Transnational Interregional Water Footprint Analysis in China and South Korea and Japan

Taku Ishiro[1]

1. Introduction

The 10th meeting of the Conference of the Parties (COP10) to the Convention on Biological Diversity (CBD) ended in Nagoya, Aichi Prefecture, on Oct. 30.2010. Previously, The Millennium Ecosystem Assessment (MA) concluded concludes that human activity is having a significant and escalating impact on the biodiversity of world ecosystems, reducing both their resilience and biocapacity. Additionally, MA included the sub-global assessment (SGA) that is the assessment of regional, watershed, state as well as the global scale. In Japan SATOYAMA SATOMI SGA is put into practice by using SGA framework. We chose the Hokkaido Tohoku Kanto-Chubu Hokuriku Nishi-nihon cluster as the area of SATOYAMA SATOMI SGA. Above all, Kanto-Chubu cluster has four sites that is Kanagawa Tochigi Chiba Tokyo and the scope of target is Tokyo Bay, Naka River, Ise Bay, Mikawa Bay. The author collaborates with the researcher of Kanagawa site and studies the impact of ecological system through the change of socio-economy of Kanagawa, Ishiro and Hasebe(2010).

Secondly the author expand this research framework into interregional relation about Kanto area, Ishiro(2011). Thirdly to advance further analysis of these, the author, published a paper that analyzed the water inducement relationship between regions in China and Japan, Ishiro(2012).

The Objective of this paper is to clarify the relation between economic activity and structure of water inducement among East Asian countries taking author's research one step further. Especially, having regard to the fact that trade with other country's region is essential to regional activity in recent years , the main purpose is to see how trading of each transnational region between Japan and China region affects the water inducement of each region.

There are previous study, Okadera, Fujita, Watanabe and Suzuki (2005), Shimoda Watanabe Yue , and Fujikawa(2009)that has common awareness of the issues. The former analyze water inducement by the Kanto interregional input output table they made. The latter analyze environmental load including water inducement by Asian international input output table. On the other hand, our study analyzes transnational interregional water inducement by the Transnational Interregional Input-Output Table

[1] Yokohama National University, Graduate School of Social Science,
ishiro-taku@ynu.ac.jp

between China and Japan dividing Kanto region into 11 regions[2]. On the other hand, our study analyzes transnational interregional water inducement by the Transnational Interregional Input-Output Table between Japan and China and South Korea that have 9 regions in China, 6 regions in South Korea, 20 regions in Japan including 11 regions of Kanto.

2. Previous study

There are many studies that analyze the CO_2 emission Land and Waste by using interregional input output tables. As for water, the studies of Niizawa(1988), Okadera, Fujita, Watanabe and Suzuki (2005), Shimoda Watanabe Yue , and Fujikawa(2009) are representative research in Japan. Or there is earlier research of input output study, Carter and Ireli(1970). Niizawa(1988) reveals the balance of water inducement between Chiba and Ibaraki by using regional input output tables. Judging from the result of this analysis he speculates the high water dependency of Tokyo to other region.

In Okadera, Fujita, Watanabe and Suzuki (2005) they target six regions including Tokyo as Tokyo Bay Basin and estimate the structure of water demand of this area by compiling the interregional input output table of six regions. They conclude water demand of Chiba Kanagawa Ibaraki is high compared to the one of Tokyo however water inducement from consumption of Tokyo derives from other region over 50 percent. In Ishiro(2011) we expand the geographical area from seven regions in Okadera, Fujita, Watanabe and Suzuki (2005) to eleven regions and expand the estimation of sectoral water use from Kanagawa in Ishiro and Hasebe(2010) to other regions. We said that Tokyo water inducement in its region by demand of other region is small however water inducement in other region such as Ibaraki and Chiba by demand of Tokyo is large. In Shimoda Watanabe Yue, and Fujikawa(2009), they analyze the embedded water trade with CO_2 energy land by using Asian international input output table made by IDE-JETRO. They concluded the maximum user of water is China, and the maximum transfer of embed water is transfer from China to Japan. Additionally Japan support oneself through domestic water about only 66%, they import largest amount of water from China. In Carter and Ireli(1970) , they calculate water transfer between Arizona and California by using two interregional input-output table between Arizona and California in 1958. They conclude in the actual trade of goods between Arizona and California export from California to Arizona is four times larger than import from Arizona to California, on the other hand in water transfer import from Arizona to California is three times larger than

[2] In this study we compile the transnational interregional Input-Output table based on The 2000 Transnational Interregional Input-Output Table between China and Japan made by IDE and Kanto interregional Input-Output table from Ishiro(2011).

export from California to Arizona.

In this study, we expand the geographical area from Kanto region in Ishiro(2011) to other regions of Japan and China and expand the estimation of sectoral water use from Kanto region in Ishiro (2011) to other regions. In method of analysis we refer to the method of Shimoda Watanabe Yue, and Fujikawa(2009). Additionally we have same problem consciousness that in water transfer considering inter regional economic activity the region have large scale of economic activity depends on other region have water resource in earlier work of Carter and Ireli(1970).

3. Compilation of data

3-1 interregional input-output table (division of Kanto region)

We compile our transnational interregional input-output table between Japan and China based on the transnational interregional input-output table between Japan and China (TIIOT) made by IDE and Kanto interregional input-output table made by Ishiro(2011). Specifically we divide Kanto area of TIIOT into 11 regions by information of Kanto interregional input-output table. The procedure of division is as follows. 1) In intermediate transaction within Kanto area we divide Kanto area by information of Kanto interregional input-output table. 2) In transaction between Kanto and other region of Japan we divide Kanto area from agricultural sector to manufacturing sector by information of census of logistics in Japan. We divide from electricity to services sector by assumption that trading from one region to another region depends on the volume of demand. 3) In transaction between Kanto and foreign country including the Chinese region we divide Kanto area by assumption that trading from one region to another region depends on the volume of demand.

3-2 interregional input-output table (division of South Korea and Taiwan)

We use the information of the Asian International Input-Output Table 2000 in order to isolate Taiwan and South Korea that have been integrated as East Asia in TIOOT, Taiwan and South Korea are already separated. We aggregate the sector of Asian international input-output table into the 10 sector in accordance with TIOOT, and calculate a transaction of Taiwan and South Korea in domestic level and calculate a trading from South Korea and Taiwan with ASEAN, China, Japan, the U.S.A. As a result we could divide each column and row into South Korea and Taiwan in TIIOT. However, since Japan is divided into 18 regions and China divided into seven regions in TIIOT, it is necessary to determine the input-output ratio of each region of Japan South Korea, Taiwan and China during TIOOT. In this paper, we use the value of production in the domestic share of each region, we estimated the Transaction with each region of Japan South Korea, Taiwan China.

3-3 interregional input-output table (division of the region of South Korea)

In the previous section, we were separated Korea and Taiwan of TIIOT. However in this section, we are divided South Korea into six regions. For transactions in South Korea, use the information of Korea inter-regional input-output tables of 2003, was carried out by dividing. However, since we did not have sufficient information of transaction of six regions in Korea to other countries and regions, we used a production value share of the partner countries and regions as well as in the previous section.

We have estimated Transnational Interregional Input-Output Table in China and South Korea and Japan in the above procedure.

3-3 water use

Firstly we estimate the sectoral water use data in Japanese region by the same method as Ishiro(2011) that it estimate the data from cultivated acreage, water use of manufacturing and unit water use data from Tsurumaki and Noike(1997). Secondly we estimate water use data in Chinese region from the data of Water Resources Bulletin of China by province. Thirdly we estimate water use of South Korea by region. We estimated water use of agriculture by region by water usage, cultivated acreage. We also estimated the water use in manufacturing from census of manufacturing. As for other sector we use the data from Statistical Yearbook for Asia and the Pacific 2007 by United Nations ESCAP. Fourthly we drive the water use data of other country from Statistical Yearbook for Asia and the Pacific 2007 by United Nations ESCAP and The World's Water 2008-2009 Data by Pacific institute[3].

