

Global Environmental Studies

Makoto Taniguchi  
Takayuki Shiraiwa *Editors*

# The Dilemma of Boundaries

Toward a New Concept of Catchment



Research Institute  
for Humanity and Nature

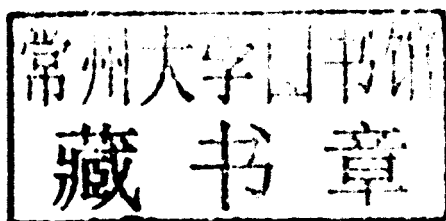


Springer

Makoto Taniguchi • Takayuki Shiraiwa  
Editors

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Toward a New Concept of Catchment



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# **Global Environmental Studies**

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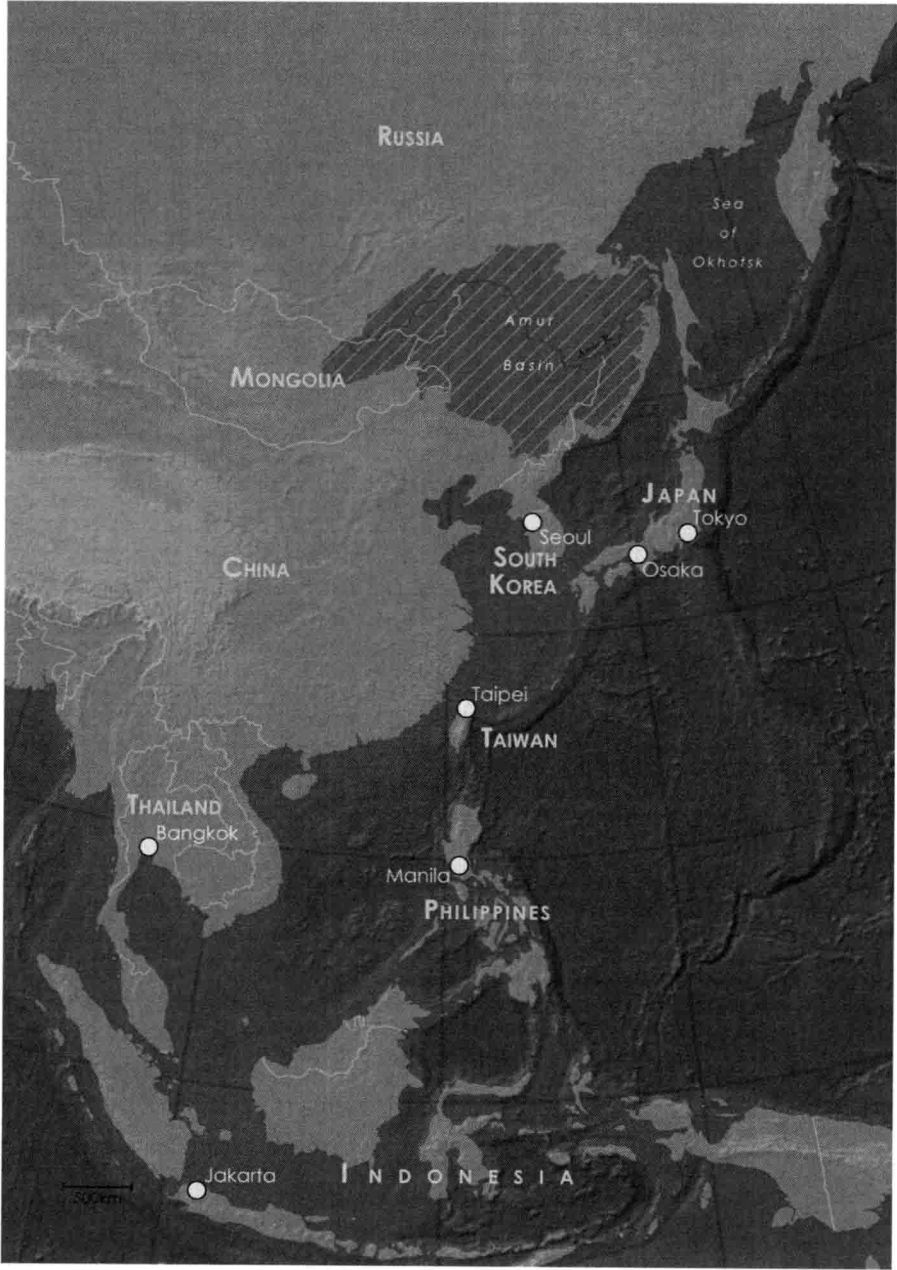
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# Preface

