Codification of International Law for Transboundary Aquifers by the United Nations

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One of the important functions of the United Nations General Assembly is to codify the international law in order to establish the rule of law for the justice and order of the international community. The UN International Law Commission is the subsidiary organ of the UN General Assembly to prepare the basic documents for such codification. The Commission embarked on the work of formulating draft articles on the law of transboundary aquifers in 2002. The author was appointed as the Special Rapporteur for this project and the Commission was able to report to the UN General Assembly its final result in 2008. The UN General Assembly is to make its decision on how to proceed to transform these draft articles into the treaty. The most of the States have transboundary aquifers with their neighbours. The groundwater is an indispensable life support resource for the mankind and also the most heavily exploited single resource for which no alternative exists. The establishment of legal norms for the proper management of transboundary aquifers, protection of environment, international cooperation and pacific settlement of disputes among the States sharing the aquifers is urgently required by the international community. My address will be designed to present the background of the issue, how the draft articles are formulated in cooperation with hydrogeologists and groundwater administrators, main elements of the draft articles, positions of various States and the future prospect of the draft articles.

Keywords: International Law for Transboundary Aquifers

Linkages of boundaries between surface/subsurface and land /ocean for better management of environment in Asia

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Change in reliable water resources between groundwater and surface water occurred in many Asian cities depending on the development stage of urbanization. Although the subsurface water is connected with surface water in hydrological cycle, both waters were treated separately for both natural and social sciences. In RIHN's project of "Human impacts on subsurface environment", one surface environment: urban, and three subsurface environments; groundwater, heat, and contamination, have been chosen. Intensive field observations and data collections had been made in the basins including Tokyo, Osaka, Bangkok, Jakarta, Manila, Seoul, and Taipei, to evaluate the relationship between development stage of the city and various subsurface environments in Asia beyond the boundary between surface and subsurface environment.

As a factor of separating water, energy and material at the earth surface into above and below the surface, land use/cover changes at three ages (1940's, 1970's and 2000's) in Asian 7 cities (Tokyo, Osaka, Bangkok, Jakarta, manila, Seoul and Taipei) have been analyzed based on GIS with 0.5 km grid at seven targeted cities. Urbanization causes the decease in groundwater recharge rate and increase thermal energy transport into the subsurface.

Another boundary for water and material transports exists between land and ocean. Regarding material (contaminant) transports to the coast, direct groundwater discharge is recently recognized as a significant water and material pathway from land to ocean. Many Asian major cities are located in the coastal zone so material and contaminant transport by groundwater is a key to understanding the coastal water pollution and the effects on associated ecosystems.

In this paper, the importance of integrated treatments between surface/subsurface and land/ocean will be shown for better understanding and management of environment.

The NA (nitrate-arsenic) Boundary as an Important Concept in Aquatic Environmental Studies

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Abstract. The NA (nitrate and arsenic) boundary is proposed as an important new boundary concept for catchments. It is defined as the redox border distinguishing whether nitrate or arsenic can be present in water. The NA boundary concept is explained based on the role of the redox system and by introducing research examples which use nitrate and sulfate isotope ratios from urban catchments in a variety of Asian countries. The global-scale importance of the NA boundary concept for sustainable groundwater use is illustrated based on a compiled Asian dataset.

Keywords: Asia; boundary; redox; pollution; groundwater

A Model to Assess Groundwater Inflows to Lakes via a Rn-222 Mass Balance

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Radon in the water column of lakes can typically be derived from the following sources: production by decay of dissolved Ra-226 (parent of Rn-222); diffusion from sediments; inflow from streams or rivers (especially if these “surface” inputs are groundwater derived); and direct groundwater inputs. Losses of radon include radioactive decay; evasion to the atmosphere; and outflows of lake water either by surface flow or recharge to underlying aquifers. We have examined the radon budget of several small lakes in Florida and observed that inputs are often dominated by groundwater and losses via atmospheric evasion. This prompted us to develop a simple mass balance model to allow for rapid estimations of groundwater flow into lakes.

Our model requires the following assumptions: (1) the lake is well-mixed both horizontally and vertically; (2) the only radon inputs to the lake are by advection of groundwater and diffusion from sediments; and (3) the only losses of radon are via decay and loss to the atmosphere. Preliminary studies of several “seepage” lakes in Florida has shown that they are indeed well-mixed, i.e., no significant gradients in radon concentrations. The assumptions regarding inputs and outputs of radon also seem to hold, at least for lakes without significant surface water inflows or outflows.

