

Challenges and Opportunities for Water Resources Management in a Unified Korea

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Introduction

This research aims to analyze the challenges and opportunities for water resource management of the shared rivers between South and North Korea, the Imjin and the North Han Rivers, and the rivers that will become transboundary rivers after reunification, the Yalu and the Tumen Rivers. Particular attention will be paid to the period from the early 2000s to the present.

Recently, there have been a plethora of socio-economic and political discourses on the reunification of the two Koreas. 2014 marked the 70th anniversary of Korean Independence and the division of Korea. President Park Geun-hye began to promote preparation for national unification and launched the Presidential Unification Preparation Committee in July of 2014. This has encouraged many social entities to focus their attention on topics related to unification, and amongst these the field of water resources management needs to be explored as one of the stepping stones toward and after national reunification (Huh, 2015).

Water issues are among the imminent issues to be dealt with on the path to reunification. No development projects or plans can be adequately implemented without resolving the issues of clean water and proper sanitation, water pollution abatement, and water-related disasters (flood and drought). Shared water resources are a potential source of conflict between the two Koreas and their neighboring countries, China and Russia. Therefore, it is timely to delve into the myriad of issues involved in water resources management in preparation for reunification.

The shared rivers between the two Koreas, the Imjin and the North Han Rivers, hold an array of challenges, including water allocation for the agricultural sector, flood prevention, and drought management. There is a growing recognition of the need for joint management of the water resources of the shared rivers, especially with regards to the prevention and mitigation of water-related disasters, floods, and drought, which are intensifying due to climate change. The abrupt discharge of large amounts of water from the upstream area in North Korea in 2009 triggered human losses in South Korea, an explicit illustration of the disastrous consequences of failure to engage in mutual cooperation on management of the shared rivers.



North Korea currently has the two transboundary rivers, the Yalu River and the Tumen River. The Yalu River serves as the border between North Korea and China, and there are three riparian countries in the Tumen River Basin; North Korea, China, and Russia. Attention has been placed on hydropower development for the Yalu River and water quality amelioration and ecosystem protection for the Tumen River. Enlarging the shared basket of benefits in the two transboundary river basins will require a careful approach. The close ties between North Korea and China have been cemented through the year-long cooperation over the hydropower dams on the Yalu River. The case of the Tumen River shows the complexity of relationships for promoting trade and investment, tourism, energy, and the environment since the early 1990s between the three riparian countries and the adjacent countries in Northeast Asia, including South Korea, Mongolia and Japan.

The first part of this report sheds light on the current situation of shared water resources management between the two Koreas, discussing major challenges and the development of South-North cooperation on the river. Transboundary water management issues are discussed in the second part, which addresses a variety of obstacles with a focus on the Yalu and the Tumen River Basins. The study also highlights the trajectory of cooperation activities on the rivers. Finally, this article sketches a path to cooperation on the shared rivers between the two Koreas and presents policy suggestions for the Yalu and Tumen River Basins.

The Shared Rivers of South and North Korea

Overview of the Shared Rivers

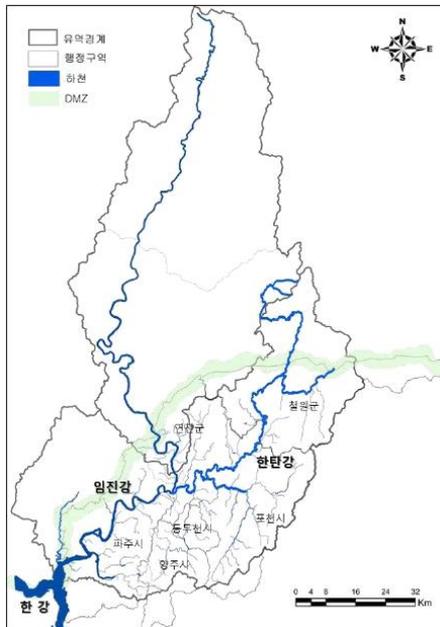
There are the two river basins shared by South and North Korea, the Imjin and the North Han Rivers. Both rivers stem from North Korea, flowing north to south. The size of the Imjin River Basin reaches 8,117.5 km², and the river is 254.6 km long. North Korea occupies 62.9% of the total river basin (5,108.8 km²) whereas South Korea occupies 37.1% (3,008.7 km²). There are 88 tributaries in the river basin, including the 2nd largest tributary of the Han River, the Hantan River. The Imjin River Basin has mountains in the North and flatlands in the South. The De-Militarized Zone (DMZ) is located in the river basin (Son, 2006). Figure 1 shows the boundary of the Imjin River Basin.