Boundaries have broad meanings: There are natural boundaries of two different spheres, conditions, or materials such as land-and-ocean and surface-and-subsurface environments; social boundaries such as national and local demographic boundaries; and human boundaries such as those created by races, cultures, and religions. These boundaries are necessary for maintaining each society and for managing each environment. For instance, there are individual laws for each area, sphere, or condition, and each individual country has different laws on the usage of water on land. In addition, different laws have been applied to water under the ground (groundwater), even in the same country. The management of water in the ocean also differs from the management of water on land. Although water circulates seamlessly above the surface as vapor, on the ground as surface water, under the ground as groundwater, and in the ocean as sea water, different ways and laws exist to control each type of water separately.

There are many water problems depending on boundaries, which include land subsidence and trans-boundary of water movement beyond the demographic boundaries. Land subsidence is caused mainly by excessive groundwater pumping, and this relationship demonstrates the situation of the “tragedy of commons.” Individual people use cheap (free) groundwater instead of relatively expensive tap water to get individual benefits. However, the accumulation of individual small benefit by consumption of groundwater can lead to land subsidence, which will then cause all individual benefits to be lost. The solution for land subsidence by regulation of pumping may be the symptomatic solution. It was used in Tokyo and Osaka in the 1970s and might help solve similar problems that latecomer cities, such as Bangkok, Jakarta, and Manila, are facing. However, what should be understood fundamentally is that land subsidence occurs because of the tradeoff between water fluxes as resources and water stock in subsurface environment. We need boundaries to manage the water; however, those boundaries cause many problems because water moves seamlessly. This is the “dilemma of boundaries.”

Water movements across boundaries cause not only problems but also benefits. Transports of dissolved materials from land to the ocean feed nutrients to the life in the sea. This concept is so called “fish-breeding forest” through ecological services

(linkages) between river basin and ocean. This continental-scale terrestrial–marine linkage, the giant fish-breeding forest, is another example of the dilemma of the boundaries, because it is a trans-boundary issue across countries with different stakeholders and also an interdisciplinary study between hydrology and oceanography beyond the boundary between land and ocean.

Water on land and ocean is a “commons,” and it moves seamlessly beyond boundaries. However, we still do not know how to manage the water beyond the dilemma of the boundaries and the tragedy of commons. In this book, we will discuss how the boundaries have important roles and meanings and cause many problems not only in water and material cycles, but also in laws and institutions. Finally, we summarize the dilemma of the boundaries toward a new concept of the basin.

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# Global Environmental Series

The Global Environmental Studies series introduces the research undertaken at, or in association with, the Research Institute for Humanity and Nature (RIHN). Located in Kyoto, Japan, RIHN is a national institute conducting fixed-term, multidisciplinary, international research projects on pressing areas of environmental concern.

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# **Part I**

## **Introduction**



# Chapter 1

## Introduction

**Makoto Taniguchi and Takayuki Shiraiwa**

**Abstract** This chapter shows a brief introduction of four sections which are summarized as ignored linkages between surface and subsurface environments, trans-boundary linkages of land and ocean, the impacts of human-made boundaries, and challenges for new management beyond boundaries. This chapter brings readers to understand the importance of ignored linkages and how to redraw a traditional concept of catchment management into a new one.