In order to evaluate the groundwater-derived radon flux, we monitor the Rn concentration in lake water over time for a period long enough (usually 1-3 days) to observe changes likely caused by variations in atmospheric exchange (primarily a function of wind speed). We then attempt to reproduce the observed record by accounting for decay and atmospheric losses and by evaluating the total Rn flux using an iterative approach. Once the Rn flux is evaluated, we estimate groundwater discharge by dividing this value by the measured groundwater radon concentration.

Keywords: groundwater discharge; lakes; radon; Florida

"Giant" Fish-Breeding Forest: A new environmental system linking continental watershed with open water

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The Amur–Okhotsk Project (AOP) attempted to create a new global environmental concept referred to as the “Giant” fish-breeding forest (GFBF) by expanding the traditional Japanese idea of Uotsuki-Rin (fish-breeding forest), which related upstream forest with the coastal ecosystem both physically and conceptually. The AOP found that primary production in the Sea of Okhotsk and Oyashio region depended on dissolved iron transported from the Amur River and its watershed. Therefore, the Amur River basin can be recognized as the “Giant” fish-breeding forest of the Sea of Okhotsk and the Oyashio region. This hypothesis presents new perspectives in global environmental issues: an ecological linkage between the continent and open sea, the relating less dependent stakeholders in the system, and finding environmental common ground across coast lines and complex international boundaries. Multidisciplinary approaches are indispensable in studying and conserving the GFBF because stakeholders need to understand how to achieve a sustainable marine ecosystem in the Sea of Okhotsk and Oyashio region without limiting human activity on land. Connecting less dependent stakeholders could be a first step in coping with complicated environmental issues. We attempt to visualize socio-economic relationships inside the GFBF system to demonstrate how stakeholders are related to each other unconsciously. Establishment of the concept will help bring together people who have been separated for many years under political tensions.

Keywords: fish-breeding forest, dissolved iron, open sea, uotsukirin

Numerical Simulation of Dissolved Iron Production and Transport in the Amur river and the Sea of Okhotsk

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Wetland in the Amur River basin plays an important role in producing dissolved iron. Though significant part of dissolved iron is removed at the estuary zone, the mouth of the river is located coincidentally over the northwestern shelf where Dense Shelf Water (DSW) is vigorously produced. Thus, dissolved iron from the Amur River should be transported by DSW to the Sea of Okhotsk in which iron is the limiting factor of primary production. During the last century, wetland was drastically converted into cultivated land, which in turn may have great impact on dissolved iron production. To assess the land cover conversion impact on dissolved iron production and primary production of the Sea of Okhotsk, we constructed numerical model to simulate dissolved iron production and transport in the Amur River and the Sea of Okhotsk.

Developed model consists of terrestrial module and marine module. The terrestrial module successfully simulates discharge and dissolved iron flux of the basin. The marine module can also simulates realistic DSW well, which flows along the Sakhalin coast through the intermediate layer of 200-500m deep, and then experiences strong tidal mixing along the Kuril Islands in the southern Okhotsk Sea. Thus, our model can simulate dissolved iron production and transport in the Amur River basin and the Sea of Okhotsk.

By using the terrestrial module, we tried to simulate the land cover change impact on dissolved iron productivity of the Amur River basin under different land cover scenarios. Two typical land cover change scenarios were set up as possible future land cover change in the basin. One is conversion of wetland to agricultural land (paddy fields and dry lands). The other is forest fire. Results indicated that wetland conversion to agricultural lands has significant impact on dissolved iron flux. Further research is needed to know how wetland decrease affects primary production of the Sea of Okhotsk.

Keywords: Amur river, Sea of Okhotsk, wetland, dissolved iron, dense shelf water, land cover change

Basic Concept of a Newly Established Integrated Study on the Linkage of Forest-Sato-Sea Collaborating with a Social Movement Flagged “The Sea is Longing for the Forest” and Its Actual Case Research Conducted in Ariake Bay-Chikugo River System, Japan

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20th century science had been highly specialized to create a large variety of new technologies, resulting in “happy” easier life only for human being. However those individually separated technologies caused serious impacts on the earth systems. The author believes it is necessary to create integrated new science in 21st century because all of the present global-scale issues have complicated and/or comprehensive aspects.