Figure1 Table type of Interregional Input-Output Table (intermediate Part)

				Intermediate sector																																	
				ASEAN5	China							Taiwan	Korea						Japan																		U.S.A
					Dongbei	Huabei	Huadong	Huanan	Huazhong	Xibei	Xinan		Sudogwon	Gangwong	Chungcheon	Jeolla	Gyeongbuk	Gyeongnam	Hokkaido	Tohoku	Kanto											Chubu	Kinki	Chugoku	Shikoku	Kyushu	
																					Tokyo	Kanagwa	Chiba	Saitama	Ibaraki	Tochigi	Gunma	Niigata	Nagano	Yamanashi	Shizoka						
Intermediate sector	ASEAN5																																				
	China	Dongbei																																			
		Huabei																																			
		Huadong																																			
		Huanan																																			
		Huazhong																																			
		Xibei																																			
		Xinan																																			
	Taiwan																																				
	Korea	Sudogwon																																			
		Gangwong																																			
		Chungcheon																																			
		Jeolla																																			
		Gyeongbuk																																			
		Gyeongnam																																			
	Japan	Hokkaido																																			
		Tohoku																																			
		Kanto	Tokyo																																		
			Kanagwa																																		
			Chiba																																		
			Saitama																																		
			Ibaraki																																		
			Tochigi																																		
			Gunma																																		
			Niigata																																		
			Nagano																																		
			Yamanashi																																		
			Shizoka																																		
		Chubu																																			
		Kinki																																			
		Chugoku																																			
		Shikoku																																			
		Kyushu																																			
	U.S.A																																				
International Freight and Insurance																																					
Import From ROW																																					
Duties and Import Tax																																					
Value Added																																					
Total Input																																					

[3] In this paper we are not able to collect the water use data of Taiwan. Therefore we use the unit water use of Korea for Korea and Taiwan sector.

Figure1 Table type of Interregional Input-Output Table (Final demand Part)

			Final Demand																																		Export to ROW	Discrepancies	Total Output
			ASEAN5	China							Taiwan	Korea						Japan																	U.S.A			
				Dongbei	Huabei	Huadong	Huanan	Huazhong	Xibei	Xinan		Sudogwon	Gangwong	Chungche	Jeolla	Gyeongbuk	Gyeongnam	Hokkaido	Tohoku	Kanto											Chubu	Kinki	Chugoku	Shikoku	Kyushu				
																				Tokyo	Kanagwa	Chiba	Saitama	Ibaraki	Tochigi	Gunma	Niigata	Nagano	Yamanashi	Shizuoka									
ASEAN5																																							
China	Dongbei																																						
	Huabei																																						
	Huadong																																						
	Huanan																																						
	Huazhong																																						
	Xibei																																						
	Xinan																																						
Taiwan																																							
Korea	Sudogwon																																						
	Gangwong																																						
	Chungcheon																																						
	Jeolla																																						
	Gyeongbuk																																						
	Gyeongnam																																						
Japan	Hokkaido																																						
	Tohoku																																						
	Kanto	Tokyo																																					
		Kanagwa																																					
		Chiba																																					
		Saitama																																					
		Ibaraki																																					
		Tochigi																																					
		Gunma																																					
		Niigata																																					
		Nagano																																					
		Yamanashi																																					
		Shizuoka																																					
	Chubu																																						
	Kinki																																						
	Chugoku																																						
	Shikoku																																						
	Kyushu																																						
U.S.A																																							
International Freight and Insurance																																							
Import From ROW																																							
Duties and Import Tax																																							

Figure 2 Classification of regions in China

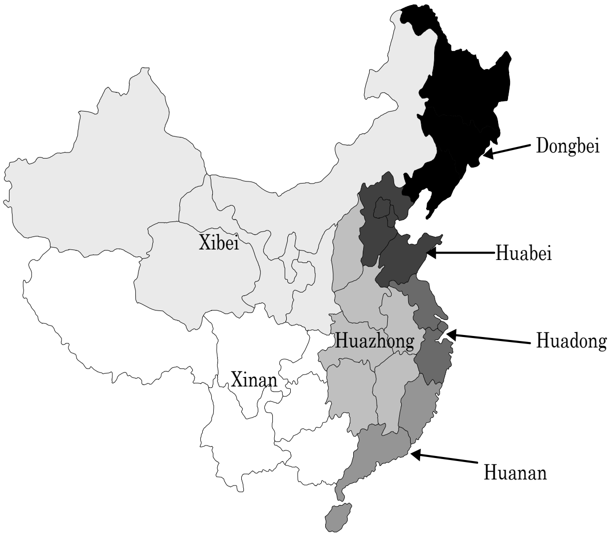


Figure3 Classification of regions in South Korea

Figure 4 Classification of regions in Japan

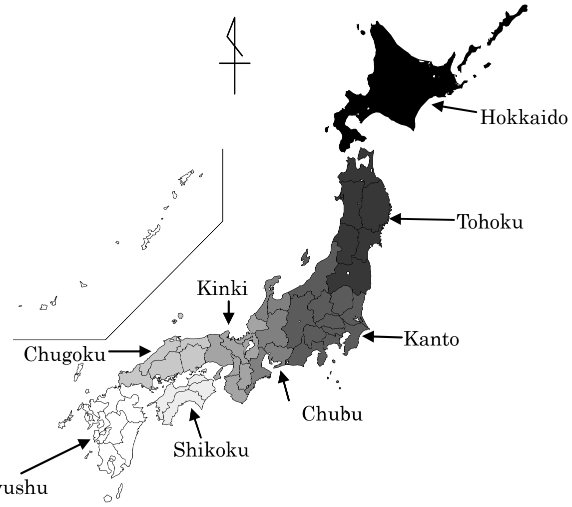


Figure 5 Classification of regions in Kanto

Figure 6 Regional classification

Asean5		Indonesia	Malaysia	the Philippines	Singapore	Thailand			
China	**Dongbei**	Liaoning	Jilin	Heilongjiang					
	Huabei	Beijing	Tianjin	Hebei	Shandong				
	Huadong	Shanghai	Jiangsu	Zhejiang					
	Huanan	Fujian	Guangdong	Hainan					
	Huazhong	Shanxi	Anhui	Jiangxi	Henan	Hubei	Hunan		
	Xibei	Inner Mongolia	Shaanxi	Gansu	Qinghai	Ningxia	Xinjiang		
	Xinan	Guangxi	Chongqing	Sichuan	Guizhou	Yunnan	Tibet		
Taiwan									
Korea	**Sudogwon**	Seoul-teukbyeolsi	Gyeonggi-do	Incheon-gwangyeoksi					
	Gangwong	Gangwon-do							
	Chungcheon	Chungcheongnam-do	Chungcheongbuk-d	Daejeon-gwangyeoksi					
	Jeolla	Jeollabuk-do	Jeollanam-do	Gwangju-gwangyeoksi					
	Gyeongbuk	Gyeongsangbuk-do	Daegu-gwangyeoksi						
	Gyeongnam	Gyeongsangnam-do	Busan-gwangyeoks	Ulsan-gwangyeoksi					
Japan	**Hokkaido**	Hokkaido							
	Tohoku	Aomori	Iwate	Miyagi	Akita	Yamagata	Fukushima		
	Kanto	Tokyo	Kanagawa	Chiba	Saitama	Ibaraki	Tochigi	Gunma	Niigata
		Nagano	Yamanashi	Shizuoka					
	Chubu	Toyama	Ishikawa	Gifu	Aichi	Mie			
	Kinki	Fukui	Shiga	Kyoto	Osaka	Hyogo	Nara	Wakayama	
	Chugoku	Tottori	Shimane	Okayama	Hiroshima	Yamaguchi			
	Shikoku	Kagawa	Ehime	Kochi	Tokushima				
	Kyushu	Fukuoka	Saga	Nagasaki	Kumamoto	Oita	Miyazaki	Kagoshima	Okinawa
U.S.A		the United States							

Figure 7 Sector classification

1	Agriculture, livestock, forestry and fishery
2	Mining and quarrying
3	Household consumption products(Life-related manufacturing products)
4	Basic industrial materials(Primary makers' manufacturing products)
5	Processing and assembling(Secondary makers' manufacturing products)
6	Electricity, gas and w ater supply
7	Construction
8	Trade
9	Transportation
10	Services

4. The models

We use basically the same model of the one of Ishiro (2011) refer to the model of Shimoda Watanabe Yue, and Fujikawa(2009).