The North Han River is 317.5 km long, and the size of the river basin is estimated at 10,834.8 km², which is equivalent to 41% of the total Han River Basin. 36% of the river basin belongs to North Korea (3,901 km²), and the rest to South Korea (64%). Some of the largest multi-purpose dams in South Korea are located in the river basin. These dams include the Soyang Dam, with a storage capacity of 2.9 billion m³, the Peace Dam, which was built for flood control with a storage capacity of 2.63 billion m³, and the Hwachon Dam, with a storage capacity of 1.02 billion m³. In addition to these, a cascade of other dams have been constructed, including the Chunchon, the Uiam, and the Chungpyong Dams. On the North Korean side, there are six dams in operation;



the Innam Dam, Pochon 1 and 2 Dams, the Jungok Dam, the Shinmyungli Dam, and Jojungji Dam (Son, 2006) (See Figure 2).

Figure 1. The Imjin River Basin



Source: Song et al. (2015)

Figure 2. The North Han River



Source: Son (2006)

The ecosystems in the two river basins boast a high degree of biodiversity, an abundance of rare species, and well-preserved water environments. Over 70 years of armistice between the two Koreas has allowed ecosystems to recover and rare species of flora and fauna to flourish, including the crane, a protected species of rare bird. There are large areas of thick forest in the upper reaches of the Imjin River and the DMZ border areas, and the Imjin and the North Han Rivers have significant water flow and good water quality. A considerable number of rare fish species thrive there (Lee, 2015; Son, 2006).

The socio-economic benefits derived from the two rivers are hydropower development and a water supply for agricultural, industrial, and domestic uses. In addition, some of the main motorways and railways in the Korean Peninsula pass through the two river basins, which are situated in the middle of the peninsula, and could become a transport hub for the two Koreas in the future. The river basins are adjacent to some of the major urban centers in South and North Korea, including Seoul, Kaesong, and Incheon (Son, 2006).

Critical Challenges

The shared river basins face a multitude of challenges. The most salient of these is the fact that both rivers flow from North Korea to South Korea. There is a potential for conflicts to occur with a lack of cooperation between the upstream and downstream. South Korea would like to share information to prevent flooding and have a guaranteed volume of water for the purposes of agri-



culture and hydropower. South Korea's major concern regarding the Imjin River is possible flood damage. The upper reaches of the Imjin River are full of deep valleys and high mountains, which can accelerate the velocity of river flow and increase the amount of water that flows downstream. Loads of sediment from the upper and middle stream of the river are often discharged downstream, which results in a rise in the river bed and poses a high flood risk to lowland villages in the delta area (Son, 2006). For instance, in September 2009, North Korea opened the gates of the Hwanggang Dam without first warning or notifying South Korea, and six civilians were killed due to the abrupt rise of the water level in the Imjin River (Lee, 2015).

The construction of the three dams upstream in the North Korean section of the Imjin River (Hwanggang, Guryong, and Napyong Dam) have resulted in a reduced amount of water flow downstream, which often leaves the South short of water for agricultural production. Abrupt changes in water flow in the river have brought about uncertainty in the water management of the lower reaches, which in turn places livelihoods at risk (K-Water, 2016).

The Imnam Dam, also known as the Geumgang Mountain Dam in North Korea, was constructed in 2003 and has had a major impact on the flow of the North Han River downstream by diverting water to the Youth Hydropower Station in Wonsan, North Korea. Consequently, the amount of water flow downstream has decreased and has the potential to cause a serious water deficit in the lower reaches of the river, especially for the Seoul Metropolitan Area, disrupting ecosystems and intensifying water pollution in the Han River due to the lack of water (K-Water, 2016). Deforestation in the middle reaches of the North Han River has occurred over the last few decades, which may exacerbate the possibility of flooding in the downstream area of South Korea (Son, 2006).