Japan is characterized by two unique features of being covered by forest (67%) and surrounded by highly diverse marine systems ranging from sub-arctic to subtropical regions. The forest is of course connecting to the sea basically by river which conveys continuously clean but nutrients / minute elements-rich water from the forest. However, the linkage between forest and sea was largely damaged by high energy-consuming urban life and industrial activities which are concentrated to river side and estuarine land area. Unfortunately previous sectionalized science couldn’t efficiently contribute to solve the present comprehensive global-scale issues. Thus the author proposed a newly integrated study on linkage of forest-sato-sea in 2003 primarily based on my own research experiences as well as a preceded fishermen’s social activity. The goals of this new study are to restore the linkage and to recover intimate relationship among people.

This idea has been first emerged from an estuarine ecosystem research conducted in the bottom of Ariake Bay where a unique and precious biodiversity with large number of last ice-age continental relict organisms including 8 sub-endemic fish species exists. These relict fish aggregate at low-salinity ETM (estuarine turbidity maximum) during the early juvenile stage, although their spawning grounds are different. The reason is that a large biomass of a brackish-water copepod Sinocalanus sinensis (relict species) assemblage exists there. This relict copepod is a detritus-eater which is formed at the ETM area owing to aggregation of clay-silt particles transported from volcanic Mt.Aso catchment via largest river Chikugo. Thus I could conclude intimate linkage: sub-endemic fish – prey zooplankton – minute particles (detritus) – Chikugo river – Mt.Aso. However, this relation has been highly influenced by decreases of water and sand supply caused by construction of dams.

Discussion will be also made from the viewpoint of forest-origin iron contribution to enhancing primary production in the coastal waters in relation to fishermen’s social movement “The sea is longing for the forest “

Coastal changes in the Anthropocene: The perspective of the IAEA - Marine Environment Laboratories

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Coastal zones which comprise < 20% of the earth surface are one of the most dynamic areas of the world. Giving home to more than 50 % of the earth's population the coastal zones are affected by natural and anthropogenic induced pressures which challenge the sustainability of the coastal environment and its resources. Most of the environmental pressures originate from outside the coastal zones thus requiring an interregional approach for coastal environmental assessments. It is one of the missions of the Marine Environment Laboratories (MEL) of the International Atomic Energy Agency to assist member states in coastal zone management by applying nuclear and isotopic techniques. These techniques are used in many ways at MEL to enhance the understanding of marine ecosystems and to improve their management and protection.

Pollution of the Oceans is essentially a 20th century problem. Up to 80 percent of all ocean contamination originates from human activities on land. Historical records of organic and inorganic pollution combined with isotopic fingerprinting of contaminant sources are a powerful argumentative tool to link the evolution of contaminants with socioeconomic decisions at local and regional scales.

One of the most damaging and widening problems facing coastal waters around the world is the phenomenon known as "red tides," scientifically called Harmful Algal Blooms (HABs). The rapid growth of algae leads to a toxic contamination of shellfish and the deadly Paralytic Shellfish Poisoning. An oversupply of nutrients is believed to be one trigger for the outbreaks of HABs with the role of submarine groundwater discharge as a transport medium for the nutrients being largely unexplored.

The presentation will give an overview of MEL´s current marine coastal projects and future research activities.

Transportation of Marine-derived Nutrients (MDN) onto Land by Anadromous Fish: A Case Study of Pacific salmon in Russian Far East

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Land and ocean are connected with each other through many pathways. Rivers are the major corridor of nutrients transportation between them. There have been many important studies in North America which demonstrate that anadromous fish, especially Pacific salmon (Oncorhyncus spp.) , play a siginificant role of transporting marine-derived nutrients (MDN) onto terrestiral ecosystems. But such salmon studies are not so many for Russian Rivers such as the Amur River. The purpose of this paper is to fill the gap of research between North America and Russia. Using the data of escapement of adult Pacific salmon to spawning areas in Russian Far East, the paper shows preliminary estimates as of how much marine-derived nitrogen (N) and phosphorus (P) are annually uploaded onto terrestrial ecosystems from the Northern Pacific. Fish breeding forest on land has been known to nourish the ocean with iron and other life-support matters. In contrast, this paper demonstrates a type of transportation of life-support matters in the opposite direction, i.e., from ocean to land.