We indicate the model of simplified version about two endogenous regions and one exogenous region. The equation (1) denote as follows.

$$\begin{bmatrix} \mathbf{x}_1 \\ \mathbf{x}_2 \end{bmatrix} = \begin{bmatrix} \mathbf{A}_{11} & \mathbf{A}_{12} \\ \mathbf{A}_{21} & \mathbf{A}_{22} \end{bmatrix} \begin{bmatrix} \mathbf{x}_1 \\ \mathbf{x}_2 \end{bmatrix} + \begin{bmatrix} \mathbf{f}_{11} + \mathbf{f}_{12} + \mathbf{f}_{13} \\ \mathbf{f}_{21} + \mathbf{f}_{22} + \mathbf{f}_{23} \end{bmatrix} \tag{1}$$

$\mathbf{x}_i$ denotes domestic products of i regions, $\mathbf{A}_{ij}$ denotes input coefficient if $i=j$ it represents intermediate goods within this region, if $i \neq j$ input coefficient of import intermediate goods from i region to j region. $\mathbf{f}_{ij}$ denotes final demand of j region about the goods of i region. $\mathbf{f}_{i3}$denotes the export to exogenous region. $\mathbf{I}$ denotes unit matrix.

If we development equation (1), we get equation (2) as follows.

$$\begin{bmatrix} \mathbf{x}_1 \\ \mathbf{x}_2 \end{bmatrix} = \left[\mathbf{I} - \begin{bmatrix} \mathbf{A}_{11} & \mathbf{A}_{12} \\ \mathbf{A}_{21} & \mathbf{A}_{22} \end{bmatrix} \right]^{-1} \begin{bmatrix} \mathbf{f}_{11} + \mathbf{f}_{12} + \mathbf{f}_{13} \\ \mathbf{f}_{21} + \mathbf{f}_{22} + \mathbf{f}_{23} \end{bmatrix} = \begin{bmatrix} \mathbf{B}_{11} & \mathbf{B}_{12} \\ \mathbf{B}_{21} & \mathbf{B}_{22} \end{bmatrix} \begin{bmatrix} \mathbf{f}_{11} + \mathbf{f}_{12} + \mathbf{f}_{13} \\ \mathbf{f}_{21} + \mathbf{f}_{22} + \mathbf{f}_{23} \end{bmatrix} \tag{2}$$

If $\mathbf{w}_i$ denotes unit of water use of i region, $\mathbf{h}_i$ represents water intensity equation (3) as follows.

$$\begin{bmatrix} \mathbf{h}_1 & \mathbf{h}_2 \end{bmatrix} = \begin{bmatrix} \mathbf{w}_1 & \mathbf{w}_2 \end{bmatrix} \begin{bmatrix} \mathbf{B}_{11} & \mathbf{B}_{12} \\ \mathbf{B}_{21} & \mathbf{B}_{22} \end{bmatrix} \tag{3}$$

About water inducement in each region, we divide the final demand of equation (2) into region 1 region 2 and region3 and if $\mathbf{W}_i$ denotes diagonal matrix of $\mathbf{w}_i$, we get equation (4) as follows.

$$\mathbf{L} = \begin{bmatrix} \mathbf{W}_1 & 0 \\ 0 & \mathbf{W}_2 \end{bmatrix} \begin{bmatrix} \mathbf{B}_{11} & \mathbf{B}_{12} \\ \mathbf{B}_{21} & \mathbf{B}_{22} \end{bmatrix} \begin{bmatrix} \mathbf{f}_{11} & \mathbf{f}_{12} & \mathbf{f}_{13} \\ \mathbf{f}_{21} & \mathbf{f}_{22} & \mathbf{f}_{23} \end{bmatrix} \tag{4}$$

$\mathbf{L}$ denotes two by three matrixes. The column side of the matrix means the region that generates final demand. The Row side of the matrix means the region that is done by water inducement. In the analysis of this thesis there are 34 endogenous regions and 1 exogenous regions including rest of the world therefore $\mathbf{L}$ denotes 34 by 35 matrixes.

5. The results

In this chapter we summarize the analysis of water footprint of in Japan and China and South Korea. **Figure** 8 shows the result of calculation based on equation (4). Grey cells shows the diagonal factor that represents water inducement of its own demand in its own region. Furthermore in the row direction **Figure** 8 shows the water inducement that occurs in the other regions based on demand in its region in the column direction water inducement that occurs in its region based on demand in other regions. For convenience of reference we aggregate the Kanto 11 region in **Figure 8.** Additionally we shows **Figure 8** that is the disaggregated version of figure

First of all we focus on Chinese part. In Huazhong there are 12 billion cubic meter of water inducement in its region out of water demand in its region. Additionally in Xinan there are also large amount of water inducement in its region out of water demand in its region. However the water inducement in other region of China and Japan by water demand of Huazhong or Xinan is comparatively small. On the other hand in Huadong and Huanan water demand of these regions cause comparatively large water inducement in other region like Huazhong and moreover certain amount of water inducement in Japanese region like Kanto and Kinki. For that reason Huadong and Huanan have large dependency on water resources of other region such as Huazhong and have a few dependencies on water resources of other country compared to other Chinese region. Moreover the water demand of Huanan caused large water inducement compared to Huadong in the region of South Korea like Jeolla and Chungcheon that is agricultural region. For that reason Huanan have large dependency in water resources of the region of South Korea compared to Huadong.

Secondly we focus on South Korean part. The water demand of Sudogwon caused large water inducement in Chungcheon and Jeolla. As a whole there is a same tendency in other region of South Korea. For that reason South Korea has large dependency on water resources of Jeolla and Chungcheon that is an agricultural region in South Korea. There is a exceptional cases in Gyeonbuk and Gyeonan. These two regions have strong water dependency each other compared to other region in South Korea. As for the foreign countries there is a large water inducement in Huabei and Huadong in China by the demand of regions of South Korea. Additionally there is some water inducement in Kanto by the demand of Sudogwon. As for the relation of water inducement between China and South Korea each region of South Korea unilaterally depends on water resources of each region of China.

Thirdly we focus on Japanese part. The water demand of Kanto caused large water inducement in other region like Tohoku Hokkaido Chubu and even Huadong and Jeolla and Chungcheon. Additionally the water inducement in the U.S.A by the demand of Kanto is largest amount compared to other region. Though it is not as large as Kanto, Kinki denotes the same tendency of Kanto. As a whole Kanto and Kinki have large dependency on water resources of rest of Japan and regions of other countries. On the other hand Tohoku assume the water demand of Kanto and Kinki. However water inducement in Kanto by demand of Kinki and Chubu have some level. For that reason it is not the case that Kanto unilaterally depend on water resources of other region. As for the relation of water inducement between Japan and China each region of Japan unilaterally depends on water resources of each region of China. As for the relation of water inducement between South Korea and Japan there is a bilaterally dependency on water resources of each regions of countries.

