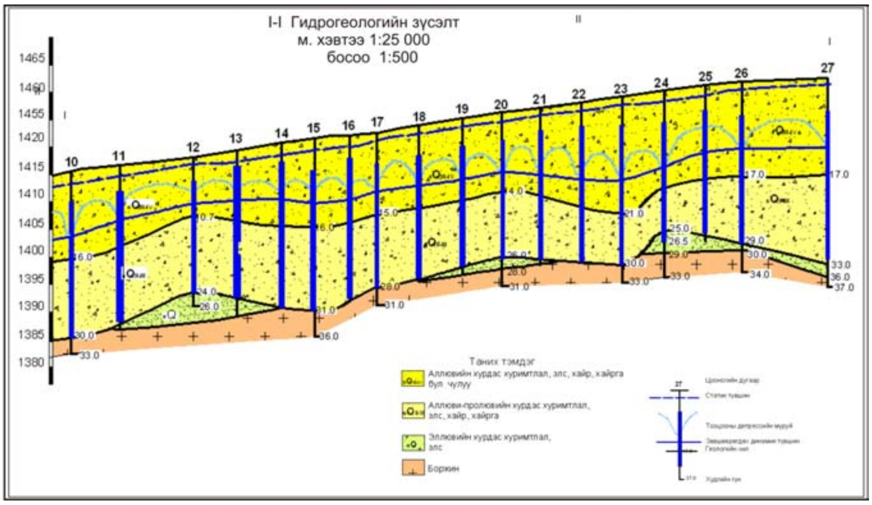

Fig. 6. Hydro-geological section of production well which locates in upper sources of water supply UB city.

Fig. 7. Tuul river near wel 8.

Fig. 8. The production well 8.

Fig. 9. Monitoring point 1 near the well 8.

Fig. 10. Field work activity for changing a tape.

We can change tape of recorded groundwater level in first week of each month. The comparison graph of groundwater level during scarce period of groundwater in upper sources of urban water supply (2008-2009).

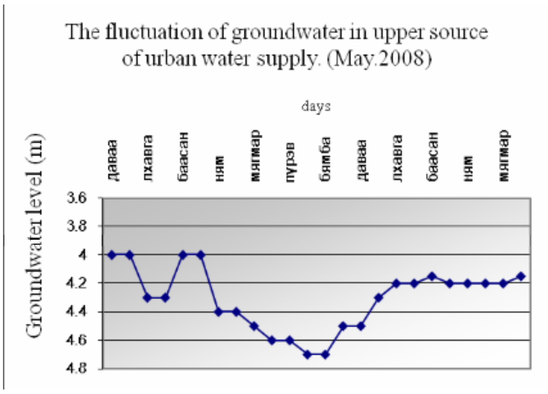

Fig. 11. Groundwater level fluctuation in May, 2008.

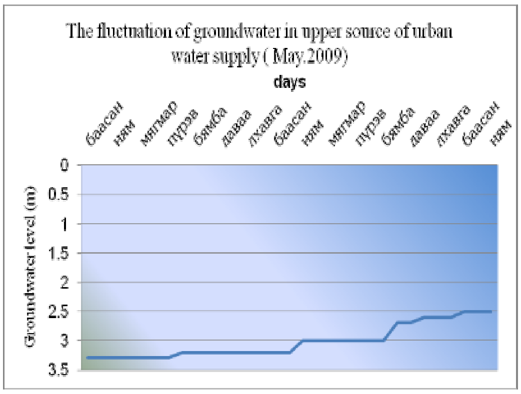

Fig. 12. Groundwater level fluctuation in May, 2009.

The average groundwater level was 4-4.7 m in May, 2008 and 5-3.3 m in May, 2009. The comparison graph of groundwater level during recharge period of groundwater in upper sources of urban water supply (2008-2009).

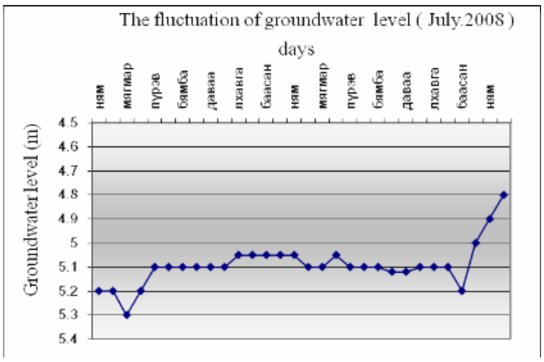

Fig. 13. Groundwater level fluctuation in July, 2008.

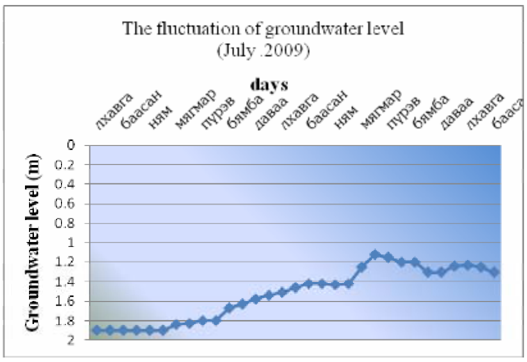

Fig. 14. Groundwater level fluctuation in July, 2009.

The average groundwater level was 4.8-5.3 m in July, 2008 and 1.95-1.1m in July, 2009.