Keywords: anadromous fish, marine-derived nutrients (MDN), Russian Far East, nutrients transportation

National boundaries and the fragmentation of governance systems: Amur-Okhotsk ecosystem from the legal, political perspective

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The Amur-Okhotsk Project has recently found that primary production in the Sea of Okhotsk and the neighboring Oyashio region has been dependent on dissolved iron transport from the Amur River. And in the Amur River basin, dissolved iron originates mainly in wetland and forest. Our project calls this ecological linkage between the continent and open waters as “Giant” Fish-Breeding Forest system. This means that in order to conserve the marine living resources in the Sea of Okhotsk and Oyashio region, it is also necessary to protect the environment in the Amur River basin, especially wetland and forest.

From the legal and political perspective, this “Giant” Fish-Breeding Forest system has two different kinds of boundaries; national boundaries (transboundary) and regime boundaries (fragmentation of governance systems). This system cuts across borders between China, Russia, Mongolia and Japan, and they do not share the same benefit and cost on the conservation of this system, suffering from the "free riding" problem. In addition, some aspects of environmental factors in this area has already been regulated by international and national law, but these management regimes have been concluded and implemented independently, and sometimes overlap or conflict, therefore are not appropriate for the conservation of the whole system of “Giant” Fish-Breeding Forest.

Discussing problems cause by these two human-made boundaries, this paper will try to show that, so as to manage this ecosystem effectively, it is important to coordinate the existing legal systems and policies in an integrated manner as well as to make the common understanding among countries in this system.

Keywords: “Giant” Fish-Breeding Forest, national boundaries, regime boundaries, integrated management

The History of ‘Uotsukirin’ (Fish-Breeding Forest) in Japan

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The oldest 'Uotsukirin' (Fish-Breeding Forest) in Japan is at Tokushima Prefecture of the 10th century in literature. 'Uotsukirin' existed in all over Japan in the 17th century.
According to the literature, 'Uotsukirin' in Japan were located in the following places (They are written with present Prefecture names).
[1] Tokushima (947-956), [2] Oita (1623), [3] Miyagi (1657), [4] Shizuoka (1713), [5] Nagasaki (1727), [6] Iwate (1736), [7] Yamaguchi (1743), [8] Yamagata (1747), [9] Niigata (1751-1772), [10] Wakayama (1753), [11] Yamaguchi (1775), [12] Tokushima (1781), [13] Shiga (1783-1787), [14] Iwate (1807), [15] Iwate (1816), [16] Oita (1837), [17] Fukuoka (1860), etc.
'Uotsukirin' spread throughout Japan after the 17th century. There were the intentions to promote of the sardine fishing in that background. Sardines were the important industry resources (foods, lamp oil and fish manure) at that time.
In 1623, the southern part of Oita Prefecture (at present), the first lord of feudal clan took out the following direction. "I had heard that sardines don't come near to coast if trees don't grow thickly in the mountain around the seashore. For the promotion of sardine fishing, I forbid firmly felling of the plant in small islands and swiddening in the mountain at the creek". He had become aware of the importance of the sardine in 1604. Huge amounts of sardines were thrown into the inland as fish manure in Japan in the 17-19th century. And so, Japanese agricultures developed.
The Japanese Government enacted the Forest Law in 1897. The protection-forest system was introduced in this Forest Law.
From view of natural science, in the 20th century, the researches of relations between the inland forests and the sea appeared. Dr.ENDO Kichisaburo (Studies on the seaweeds, professor of Sapporo Agricultural College) issued that the cause of 'Isoyake' (rocky-shore denudation) is the devastation of the watershed forests in inland (1902, 1903, etc.). Dr.INUKAI Tetsuo (Zoology, professor of Hokkaido University) issued that forests all over Japan are 'Uotsukirn' (fish-breeding forest)(1937,1951,etc.). Now, fishermen are planting trees eagerly all over country. In the 21st century, 'Uotsukirn' may get over the sea.

Keywords: 'Uotsukirin'(Fish-Breeding Forest), Material Cycle, Fish Manure, Forest Law, Protection Forest

Integrating Groundwater Boundary Matters into Catchment Management

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With 97% of the world’s freshwater resources stored underground, the connection between groundwater resources to the metrics of space, scale and time common to the geographic study of groundwater has not been extensively investigated by political geographers. Recognized as a common pool resource, the management and governance of groundwater resources is challenging and increasingly conflictive not only due to its hidden nature, but also because of the difficulty in placing boundaries around the groundwater resources and user domains.