With these challenges facing the two shared rivers, several issues should be discussed by the two Korean governments. A joint Environmental Impact Assessment (EIA) should be conducted in the Imjin River Basin on the diversion of the Hwanggang Dam on the North Korean side, which has reduced water flow to the agricultural sector and hydropower development downstream and poses a threat to the livelihood of residents in the South. Further discussions are needed to prevent any future flooding downstream, and thorough research is required to assess the measurement of the instream flow on the South Korean side (Baek, 2015; Lee, 2015; Song et al, 2015).

The hydropower development of the North Han River is of primary concern for North Korea. One viable strategy for South Korea is to incentivize North Korea by providing financial and technical assistance to enhance hydropower development capacity. The other significant negotiation point for South Korea is the issue of guaranteed downstream water flow. Similar to the Imjin River, the South Korean government should undertake an in-depth study, set up a feasible formula to share water resources, and strive to reach an agreement with the North Korean government. In this case, since water can be a trigger for disagreements, it would be wise to put forward non-water issues first, such as joint economic development projects. A guaranteed flow of water for South Korea can be discussed afterwards on the basis of mutual understanding and trust (Baek, 2015; Lee, 2015; Son, 2006).



South-North Korea Cooperation

The first South-North Korea Meeting was held in September 2001, during which the two Koreas agreed to undertake a flood prevention project on the Imjin River. In 2004, North Korea provided basic data and information on the river to South Korea, and South Korea offered monitoring machines and received some hydrological data from its Northern counterpart.

A flood occurred in September 2009, which resulted in the two Koreas organizing a meeting on the prevention of flooding in October 2009. The other important agenda item in the meeting was South Korea's demand for an apology from North Korea for the sudden discharge of water from the Hwanggang Dam that resulted in the death of six people in South Korea. The meeting saw no resolution of this issue (K-Water, 2016). Since that time, inter-Korean cooperation has ground to a halt due to the deterioration of the political relationship between the two Koreas (Baek, 2015; Son, 2006).

Collaboration on the North Han River had a more disappointing outcome. The South Korean government expressed its concerns over the structural safety of the Imnam Dam in 1986, and the two Korean governments agreed to conduct a joint investigation on the dam during the 7th South-North Korea Ministerial Meeting in August 2002. This agreement, however, did not lead to further discussions on how to implement the investigation. Since then, there have been no further developments.

The past decade of inter-Korean talks indicates that the main discussion points have been limited to flood prevention measures and have failed to address other important challenges, such as water scarcity in dry seasons and the deterioration of water quality. Further research should be undertaken on the socio-economic interests of North Korea in association with the two rivers, which could help South Korea prepare adequate incentives for the North in order to reach a consensus for benefit sharing. Third, continuous efforts should be made to institutionalize cooperation on water resources management of the two shared rivers and specify agendas for plausible joint projects (Baek, 2015).

Transboundary Rivers: The Yalu River and the Tumen River

Overview of the Transboundary Rivers

The Yalu River

The transboundary rivers between North Korea and its neighboring countries (China and Russia) are the Yalu (Amnok in Korean) River and the Tumen (Duman in Korean) River. The Yalu River marks the political boundary between North Korea and China (see Figure 3), while the Tumen River flows through the border between North Korea, China, and Russia. The Yalu River runs over 800 km and stems from Heaven Lake at the peak of Changbai or Baekdu (Korean) Mountain, which is the highest lake in the world (2,744 m above sea level), and flows towards the Yellow or



Bohai Sea. The river basin is 64,739 km² (32,557.2 km² on the North Korean side. The annual average precipitation reaches approximately 900 mm, and the temperature fluctuation is vast, ranging from -22 degrees C to 22 degrees C (Kim et al., 2013; Yang, 2012).

Figure 3. The Yalu River Basin



Source: Modified based on Kmusser - Author's work using the Digital Chart of the World and GTOPO data., CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=6345365> (accessed 28 September 2016).