Fourthly we focus on Kanto part in **Figure 9**. In water inducement within Kanto region the result is the same as Ishiro(2011) that analyze water footprint within Kanto region by using Kanto interregional input-output table. In the next place we focus attention on the relation between Kanto and other region. It is found that the water inducement of Tohoku by demand of Kanto is attributed to the demand of Tokyo Kanagawa Saitama Chiba. Furthermore the water inducement of Huadong in China by demand of Kanto is similarly attributed to the demand of Tokyo Kanagawa Saitama Chiba. Additionally the water inducement of the Jeolla by demand of Kanto is mainly attributed to the demand of Tokyo and Kanagawa. The water inducement of Kanto by demand of other Japanese region such as Kinki and Chubu is attributed to the water inducement of Niigata.

We plot the information of **Figure 8 and Figure 9** on geographical information for the sake of understandable way. **Figure 10** shows the water inducement by demand of Tokyo in each region of Japan and China and South Korea. **Figure 11** shows the water inducement by demand of Kanagawa in each region of Japan and China and South Korea. **Figure 12** shows the water inducement by demand of Huadong in each region of Japan and China and South Korea. **Figure 13** shows the water inducement by demand of Huabei in each region of Japan and China and South Korea. **Figure 14** shows the water inducement by demand of Huanan in each region of Japan and China and South Korea. **Figure 15** shows the water inducement by demand of Sudogwon in each region of Japan and China and South Korea. **Figure 16** shows the water inducement by demand of Gyeongnam in each region of Japan and China and South Korea. We can see the water inducement in each region by the demand of the region that is noted on the map including its own region.

Figure 10 Water Inducement by demand of Tokyo in Japan and China and South Korea

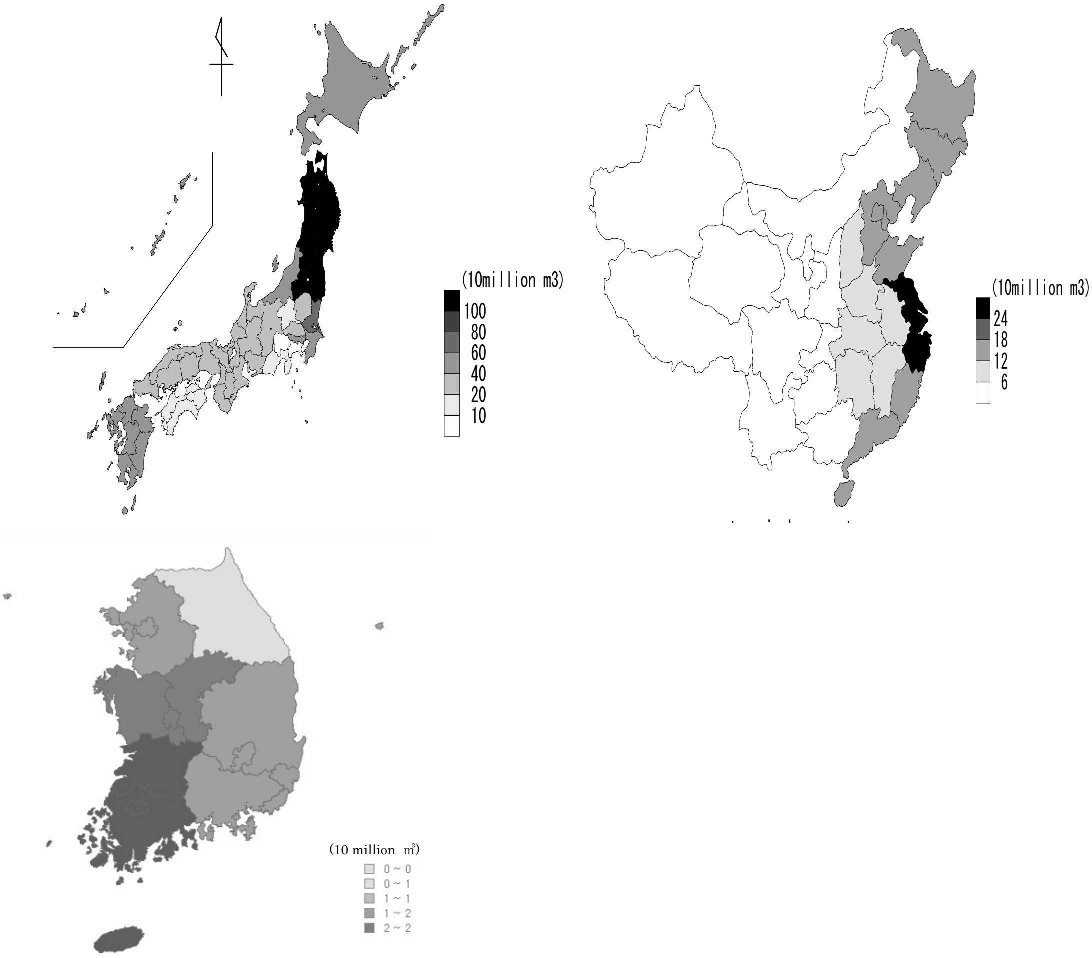


Figure 11 Water Inducement by demand of Kanagawa in Japan and China and South Korea

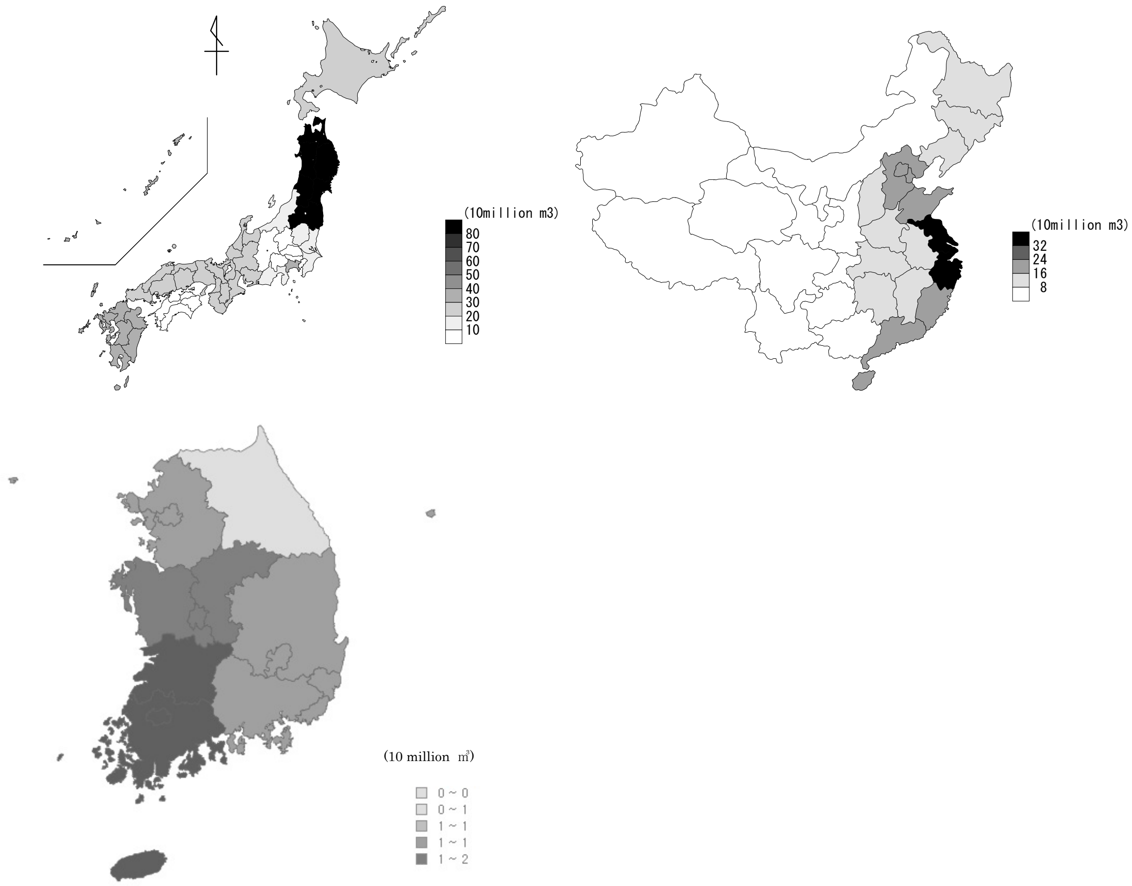
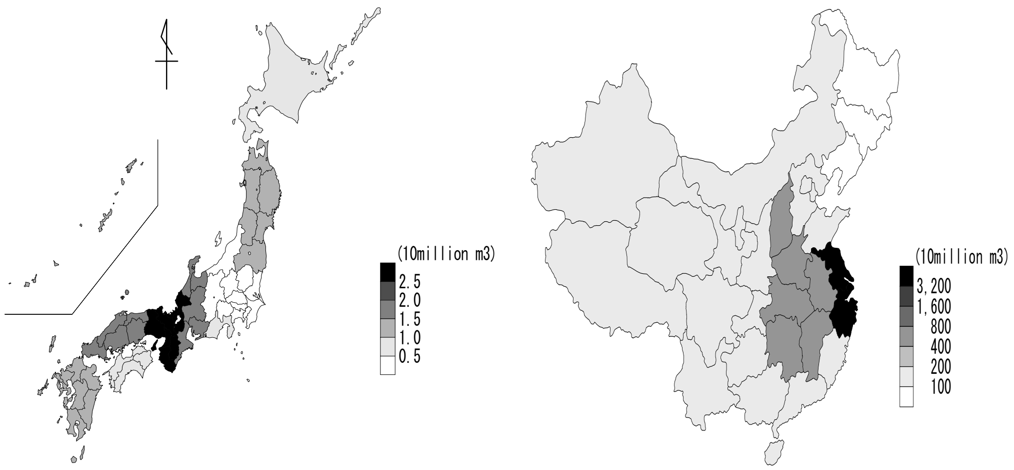