Given that groundwater is the world’s most extracted raw material with withdrawal rates estimated to range between 800 to 1,000 km^3 per year through millions of water wells, the groundwater domain boundaries are three-dimensional and change with time. A previously unrecognized typology for groundwater resources and user domains determined that (1) traditional approaches to defining groundwater domains focus on predevelopment conditions, referred to herein as a “commons” boundary; (2) groundwater development creates human-caused or a “hydrocommons” boundary where hydrology and hydraulics are meshed, and (3) the social and cultural values of groundwater users define a “commons heritage” boundary acknowledging that groundwater resources are part of the “common heritage of humankind”. This typology helps define a fundamental unit of analysis to aggregate demographic, social, and economic data. Emerging paradigms of groundwater governance suggest “unitizing” some groundwater development situations as one means to mitigate the inefficiency of a possession or use-based system of groundwater along with the inefficiencies associated with joint access to groundwater. Yet drawing these domain boundaries is supremely political and morphs with changing social and cultural values. Incompatibilities often arise over the use and equitable, or inequitable, distribution of groundwater, “values” attached to groundwater, conceptual models, uncertainty, as well as on missing information, inaccurate data, and how the “science” will be used by knowledge entrepreneurs, fueling the “dueling expert” syndrome.

Keywords: Groundwater, boundaries, unitization, dueling experts

A Boundary between Surface and Ground Water in Japanese Legal System -Its Consequence and Remedy-

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Recently, Japanese government began to advocate the necessity of integrated management of surface and ground water, paying attention to hydrologic cycle. But, from a legal perspective, it is hard to say that such an integrated management is realized well. In Japan, while surface water is usually regarded as “public” water that is subject to a water law named the River Law, groundwater is basically regarded as “private” water that just belongs to land ownership. So, it is often said surface and groundwater connect with each other in physical sense, but those are divided in legal sense.

Why do we need integrated management of surface and ground water? A reason is efficient use of water resources. Where there is legal boundary between surface and groundwater, it will be hard to internalize external diseconomies (an activity that impose involuntary costs on others) that arise between surface water users and groundwater users. This problem can be observed in Ehime Prefecture, Japan where there is a potential conflict between two cities; Matsuyama which tries to promote a water diversion plan and Saijo which is anxious about the plan’s impact on its groundwater resource.

Saijo city government is now trying to create a new ordinance to protect groundwater that many residents totally depend on for their domestic use. In this paper, A consequence of legal boundary between surface and groundwater and its remedy will be discussed.

Keywords: public water, private water, external diseconomies, local ordinance

HELCOM Baltic Sea Action Plan – Ecosystem based approach to manage a semi-enclosed European sea area with nine riparian countries

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The Baltic Sea is a continental brackish-water sea area situated in the northern Europe. It is eutrophied, harmful substances have been accumulated in its biota and sediment.

In 1974, the then seven Baltic coastal states signed a Convention on the protection of the marine environment of the Baltic Sea area, for the first time ever, covering all the sources of pollution The 1974 Convention entered into force on 3 May 1980. In the light of political changes, and developments in international environmental and maritime law, a new convention was signed in 1992 by all the nine states bordering on the Baltic Sea, and the European Community. After ratification the Convention entered into force on 17 January 2000. The Convention covers the whole of the Baltic Sea area, including inland waters as well as the water of the sea itself and the sea-bed. Measures are also taken in the whole catchment area of the Baltic Sea to reduce land-based pollution. The governing body of the Convention is the Helsinki Commission - Baltic Marine Environment Protection Commission - also known as HELCOM.

HELCOM efforts to reduce pollution and repair the damage to the marine environment have led to noticeable improvements in many areas, enabling people to bathe on beaches that were once polluted, and helping endangered wildlife populations to recover. However, there is still a lot left to do, as many of the Baltic's environmental problems are trans-boundary, proving difficult to solve, and it could take several decades for the marine environment to recover.

In 2007, HELCOM adopted the joint Baltic Sea Action Plan, which is radically different from any other plan or programme previously undertaken by HELCOM. It is implementing the Ecosystem Approach and is based on a clear set of 'ecological objectives' defined to reflect a jointly agreed vision of 'a healthy marine environment, with diverse biological components functioning in balance, resulting in a good ecological status and supporting a wide range of sustainable human activities'.

Example objectives include clear water, an end to excessive algal blooms, and viable populations of species. Targets for 'good ecological status' are based on the best available scientific knowledge. For this purposes HELCOM co-ordinates extensive environmental monitoring programme and produces annually updated indicator reports as well as thematic and holistic assessment on the state of the Baltic sea marine environment.