Monitoring Point 2

Monitoring Point of Groundwater Regime in Natural Condition

Monitoring point 2 locates near the production well 33 of central sources of UB city's water supply and installed instruments for measurement of groundwater level.

Table 2. The average groundwater level in each month during 2001-2008.

Year	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
2001	9.77	10.45	11.12	10.23	9.47	6.44	5.71	5.03	6.12	7.14	7.58	8.02
2002	9.89	10.68	12.58	13.28	11.69	9.45	8.05	7.24	6.51	6.82	7.13	8.36
2003	9.65	10.83	12.18	12.91	11.97	9.78	7.61	6.2	6.51	7.31	8.11	9.57
2004	10.64	11.21	12.05	11.54	11.05	10.39	9.23	8.34	7.68	8.35	9.13	9.94
2005	10.36	11.15	12.64	12.12	11.35	10.47	9.84	9.15	8.52	8.13	8.75	9.54
2006	9.86	10.52	11.48	12.34	11.52	10.69	9.76	8.57	7.46	8.68	9.28	10.17
2007	10.8	11.36	12.27	12.68	11.83	10.51	9.84	8.75	7.68	8.42	9.15	9.87
2008	10.15	10.25	10.53	11.26	10.54	9.38	8.12	5.42	6.14	6.78	7.52	8.48

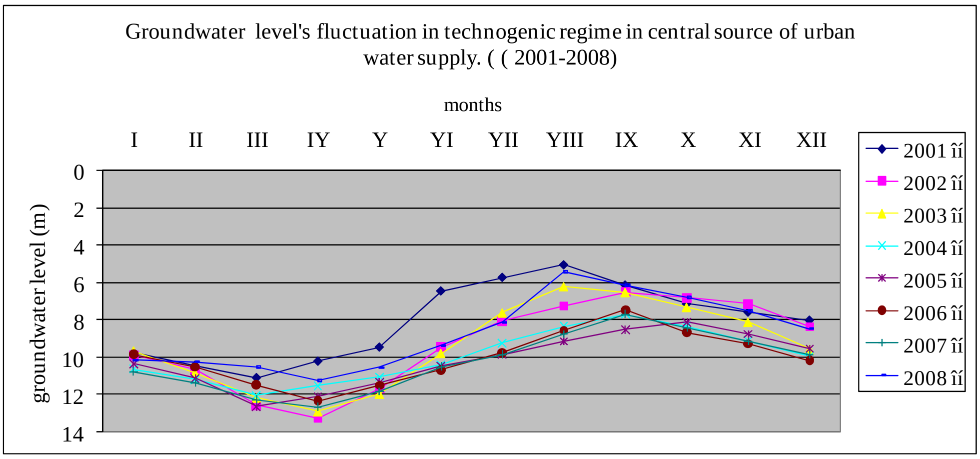

Fig. 15. The groundwater level on condition of technogenic regime in central sources of urban water supply.

We established this point depends on the observation well. The production well 33 of central sources of UB city's water supply can support 60-70 % of urban water consumption. So, we need to observe the groundwater level's fluctuation. The coordinate of this point is 106 °59'12.2" and 47 °54' 3.6".

Fig. 16. Installed instrument for groundwater monitoring.

The comparison graphs of groundwater level during recharged period of groundwater in central sources of urban water supply are shown in Figs. 17 and 18. The average groundwater level was 4.5-6.4 m in Nov., 2008 and 0.5-1.8 m in July, 2009.

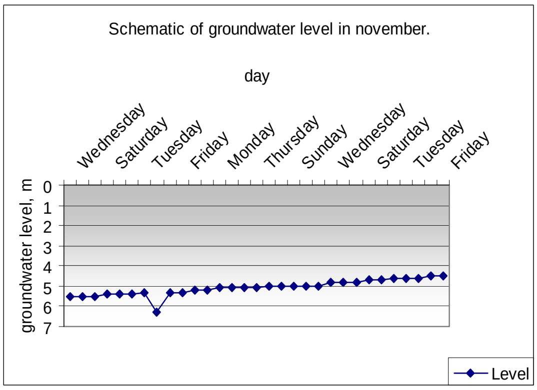

Fig. 17. Groundwater level fluctuation in Nov., 2008.

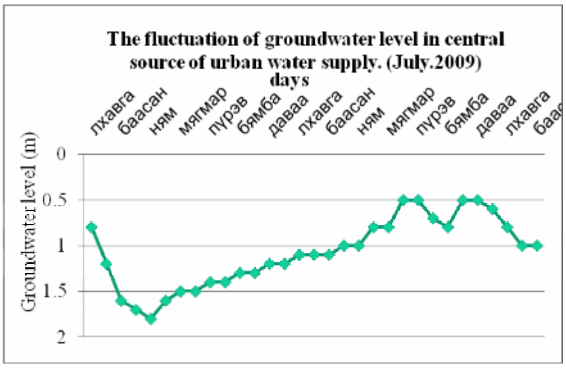

Fig. 18. Groundwater level fluctuation in July, 2009.

Fig. 19. Changing tape during field work.

The researchers are changing the tape for recording of groundwater level in November, 2008 in the central sources of urban water supply's well.

Monitoring Point of Groundwater Regime in Technogenic Condition

We compared the data of the wells which can exploiting for water consumption during the scarce water period in 2005-2009 in central water sources of urban water supply.

Figure 20 shows the dynamic groundwater level in working period of production wells in March 2005-2009.