Figure 12 Water Inducement by demand of Huadong in Japan and China and South Korea



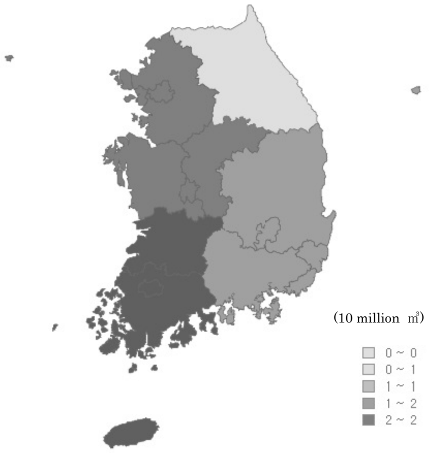


Figure 13 Water Inducement by demand of Huanan in Japan and China and South Korea

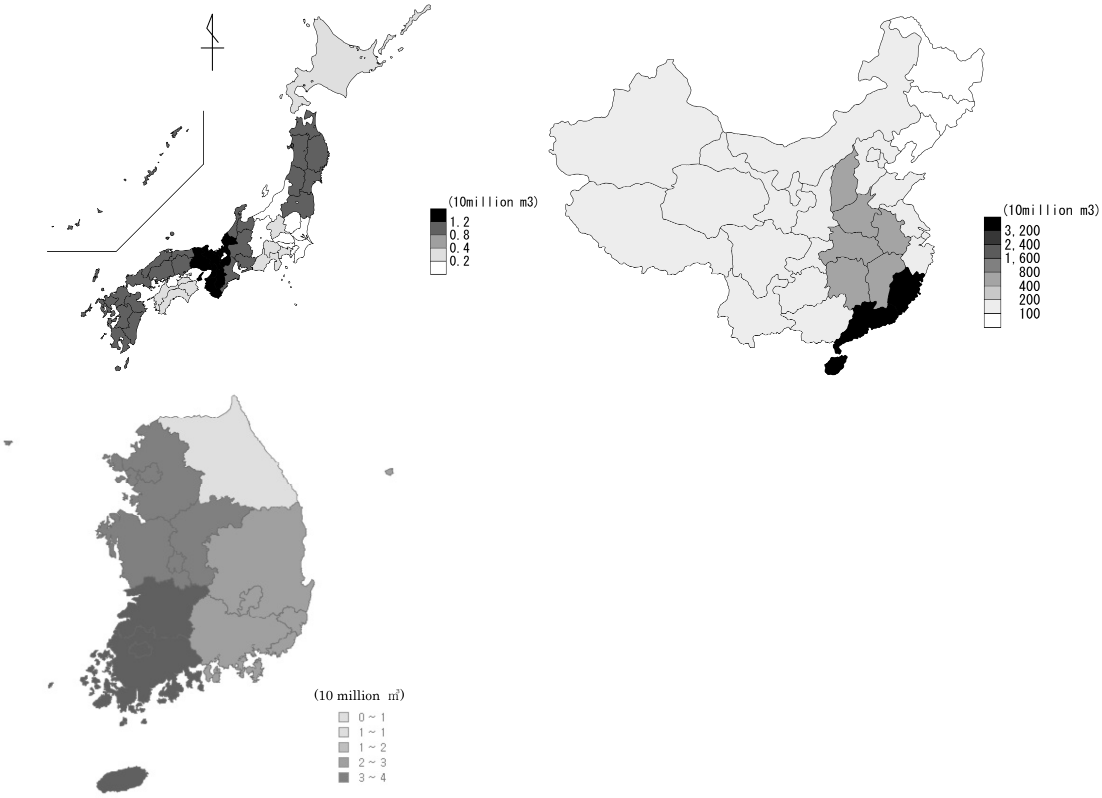


Figure 14　Water Inducement by demand of Huabei in Japan and China and South Korea