Combining Activities of Sato-umi and Sato-yama in Japan: Towards a New Type of Integrated Coastal and Watershed Management

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In the coastal marine environment of Japan, a concept of integrated coastal management (ICM) has been officially introduced very recently through establishment of the Basic Ocean Law in 2007 and the following planning of the Basic Ocean Plan in 2008. This new policy includes comprehensive management of watershed and coastal waters beyond the border of administrative sectors relating to the management of forest, river, land, agriculture, coastal environment, port and harbor etc. However, implementation of ICM based on the Basic Ocean Plan is making very little progress mainly due to strong bureaucratic sectionalism. On the other hand, activities of citizen and NGOs/NPOs which connect functions of forest, river and sea has made a remarkable progress. Among these, combining activity of Sato-umi and Sato-yama is one of promising movement towards the implementation of ICM in the private sector. Sato-yama and Sato-umi can be both defined as a dynamic area that inter-relates people and nature in agriculture, forestry and fisheries. Compared to Sato-yama which is pretty well known as traditional sustainable land use and landscape in Japan, Sato-umi is relatively new concept which indicates coastal sea under the harmonization of sustainable wise use with conservation of appropriate natural environment and habitat conditions. Sato-umi should provides higher biological diversity as habitat and higher biological productivity as fisheries ground. Recent official systems and local activities on Sato-umi will be presented and some case studies of combining activities of Sato-umi and Sato-yama in the Seto Inland Sea area towards a new type of integrated coastal and watershed management will also be presented.

Keywords: Sato-umi, Sato-yama, integrated coastal management (ICM), environmental management, resource management, sectionalism

"AQUIFERS KNOW NO BOUNDARIES.... BUT *FARMERS* DO!" SO, WHO SHOULD CARE?!"

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Practically all aspects of human endeavours are somehow governed by "boundaries", seen and unseen. Human social interactions are subject to boundaries that are set in cultural norms, certain activities are permitted and maybe encouraged, others are accepted, but not encouraged and yet others are completely taboo. Each day in our lives we either stay within these boundaries, go close to them or indeed cross them. Our perception of the world around us is also governed by boundaries though some of these may be very blurred boundaries.

Just as our daily lives are governed by boundaries, so our study of science is full of boundaries, explicit and implicit – for instance, the boundary between the science of biology and physics was once rigid and is now very blurred. This Author looks forward to the contributions and discussions that will take place in the Symposium to discuss and reflect on the dilemma. The discussion will relate boundaries in aquifers to the boundaries that a farmer might respect in his use of water in aquifers. I would suggest that it is us humans that need to make "boundaries" in a natural world, which is in fact a continuum, and exists in a smooth transition, from one state to the next.

In making a study of an aquifer system, the Rum-Saq Aquifer (Puri 1997[1]) the Author stated that, "aquifers know no boundaries" (except hydraulic ones..) because it rapidly became clear that the area of study that initially was only several hundreds of square kilometres had to be extended to several thousand square kilometres. The experience gained from that study led the Author to be a proponent of the study of transboundary aquifers, which has now been recognised through the UN having a adopted a Resolution that encourages those countries that possess transboundary aquifers, to approach the issue by referring to Draft Articles prepared by the International Law Commission, grounded in legal formulations. The presentation at the Symposium will be structured to move through conceptualisation of boundaries, to their characterisation and their calculation.

[1] "Aquifers know no boundaries". Guest Commentary in Journal of International Groundwater Technology, April/May 1997, p6.

The trans-boundary management of groundwater resources in the Kumamoto area, Japan — Sustainable management of groundwater resources for over 700,000 residents —

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The city of Kumamoto and their surrounding area, where have the population over 0.7 million, are unique in that it is the city holding prefectural government which city water is 100% supported only by their abundant groundwater. Recent expansion of the urban land-use area in and around city induces the decrease of volume of the regional groundwater resources in spite of economical water-use efforts, and the local governments try to take measures to maintain stable groundwater recharge rate. Also the groundwater contamination mainly caused by the agricultural origin N-NO3 has been clearly rising their concentration recently. To maintain environmentally stable regional groundwater resources for both quantity and quality aspects, it is necessary to enlighten the people's concern about the sustainable use of the regional groundwater resources. This paper introduces the ongoing efforts conducted by the city of Kumamoto area for this purpose.

Keywords: trans-boundary groundwater management, volcanic aquifer, artificial recharge, abandoned paddy fields