The comparison graph of groundwater level during scarce water period of groundwater in central sources of urban water supply (2008-2009) (Figs. 22 and 23). The average groundwater level was 8.8-9.9 m in April, 2008 and 8.8-8.05 m in April, 2009.

The comparison graphs of groundwater level during recharged period of groundwater in central sources of urban water supply are shown in Figs. 24 and 25 (2008-2009).

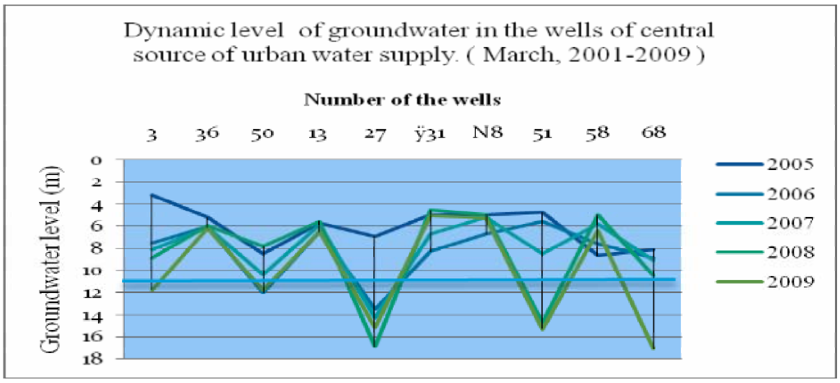

Fig. 20. The dynamic groundwater level in working period of production wells in March, 2005-2009 (in central source of urban water supply).

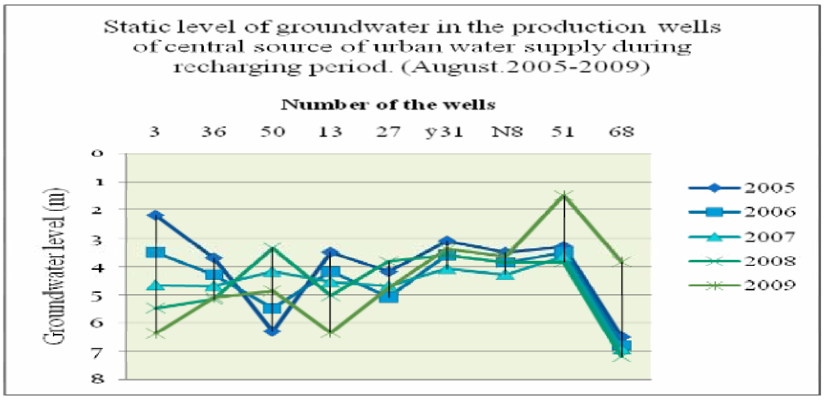

Fig. 21. Fluctuation of groundwater level during peak recharging period in production wells in August of 2005-2009 (in central source of urban water supply).

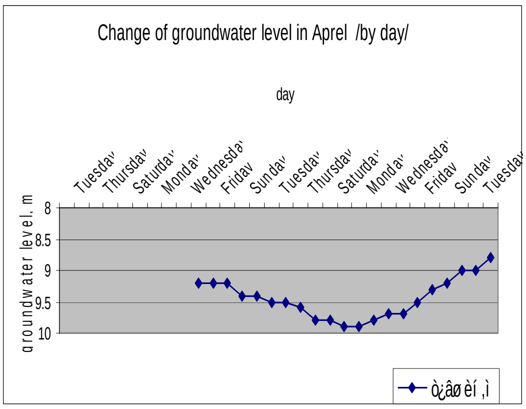

Fig. 22. Groundwater level fluctuation in April, 2008.

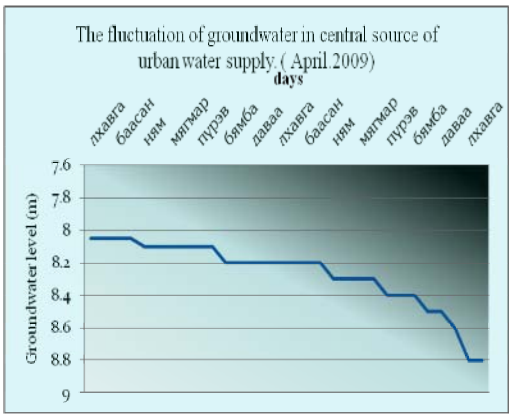

Fig. 23. Groundwater level fluctuation in April, 2009.

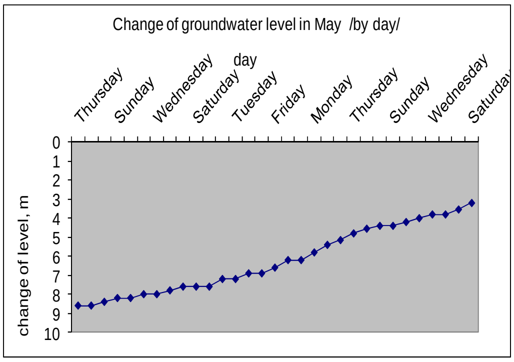

Fig. 24. Groundwater level fluctuation in May, 2008.