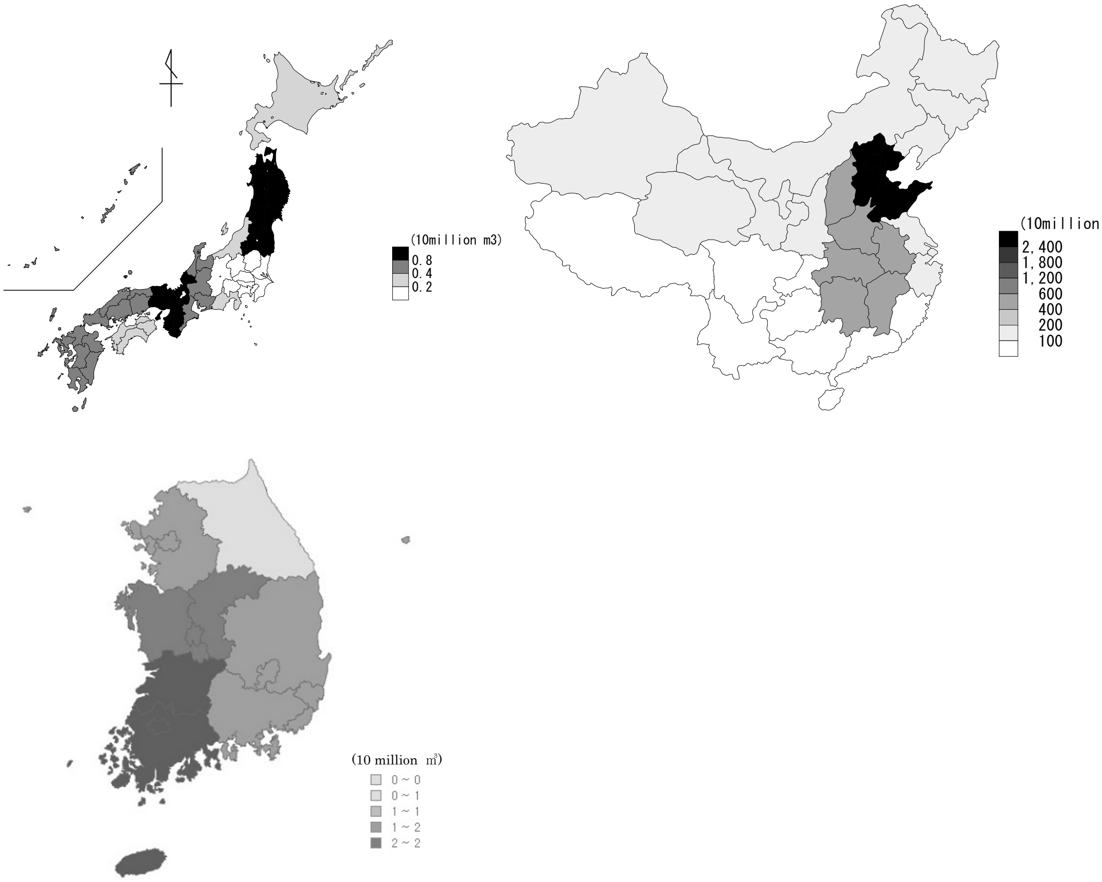
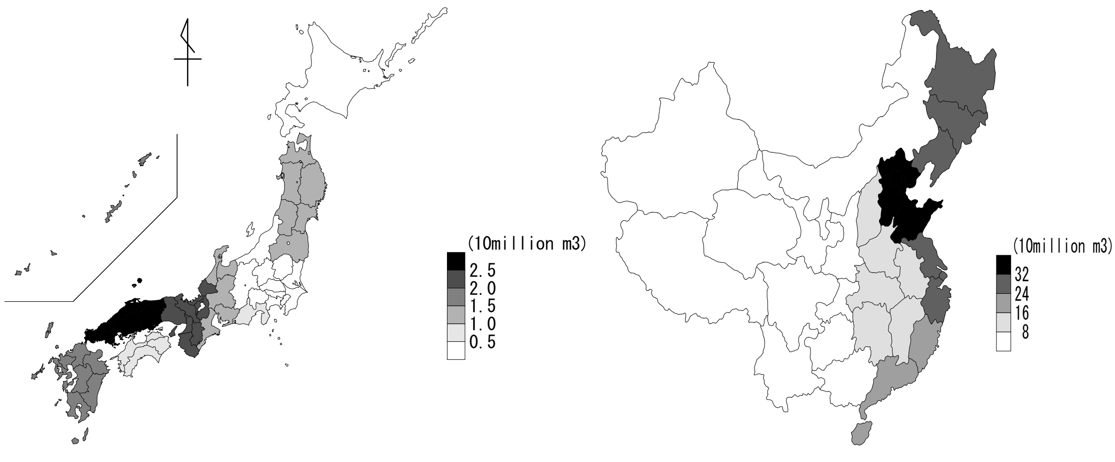


Figure 15 Water Inducement by demand of Sudogwon in Japan and China and South Korea



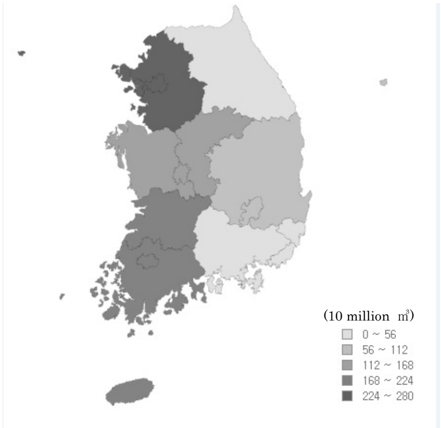
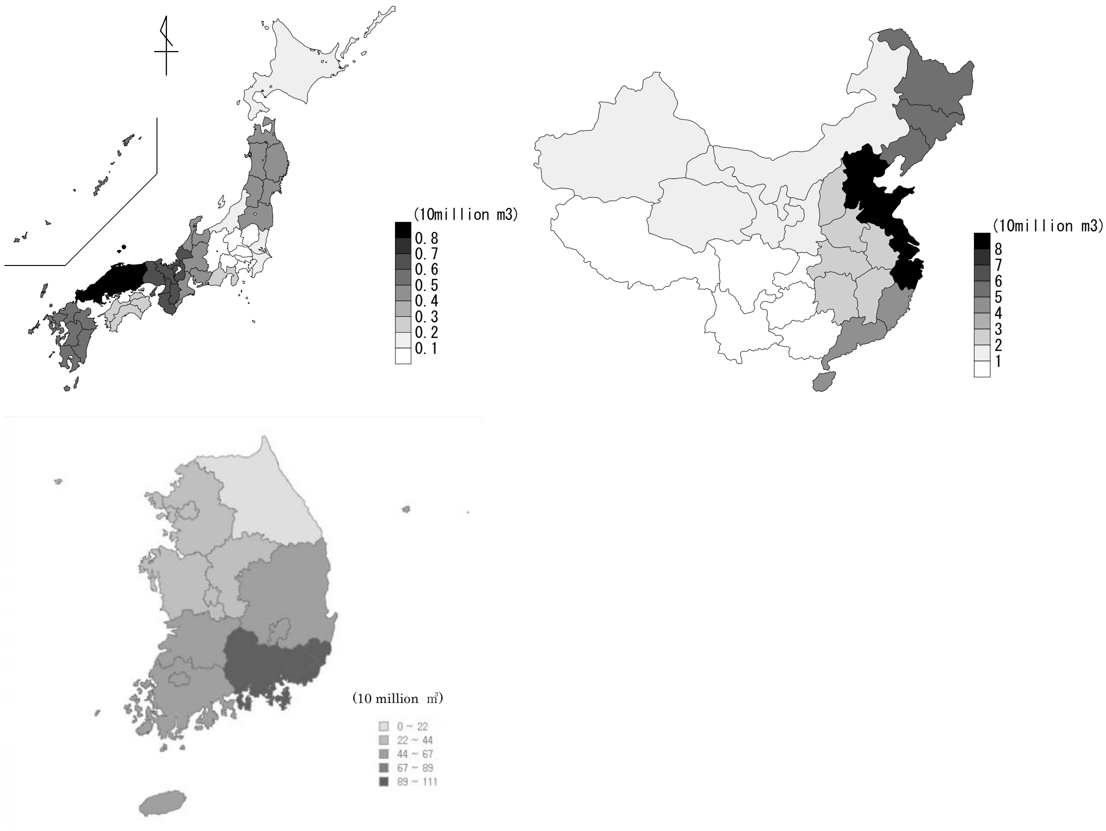


Figure 16 Water Inducement by demand of Gyeongnam in Japan and China and South Korea



6. Conclusion

In this study after we made Transnational Interregional input-output table that Kanto region is divided into 11 regions in China and South Korea and Japan and made the sectoral water usage data in accordance with such input output table we analyze the transnational interregional water inducement in China and South Korea and Japan. The result of this study is as follows.

In China Huazhong have large water inducement mainly by demand of Huadong and Huanan. For that reason Huazhong assume the water demand of Huadong and Huanan. Additionally water demand of these regions causes comparatively large water inducement in other region like Huazhong and moreover certain amount of water inducement in Japanese region like Kanto and Kinki and in South Korean region like Jeolla and Chungcheon.