**Keywords** Boundaries • Surface-subsurface interaction • Land-ocean interaction • Trans-boundaries • Ignored linkage

Although water circulates continuously and seamlessly on Earth, various research areas such as oceanography, surface hydrology, groundwater hydrology, climatology and glaciology are usually undertaken separately. However, recent findings related to interactions of water in land, oceans, and the atmosphere encourage researchers to more comprehensively understand the behavior of water through collaborative works that go beyond the boundaries of each discipline (e.g. Taniguchi et al. 2008).

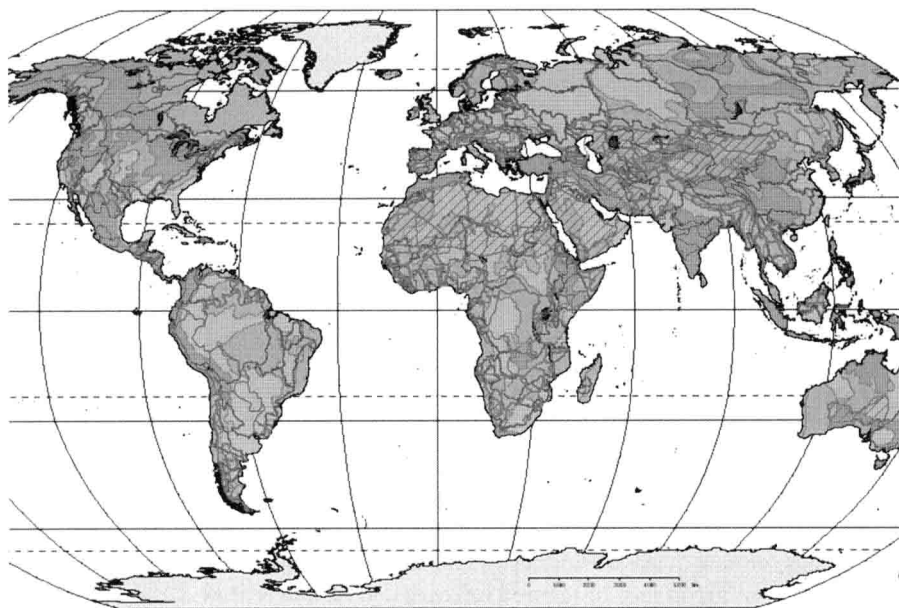
Water is also separated by numerous human-made boundaries such as national borders (Fig. 1.1), vertical administrative systems and so on. When these human created boundaries disrupt natural water circulation, water-related environmental problems can be invoked, and/or it gets very difficult to cope with these issues.

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**Fig. 1.1** Transboundary of groundwater (ISRAM, 2006)

Thus, artificial boundaries in natural water circulation raise important topics that need to be reconsidered, particularly in the social sciences.

In this book, we especially focus on two boundaries; one is that between surface water and groundwater; the other is that between basin water and ocean water. The book consists of four sections on these two boundaries: (1) ignored linkages between surface and subsurface environments, (2) trans-boundary linkages of land and ocean, (3) the impacts of human-made boundaries, and (4) challenges for new management beyond boundaries.

In sections 1 and 2, we consider the importance of interactions between surface water and groundwater, and between land water and ocean water, mainly based on findings from the natural sciences. The RIHN project “Human impacts on the urban subsurface environment (Urban Subsurface Environment (USE) project, PL: Makoto Taniguchi)” shows the importance of interactions between the surface environment and the subsurface environment in terms of water, material and thermal transports. The RIHN project “Human activities in Northeastern Asia and their impact on biological productivity in the North Pacific Ocean (Amur-Okhotsk (AOP) project, PL: Takayuki Shiraiwa)” introduces the new idea of a “giant fish-breeding forest,” which shows the importance of interactions between land and ocean.

In the USE project (Chap. 4), seven Asian cities are investigated to evaluate how deep and fast human impacts have affected the subsurface environment during last 100 years, crossing the boundary between surface and subsurface environments