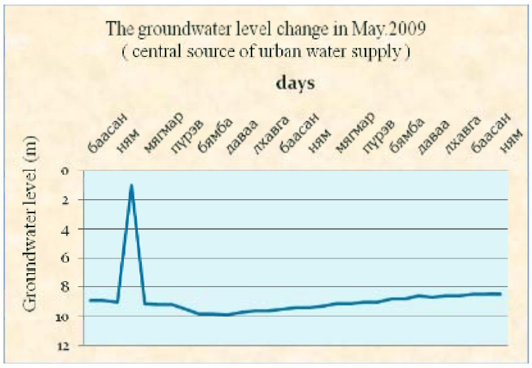

Fig. 25. Groundwater level fluctuation in May, 2009.

The average groundwater level was 3.2-9.5 m in May, 2008 and 0.1- 10 m in May, 2009.

The wells which locate in central water source of urban water supply can work most high exploited water. We compared the groundwater level in scarce period – in March and April. The peak water exploited period is in August in last 5 year. The most high level occurs in August of this year, for example, 1.5 m. The average increased level was 2.2-5 m, but this year groundwater level was higher than other last 5 year. The increased groundwater level was 14.3-17.04 m in the scarce period in March-April of last 5 year. Thus the groundwater level fluctuation is depending from usage water (water consumption), average annual precipitation of those region and infiltration of Tuul river water and etc. Those parameters are directly influenced to the recharge of groundwater.

Monitoring Point 3

Monitoring point 3 locates near the production well 10 of the Power Plant III. The Power Plant III can support UB city by heat. The production well 10 is working for technical water source of Power Plant III of UB city. The main goal of this monitoring point is to control the groundwater level in production wells of Power Plant III of UB city. The coordinate of this point is 106 ° 46’ 10.8” and 47 ° 52’ 52.6”.

Fig. 26. The production well 10 of the Power Plant III.

The average groundwater level was 4-10 m in December, 2008 and 3-4.1 m in August, 2009.

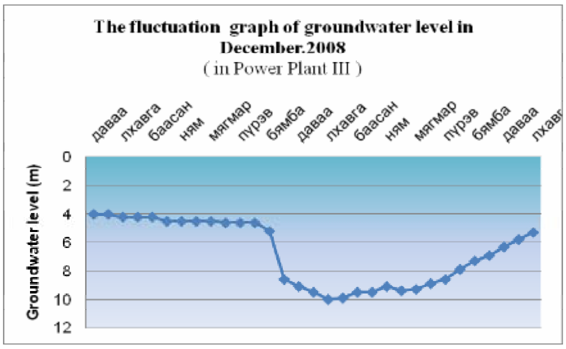

Fig. 27. The groundwater level in December, 2008.

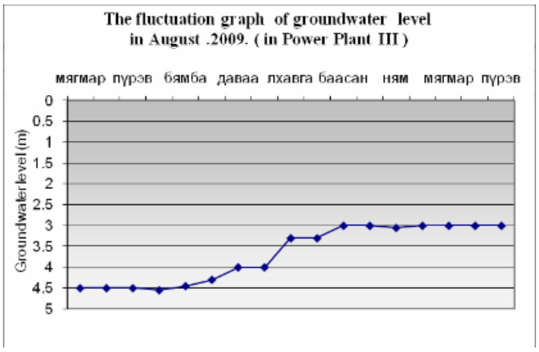

Fig. 28. The groundwater level in August, 2009.

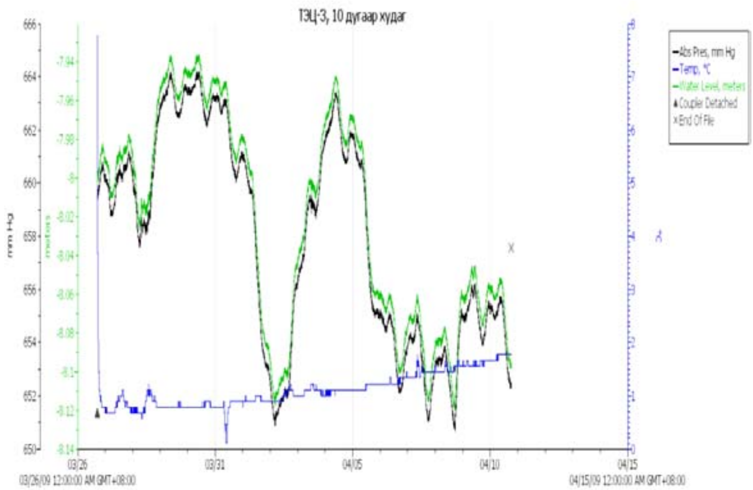

Fig. 29. The graph of tape inscription of groundwater level and temperature of water on data logger on well No. 10 on III thermo power plant in UB city, Mongolia.(26 March -15 April, 2009).

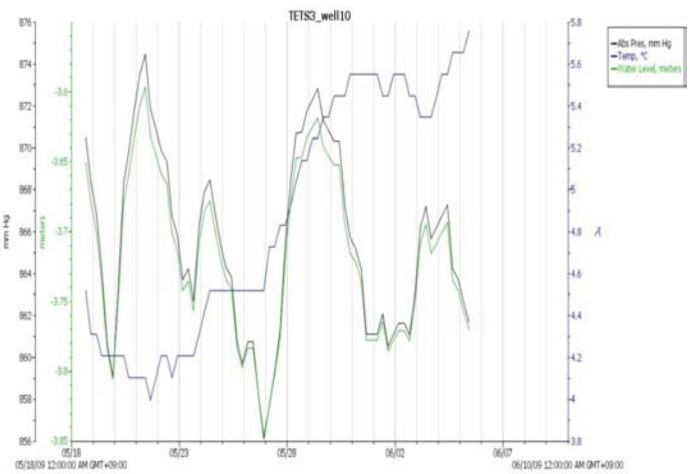

Fig. 30. The graph of tape inscription of groundwater level and temperature of water on data logger on well No. 10 on III thermo power plant in UB city, Mongolia (18 May-10 June, 2009).