In Japan the water demand of Kanto caused large water inducement in other region like Tohoku Hokkaido Chubu and even Huadong and Jeolla and Chungcheon. Secondly Tohoku assume the water demand of other Japanese region. As for the relation of water inducement between Japan and China each region of Japan unilaterally depends on water resources of each region of China. As for the relation of water inducement between South Korea and Japan there is a bilaterally dependency on water resources of each regions of countries.

In Kanto region the water inducement of Tohoku by demand of Kanto is attributed to the demand of Tokyo Kanagawa Saitama Chiba. Furthermore the water inducement of Huadong in China by demand of Kanto is similarly attributed to the demand of Tokyo Kanagawa Saitama Chiba. Additionally the water inducement of Jeolla in South Korea by the demand of Kanto is attributed to the demand of Tokyo and Kanagwa.

This study shows the transnational interregional water footprint relation in China and South Korea and Japan. These results request that considering the whole water resources in China and South Korea and Japan, the region that gives other regions the burden of water use should work on conservation and maintenance of water environment in the region that receives the burden of water use by more transnational interregional aspects.

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Figure 8　Water Inducement of each regions and countries (Kanto aggregated)

unit:100million ㎥

	ASEAN	C.Dongbei	C.Huabei	C.Huadong	C.Huanan	C.Huazhong	C.Xibei	C.Xinan	Taiwan	K.Sudogwon	K.Gangwon	K.Chungch	K.Jeolla	K.Gyeongbu	K.Gyeongna	Hokkaido	Tohoku	Kanto	Chubu	Kinki	Chugoku	Shikoku	Kyushu	USA	ROW	Total
ASEAN	2163.9	1.9	6.4	9.2	12.2	1.8	0.9	1.4	23.8	12.3	0.6	1.7	2.0	1.6	3.6	3.9	5.3	70.9	17.8	32.0	6.1	4.0	15.0	236.8	571.7	3206.4
C.Dongbei	2.2	389.5	10.3	6.4	3.2	7.0	4.4	3.0	0.9	2.4	0.1	0.3	0.3	0.3	0.6	0.3	0.4	8.3	2.4	5.8	0.8	0.3	1.9	8.6	26.4	486.4
C.Huabei	5.1	16.3	286.6	18.7	11.4	25.4	9.1	8.0	1.4	3.5	0.1	0.5	0.5	0.5	0.9	0.4	0.4	9.9	3.0	7.1	1.0	0.3	2.3	19.7	48.3	480.5
C.Huadong	5.0	11.1	16.4	384.4	19.7	29.5	7.5	10.1	1.7	3.2	0.1	0.4	0.5	0.4	0.8	0.6	0.6	17.4	5.3	12.2	1.6	0.5	3.3	40.8	99.3	672.4
C.Huanan	7.0	6.8	6.9	15.5	399.5	16.4	5.2	12.9	1.3	1.9	0.1	0.2	0.3	0.2	0.5	0.3	0.4	9.0	2.6	6.1	0.8	0.3	1.9	62.3	137.2	695.5
C.Huazhong	2.2	32.3	49.6	75.7	66.0	1280.1	35.4	47.9	0.8	1.1	0.0	0.1	0.1	0.1	0.3	0.2	0.2	5.4	1.6	3.6	0.5	0.2	1.0	20.2	52.1	1676.8
C.Xibei	0.9	12.5	17.6	11.6	11.1	26.7	550.8	18.1	0.3	0.5	0.0	0.1	0.1	0.1	0.1	0.1	0.1	2.1	0.6	1.4	0.2	0.1	0.4	4.8	18.5	678.5
C.Xinan	0.9	4.7	5.7	10.1	18.8	17.8	8.8	716.1	0.2	0.3	0.0	0.0	0.0	0.0	0.1	0.0	0.1	1.2	0.3	0.8	0.1	0.0	0.2	5.6	17.8	809.7
Taiwan	1.0	0.1	0.3	0.4	0.6	0.1	0.0	0.1	41.9	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.9	0.2	0.4	0.2	0.0	0.2	4.2	12.0	63.0
K.Sudogwon	0.3	0.1	0.1	0.2	0.2	0.0	0.0	0.0	0.2	27.9	0.6	1.6	1.6	1.3	2.4	0.0	0.0	0.5	0.1	0.2	0.2	0.0	0.1	1.9	6.6	46.4
K.Gangwong	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2	2.4	0.3	0.2	0.3	0.4	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.3	1.0	9.7
K.Chungcheor	0.3	0.1	0.1	0.1	0.3	0.0	0.0	0.0	0.2	13.6	0.6	9.2	1.9	1.6	2.4	0.0	0.0	0.7	0.2	0.3	0.2	0.0	0.2	1.8	5.5	39.5
K.Jeolla	0.5	0.1	0.2	0.2	0.4	0.1	0.0	0.0	0.2	17.2	0.7	3.4	16.4	2.9	5.2	0.0	0.0	1.0	0.2	0.4	0.3	0.0	0.3	2.4	7.6	59.9
K.Gyeongbuk	0.3	0.1	0.1	0.1	0.2	0.0	0.0	0.0	0.1	6.4	0.4	1.1	1.1	8.9	4.7	0.0	0.0	0.5	0.1	0.2	0.2	0.0	0.1	1.5	4.5	30.9
K.Gyeongnam	0.2	0.0	0.1	0.1	0.2	0.0	0.0	0.0	0.1	4.4	0.3	0.9	1.1	2.0	11.1	0.0	0.0	0.4	0.1	0.2	0.1	0.0	0.1	1.3	3.9	26.8
Hokkaido	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	38.2	3.3	19.9	3.8	6.1	1.5	0.7	3.1	0.5	1.1	78.8
Tohoku	0.4	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.3	0.1	0.0	0.0	0.0	0.0	0.0	6.5	61.0	57.8	8.3	14.7	3.4	2.1	5.7	1.5	4.6	166.8
Kanto	1.0	0.1	0.1	0.3	0.2	0.1	0.0	0.0	0.6	0.3	0.0	0.0	0.0	0.0	0.1	4.8	10.5	126.9	13.1	14.4	16.9	9.3	7.8	7.0	13.2	226.8
Chubu	0.5	0.1	0.1	0.2	0.1	0.0	0.0	0.0	0.3	0.1	0.0	0.0	0.0	0.0	0.0	1.8	2.5	19.5	39.6	10.5	2.2	1.5	3.9	2.5	5.0	90.5
Kinki	0.7	0.1	0.1	0.3	0.1	0.0	0.0	0.0	0.4	0.2	0.0	0.0	0.0	0.0	0.1	1.5	2.5	13.0	6.2	63.4	3.3	2.1	3.9	2.2	4.0	104.2
Chugoku	0.4	0.1	0.1	0.2	0.1	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.0	0.0	0.1	1.1	1.9	12.1	3.1	8.3	26.6	2.7	6.7	1.1	3.8	69.1
Shikoku	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.5	1.1	5.7	2.6	5.6	2.9	10.6	1.9	0.4	1.9	33.6
Kyushu	0.4	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.3	0.2	0.0	0.0	0.0	0.0	0.1	1.3	2.3	17.2	3.7	11.9	6.0	1.5	54.8	1.4	4.0	105.4
USA	22.2	2.0	5.3	5.6	4.1	1.1	0.5	0.8	20.7	11.3	0.4	1.4	1.6	1.1	3.3	4.4	5.0	52.3	9.7	19.7	4.7	1.8	9.4	3961.9	625.2	4775.6
Total	2215.7	478.1	406.4	539.6	548.8	1406.3	622.8	818.6	96.0	111.6	6.6	21.6	27.8	21.5	36.7	66.3	98.0	452.6	124.5	225.6	79.7	38.4	124.3	4390.8	1675.0	