Monitoring Point 4

Monitoring point 4 is locates 100 m distance from the production well 1 of the Power Plant IV. The Power Plant IV can support UB city by heat. The production well 1 is working for technical water source of Power Plant IV of UB city. The main goal of this monitoring point is to control the groundwater level in production wells of Power Plant IV of UB city. The coordinate of this point is 106° 35’31.7” and 47° 45’ 50.6”.

Fig. 31. Monitoring point 4 in Power Plant IV.

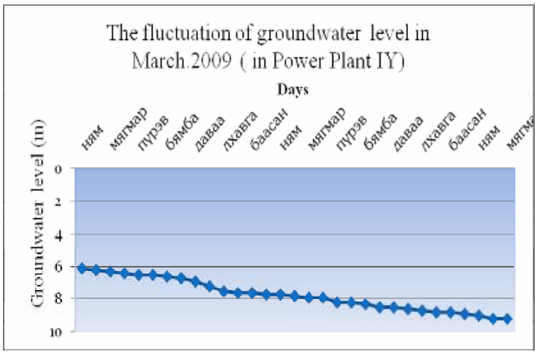

Fig. 32. The groundwater level in March, 2009.

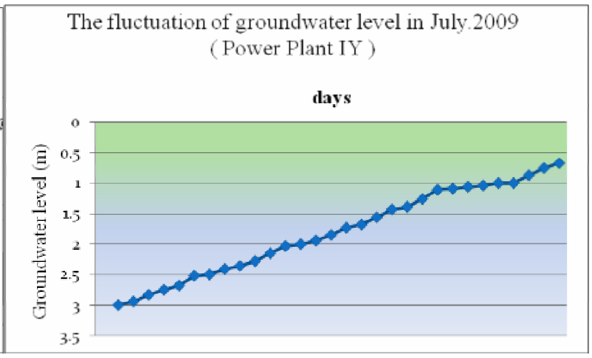

Fig. 33. The groundwater level in July, 2009.

The average groundwater level was 6.0-9.2 m in March, 2009 and 0.6- 3.0 m in July, 2009.

Monitoring Point 5

According to work plan of UNESCO Chair activity we established new monitoring point in 2009 in Gobi desert zone which locate Dornogobi province Sainshand soum Zeegiin khutul place. We established this monitoring point 5 depend on production well 3 of Sainshand soum’s water supply. This production well is working with highest capacity than other production wells. The recording groundwater level is continuing in this time. The coordinate of this point is 110 °11’ 41.0” and 44 ° 46’ 15.3”.

The average groundwater level was 9-18 m in May 2009 and 12.5-14 m in June 2009.

The principle of the groundwater regime is different in the steppe zone and Gobi desert zone. So, we established this point for investigation of Groundwater regime in Gobi desert zone.

Fig. 34. The installation work of monitoring point 5.

Fig. 35. Installed instrument for groundwater level.

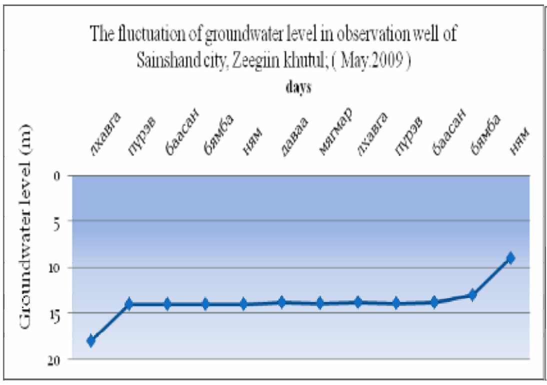

Fig. 36. Groundwater level in May, 2009.

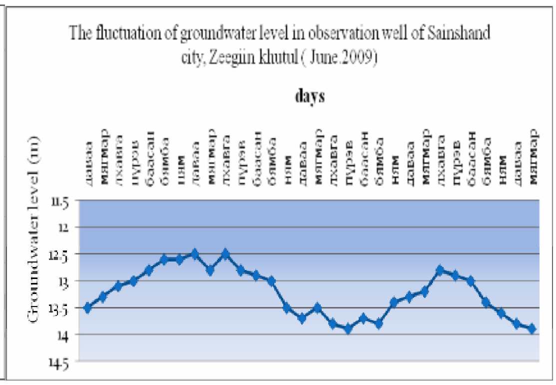

Fig. 37. Groundwater level in June, 2009.

Gobi region- Monitoring observation point

Fig. 38. Water source Zeegiin Khutul in city Sainshand.

CONCLUSION

We are recording measurement of groundwater level in each day on the established monitoring point. And on the statistical analysis we calculated average groundwater level in each month from 2008 up to now. We are controlling each monitoring point in 10 of each month and changing the tape of recording groundwater level and checking all relate process of monitoring point. Also we are doing control measurement during this time.

One of the advances of our field work is that we purchased new equipment of water data logger. This tool can record the groundwater level, air pressure and temperature of water together one times in one point.