Figure 9 Water Inducement of each regions and countries (Kanto disaggregated)

unit:100million m^3

				Kanto																			
		Hokkaido	Tohoku	Tokyo	Kanagawa	Chiba	Saitama	Ibaraki	Tochigi	Gunnma	Niigata	Nagano	Yamanashi	Shizuoka	Chubu	Kinki	Chugoku	Shikoku	Kyushu	USA	Row	Total	
	ASEAN	3.9	5.3	15.5	12.5	8.6	10.3	5.0	4.1	3.6	3.3	2.9	1.1	4.0	17.8	32.0	6.1	4.0	15.0	236.8	571.7	3,206.4	ASEAN
	C.Dongbei	0.3	0.4	1.5	1.6	1.1	1.2	0.6	0.6	0.5	0.4	0.3	0.1	0.4	2.4	5.8	0.8	0.3	1.9	8.6	26.4	486.4	C.Dongbei
	C.Huabei	0.4	0.4	1.8	1.9	1.3	1.5	0.7	0.7	0.6	0.5	0.4	0.2	0.5	3.0	7.1	1.0	0.3	2.3	19.7	48.3	480.5	C.Huabei
	C.Huadong	0.6	0.6	2.9	3.4	2.2	2.5	1.2	1.3	1.1	0.9	0.8	0.3	0.8	5.3	12.2	1.6	0.5	3.3	40.8	99.3	672.4	C.Huadong
	C.Huanan	0.3	0.4	1.6	1.7	1.1	1.2	0.6	0.8	0.6	0.4	0.4	0.1	0.4	2.6	6.1	0.8	0.3	1.9	62.3	137.2	695.5	C.Huanan
	C.Huazhong	0.2	0.2	0.9	1.1	0.7	0.8	0.4	0.4	0.4	0.3	0.2	0.1	0.2	1.6	3.6	0.5	0.2	1.0	20.2	52.1	1,676.8	C.Huazhong
	C.Xibei	0.1	0.1	0.3	0.4	0.3	0.3	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.6	1.4	0.2	0.1	0.4	4.8	18.5	678.5	C.Xibei
	C.Xinan	0.0	0.1	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.3	0.8	0.1	0.0	0.2	5.6	17.8	809.7	C.Xinan
	Taiwan	0.0	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.2	0.4	0.2	0.0	0.2	4.2	12.0	63.0	Taiwan
	K.Sudogwon	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.0	0.1	1.9	6.6	46.4	K.Sudogwon
	K.Gangwong	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.3	1.0	9.7	K.Gangwong
	K.Chungcheon	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.3	0.2	0.0	0.2	1.8	5.5	39.5	K.Chungcheon
	K.Jeolla	0.0	0.0	0.2	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.2	0.4	0.3	0.0	0.3	2.4	7.6	59.9	K.Jeolla
	K.Gyeongbuk	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.0	0.1	1.5	4.5	30.9	K.Gyeongbuk
	K.Gyeongnam	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.1	0.0	0.1	1.3	3.9	26.8	K.Gyeongnam
	Hokkaido	38.2	3.3	5.5	2.6	2.6	3.1	1.5	0.7	1.3	0.7	0.5	0.5	1.0	3.8	6.1	1.5	0.7	3.1	0.5	1.1	78.8	Hokkaido
	Tohoku	6.5	61.0	11.9	8.6	6.2	9.7	5.1	3.4	3.0	4.2	1.8	0.6	3.1	8.3	14.7	3.4	2.1	5.7	1.5	4.6	166.8	Tohoku
	Tokyo	0.2	0.4	5.5	0.5	0.3	0.7	0.2	0.1	0.1	0.1	0.1	0.0	0.1	0.5	0.6	0.2	0.1	0.4	0.2	0.5	11.3	Tokyo
	Kanagawa	0.3	0.4	0.2	3.2	0.5	0.3	0.1	0.1	0.1	0.1	0.1	0.0	0.2	0.4	0.5	0.2	0.1	0.3	0.3	0.4	8.0	Kanagawa
	Chiba	0.6	1.3	4.3	1.4	6.7	1.2	1.4	0.3	0.4	0.3	0.2	0.1	0.3	1.1	1.5	0.4	0.2	0.8	0.4	0.7	23.9	Chiba
	Saitama	0.3	0.5	3.0	0.8	0.9	5.2	0.5	0.2	0.5	0.1	0.1	0.0	0.1	0.6	0.8	0.2	0.2	0.4	0.2	0.3	15.1	Saitama
	Ibaraki	0.6	1.8	6.9	1.5	2.2	1.5	4.6	0.8	0.8	0.2	0.2	0.1	0.4	1.3	1.8	0.5	0.2	1.4	0.4	0.6	27.8	Ibaraki
kanto	Tochigi	0.6	1.2	3.3	1.5	1.0	3.0	0.8	4.8	1.8	0.6	0.3	0.1	0.3	1.2	1.7	0.4	0.2	1.0	0.4	0.4	24.7	Tochigi
	Gunnma	0.2	0.4	1.1	0.5	0.4	0.7	0.5	0.3	2.2	0.1	0.1	0.0	0.1	0.6	1.4	0.2	0.1	0.3	0.2	0.3	9.9	Gunnma
	Niigata	1.1	3.1	4.4	1.4	0.9	2.2	0.6	0.8	0.7	11.1	1.5	0.1	0.3	2.4	3.0	0.6	0.4	1.2	0.5	0.8	37.5	Niigata
	Nagano	0.3	0.5	3.6	0.6	0.5	0.8	0.2	0.1	0.3	0.4	2.7	(0.1)	0.2	1.2	1.3	0.2	0.1	0.5	0.2	0.3	14.2	Nagano
	Yamanashi	0.1	0.1	0.7	0.1	0.1	0.3	0.0	0.0	0.0	0.0	0.1	0.5	0.1	0.1	0.2	0.0	0.0	0.1	0.1	0.1	2.9	Yamanashi
	Shizuoka	0.6	0.8	1.1	1.6	0.8	1.0	0.4	0.2	0.2	0.2	0.3	0.2	2.7	1.6	1.6	0.5	0.3	1.0	0.6	1.0	17.1	Shizuoka
	Chubu	1.8	2.5	3.8	2.9	2.0	2.5	1.1	0.6	0.7	1.0	1.6	0.6	2.7	39.6	10.5	2.2	1.5	3.9	2.5	5.0	90.5	Chubu
	Kinki	1.5	2.5	2.7	2.2	1.7	2.1	1.0	0.5	0.5	0.5	0.5	0.2	1.0	6.2	63.4	3.3	2.1	3.9	2.2	4.0	104.2	Kinki
	Chugoku	1.1	1.9	2.3	2.2	1.5	1.8	0.8	0.4	0.4	0.4	0.6	0.1	1.5	3.1	8.3	26.6	2.7	6.7	1.1	3.8	69.1	Chugoku
	Shikoku	0.5	1.1	1.4	0.8	0.7	0.8	0.3	0.2	0.2	0.3	0.3	0.1	0.7	2.6	5.6	2.9	10.6	1.9	0.4	1.9	33.6	Shikoku
	Kyushu	1.3	2.3	4.3	3.5	2.1	3.0	0.8	0.5	0.7	0.7	0.6	0.2	0.9	3.7	11.9	6.0	1.5	54.8	1.4	4.0	105.4	Kyushu
	USA	4.4	5.0	11.9	9.2	6.0	7.5	3.6	3.4	2.7	2.4	2.1	0.8	2.7	9.7	19.7	4.7	1.8	9.4	3,961.9	625.2	4,775.6	USA
	Total	66.3	98.0	103.5	68.7	53.0	65.7	32.4	25.9	23.7	29.6	18.8	6.2	25.1	122.4	225.6	66.4	31.1	124.0	4,387.4	1,667.1		Total