The effect of the establishment groundwater monitoring network as following:

- we can describe the possibility of scarce water consumption and water balance of groundwater resources and its current situation.
-The obtained data can help with description of the issues of sustainable groundwater management. So, we need to establish additional monitoring points in natural groundwater resources condition.

So, most of important point of this research study as following:

-Need to establish groundwater monitoring network for determination of groundwater management issues. For example: To describe the influence object of the groundwater recharge process (it means the natural condition or human activity (water exploitation) and its principle.

We need to do regular measurement of groundwater level and detailed research study is necessary on influence of recharge process.

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Environment Diplomatic Leader (EDL) Education Program: A New Integrated Capacity to Solve Global Environmental Issues

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Abstract University of Tsukuba establishes a new graduate program of master and doctor courses which educates an Environmental Diplomatic Leader which has an ability to comprehend environmental issues within a broad academic and applied context, to bridge natural sciences and humanities with a reliable knowledge about not only science and technology but also cultural, socio-economic and political differences, and analytical and problem-solving skills for diplomatic communication and negotiation.

Key words Environmental issues, hydrology, groundwater resources, bio-diversity, public health

BACKGROUND

Global environmental issues are not only on the direct natural environmental aspects but also include governances on food security, natural resources management, energy sustainability, health, development and urbanization, economy and other social matters such on ethics, etc. Therefore, it is cardinal to enforce the human resources development with multidisciplinary talent having capacity of environment science and technology, principle of environmentology and common sense of human based on science and culture should be necessary to alleviate the environmental issues. The education program of Environment Diplomatic Leader (EDL) consists of curriculum corresponding to these necessities. The curriculum includes Master course (2 years) and Ph.D. course (3 years), and the trainee can get the titles of Senior Environment Diplomatic Leader (Ph.D. course) and Environment Diplomatic Leader (Master course) in addition to the Ph.D. and Master degrees, when he/she completes the program.

A master program in environmental sciences was established to educate specialists of environmental sciences in 1977 at University of Tsukuba as the first graduate course in the field of environmental issues in Japan, and the doctor course of sustainable environmental studies was established in 2007. The University of Tsukuba has long history of research and education of environmental issues, and has educated more than 3000 graduate students who are interested in environment issues

In addition, there are several graduate courses focusing on the environmental issues. Those are Sustainable Rural Development (SRD) Course which educates specialists of multiple issues in rural regions of Africa, International Collaboration Environmental Program (ICEP) which educates specialists of environmental policy, Bio Diplomacy Course which educates specialists of bio industry and bio hazard, and

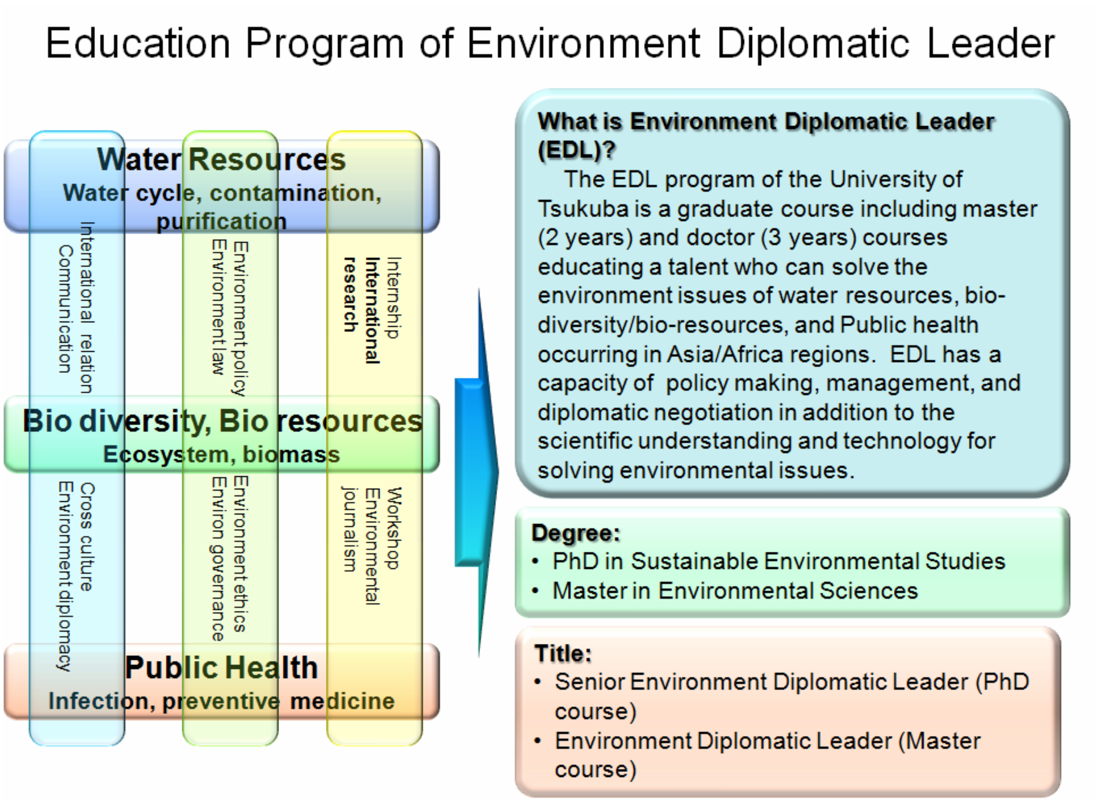

Fig.1. Education program of environment diplomatic leader.

Master of Public Health (MPH) which educates medical specialists of medical policyand infection. Every course has been managed independently, and the new program EDL integrates these programs to educate specialists by interdisciplinary education.

INTERNATIONAL COMMUNICATION IN UNIVERSITY OF TSUKUBA

The University of Tsukuba accepted 1481 foreign students, and 84% of these students are from Asia and Africa in 2008. We have 170 international communication agreements with 74 colleges and institutes of 38 nations in Asia/Africa regions, and 950 faculty staffs and students communicated with these colleges/institutes during recent 5 years. Foreign Students Center, University of Tsukuba was established in 1984, and the center has presented variety kinds of supporting program for foreign students.

The center aims North African and Mediterranean Center for Research and Education, University of Tsukuba was established in Tunis, Tunisia as the first Japanese institute in north Africa to promote the joint research with Tunisian Institutions, academic exchanges between North African countries and Japan, to provide public relations of the University of Tsukuba in North African Region, and to contribute to the development of higher education in the region.

International Center for Central Asian Research and Education was established in

Uzbekistan in 2007 to promote coordination between Central Asian Universities and Research Institutes, to promote research and education both into Central Asian and Japanese, and to encourage awareness about both Central Asian Region and Japan.

The University of Tsukuba has contributed to the nations which suffer from environmental issues through education of human resources of specialists for those problems. Therefore, the University of Tsukuba has had enough potentials to educate Environmental Diplomatic Leaders.

OUTLINE OF THE PROGRAM

A steering committee chaired by president of the University of Tsukuba is established to organize the EDL program. Under a direction of the president, the Major in Sustainable Environmental Studies, Graduate School of Life and Environmental Sciences, University of Tsukuba takes an initiative of the program in cooperation with Graduate School of Humanity and Social Science, Graduate School of Comprehensive Human Sciences, Alliance for Research on North Africa, International Center for Central Asian Research and Education, University of Tsukuba, and Research Institutes in Tsukuba Science City. Also, the program proceeds in collaboration with International Institutes such as UNESCO Paris Office, UNESCO Office Beijing, Borj Cedria Techno Park in Tunisia, Institute of Geo-ecology and Institute of Meteorology and Hydrology, Mongolia, Institute of Geographical Sciences and Natural Resources and Institute of Genetics and Developmental Biology, China, Bogor Agricultural College, Indonesia. The steering committee will establish a Tsukuba Environmental Diplomatic Leader International Consortium (TEDLIC) which consists of Institutes of Tsukuba Science City, counterpart institutes/colleges in overseas, and private companies to perform international internship, international/domestic excursion and workshop. The TEDLIC will include institutes which are counter parts to send the students to the University of Tsukuba, and the TEDLIC can support the students after they complete the program and go back to their home country. Also, the TEDLIC is going to publish an on-line journal for science, culture and policy communications. The EDL program will work well in the frame of these organizations.

COURCE STRUCTURE

The program accepts 10 students for master course and 6 students for Ph.D. course. Every course is lectured by English, and also student must speak in English throughout the courses. The curriculum especially focuses on a special lecture by Top-leader, field excursion, and workshop on site where the environmental issues occur. Also, internship should be encouraged at international organizations and/or administration offices. Every student must learn scientific environmental technology in relation to the water resources, bio-diversity, and environmental health. In addition, the students have to learn international law, environmental policy, comparative culture, environmental communication, and presentation and debate ability.

The students of Master course achieves ability to comprehend environmental issues within a broad academic and applied context, ability to bridge natural sciences and humanities with a reliable knowledge about not only science & technology but also cultural, socio-economic and political difference, and ability to debate, communicate and present their ideas in English clearly. They experiences International Internship at International Institutes such as UNESCO, CIFOR Union University, and also experiences observation, discussion and communication through International Excursion which is held in the regions where the environmental issued occur.

The students presents original idea on science and technology on water resources, bio resources and public health with a review of environmental policy in relation to that technology in their master thesis.

The doctor students are expected to bring the environmental issues with them from their home country, home town or their own interest which is dealt in their doctor thesis. The themes which is expected in their thesis are groundwater resources in the arid/semi-arid regions in Asia/African countries; environmental evaluation of water/bio resources using bio assay in Asia/Africa; water contamination in North China Plane; evaluation of environmental policy for deforestation in Indonesia, etc. The doctor thesis should include not only science and technology originality, but also political idea which is able to contribute to solving the issues indeed.

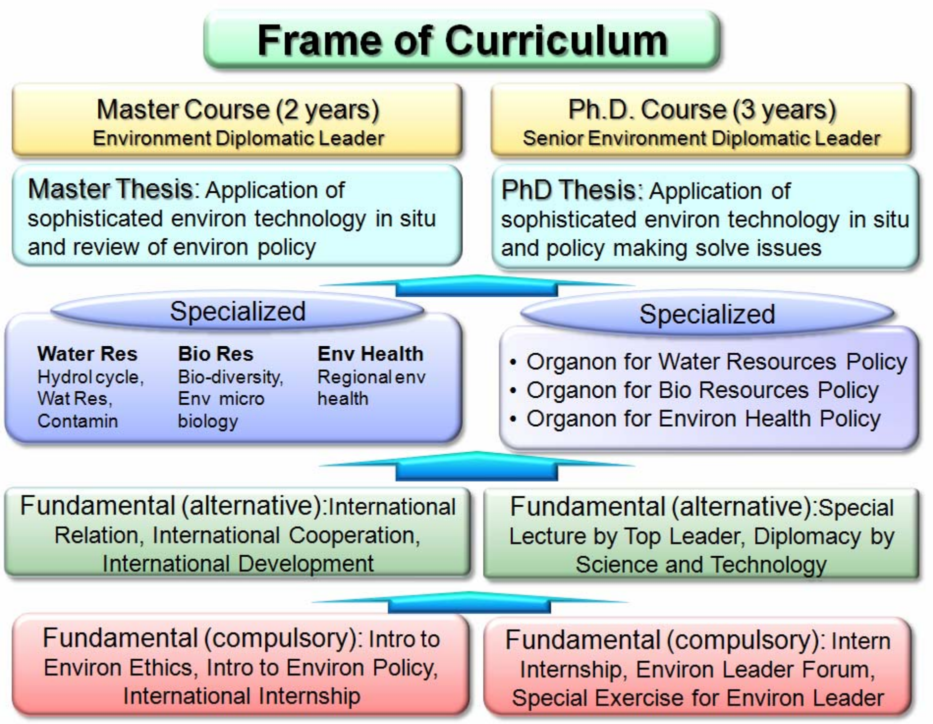

Fig. 2. Frame of curriculum.

FOLLOW UP OF THE STUDENTS

Tsukuba Environment Diplomatic Leader International Consortium (TEDLIC) is going to hold an International Workshop periodically to update the environmental

Table 1. Curriculum of Master Course (2 years)

Curriculum of Master Course (2 years)		
Fundamental Classes (Compulsory)	Introduction to Cycle-oriented Environmental Studies	
	Introduction to Environmental Symbiotic Studies	
	Field and Laboratory Works in Environmental Sciences	
	Introduction to Environmental Ethics	
	Introduction to Environmental Policy	
	Introduction to International Law	
	Statistical Analysis on Environment	
	International Practice	
	International Internship	
	Domestic Internship	
	English Presentation and Debate	
Fundamental Classes (Alternative)	International Relation	
	International Culture	
	International Cooperation	
	International Development	
	Cross Culture	
	Water Culture	
	Science and Technology Diplomacy	
	Introduction to Sustainabilogy	
	Introduction to Environmental Validation	
	Validation of Environmental Policy	
	Validation of Environmental Economy	
	Environmentalo Governance	
	Environmental Journalism	
	Introduction to GIS and Remote Sensing	
Specialized Classes	Water Resources	Hydrological Cycle
		Water Resources
		Water Treatment
		Water Contamination
		Hydrosphere Ecology
		Watershed Management
	Biodiversity and Bio Resources	Biodiversity
		Environmental Microbiology
		Introduction to Plant Biotechnology
		Recycle of Bio Resources
		Policy and Planning for Forest Conservation
		Policy and Planning of Rural Region Development
	Environmental Public Health	Regional Public Health
		Environmental Pathophysiology
		Environmental Preventive Medicine
		Environmental Stress
		Policy of Public Health
		Health Promotion
Master Thesis (Compulsory)		

Table 2. Curriculum of Ph.D. Course (3 years)

Curriculum of Ph.D. Course (3 years)	
Fundamental Classes (Compulsory)	International Practice
	International Internship
	Environment Leader Forum I
	Environment Leader Forum II (Practice for Policy Making)
	Special Exercise for Environment Leader I
	Special Exercise for Environment Leader II
	Special Exercise for Environment Leader III
Fundamental Classes (Alternative)	Special Lecture by Top Leader
	International Law
	Arangement of Agreement
	Diplomacy by Science and Technology
	Environment Diplomacy
	Comparative International Environment Policy
	Transboundary Environmrny Issues
	Comparative Environment Issues
Specialized Courses (Alternative)	Organon for Water Resources Policy
	Organon for Bio Resources Policy
	Organon for Environment Health Policy
Ph.D. Thesis (Compulsory)	

technology, keep the community on environmental issues in Asia/Africa. The community is important to promote communication in the region and solve the environmental issues indeed. Using the community of TEDLIC, the students who complete the program will send their students to our program again, thus a good circulation of human resource will be achieved fruitfully, and the presence of TEDLIC will be improved through positive feedback.

KEY PERSONS OF THE PROGRAM

Representative of the Program: Prof. Dr. Nobuhiro Yamada, President of University of Tsukuba

Head of Executive Committee of the Program: Assoc. Prof. Dr. Maki Tsujimura, Major in Sustainable Environmental Studies, Graduate School of Life and Environmental Sciences, University of Tsukuba

Executive Committee: Prof. Dr. Hiroo Uchiyama, Dean of Major in Sustainable

Environmental Studies, Graduate School of Life and Environmental Sciences, Prof. Dr. Kazuo Watanabe, Director of Foreign Students Center, and University of Tsukuba, Prof. Dr. Takehiko Fukushima, Dean of Major in Life Co-exist Sciences, Graduate School of Life and Environmental Sciences, University of Tsukuba, Assoc. Prof. Dr. Ken-ichi Matsui, Major in Sustainable Environmental Studies, Graduate School of Life and Environmental Sciences, University of Tsukuba

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