The Yalu River is ideal for hydropower generation because of the 2,400 m drop in altitude from the upper reaches of the river to the downstream. North Korea and China have so far jointly constructed and operated four hydropower dams on the mainstream of the Yalu River since the 1950s and are planning to add three more dams. The dams in operation are the Yunfeng, WeiYuan, ShuiFeng, and TaiPingwan (see Figure 4 and Table 1).

Figure 4. Dams along the Yalu River



Source: Yang (2012)

**Table 1. Cascade Hydropower Dams in Operation on the Yalu River**

Name	Location	Year of construction	Installed capacity (KW)	Average annual electricity output (Mil KW.hr)	Construction party	Cascade order	Maintenance & operation
Yunfeng	Jian City	1958-1965	400,000	1,350	China/North Korea	First	China
Weiyuan	Jian City	1980-1988	390,000	1,200	China/North Korea	Second	North Korea
Shuifeng	Kuandian City	1937-1943	630,000	3,680	Japan→North Korea	Third	North Korea/China
Taipingwan	Kuandian City	1978-1986	1,900	720	China/North Korea	Fourth	China

Source: Yang (2012).

Recently, China and North Korea agreed to construct three additional dams. This agreement was reached in January 2010 under the Minutes of the 9th Meeting on the China-North Korea Construction of Yalu River Dams. Hushan, Wangjianglou, and Wenyue Dams will be built in the near future (Yang, 2012). Table 2 indicates the specifications of the planned Yalu River dams.

Table 2. Cascade Hydropower Dams under Construction/Planning in the Yalu River

Name	Location	Year of construction	Installed capacity (KW)	Average annual electricity output (Mil KW.hr)	Construction party	Investment (US\$ Mil)	Maintenance & operation
Hushan	Hushan Area	Not yet decided	100,000	N/A	China	580	China
Wangjianglou	Jian City	Not yet decided	42,000	N/A	China	250	China
Wenyue	Jian City	Not yet decided	42,000	N/A	North Korea	250	North Korea

Source: Kim et al. (2013) and Yang (2012).

Ecosystems in the river basin are rich with flora and fauna thanks to abundant rainfall and thick forests, which function as a sanctuary for wildlife. But this high biodiversity has been seriously damaged by human activities in the past few decades. Sightings of wild animals in the river basin such as wild boars, wolves, tigers, jaguars, foxes, ptarmigans, and pheasants were once reported often, but not anymore. Previously, 62 species of fish were documented along the river. However, the most recent study reported the presence of just 42 species, including silverfish, carp, and eels (Yang, 2012).



The Tumen River

The length of the Tumen River is 521 km, and the river serves as the border between North Korea, China, and Russia. The river stems from Changbai or Baekdu Mountain and discharges into the East Sea. Most of the riverine areas (504 km) form the border between North Korea and China, while just 17 km of the river serves as the border between North Korea and Russia. More than 250 tributaries are connected to the mainstream of the river, and the width of the river usually ranges from 240 or 250 m to between 400 and 20,000 m during flood season (Cai, 2014; Koo et al., 2011).

The river basin is 33,168 km². 70% is located in the Yanbian Korean Autonomous Prefecture, China, 29% in Hamgyong Province, North Korea, and 1% in the Khasan Wetlands in Primorsky Territory, Russia. Around 2.2 million people are living within the river basin, and 75% of them are in Yanbian Prefecture, China (White, 2010) (see Figures 5 and 6).

Little potential is recognized in terms of hydropower development in the river basin, and the average slope of the river is 4.84%. The slopes in the upper, middle, and lower reaches of the river are 10.02%, 1.65%, and 0.35% respectively. Average temperatures of the river basin vary between two and six degrees Celsius, typical features of a continental climate. The highest temperature reaches 36-38 degrees Celsius in summer, while the lowest winter temperatures reach around -35-40 degrees C. Average rainfall in the river basin is around 570 mm per annum, and large amounts of rainfall are concentrated in the period between June and September (KOWACO and UNDP, 2004; Lee et al., 2011).

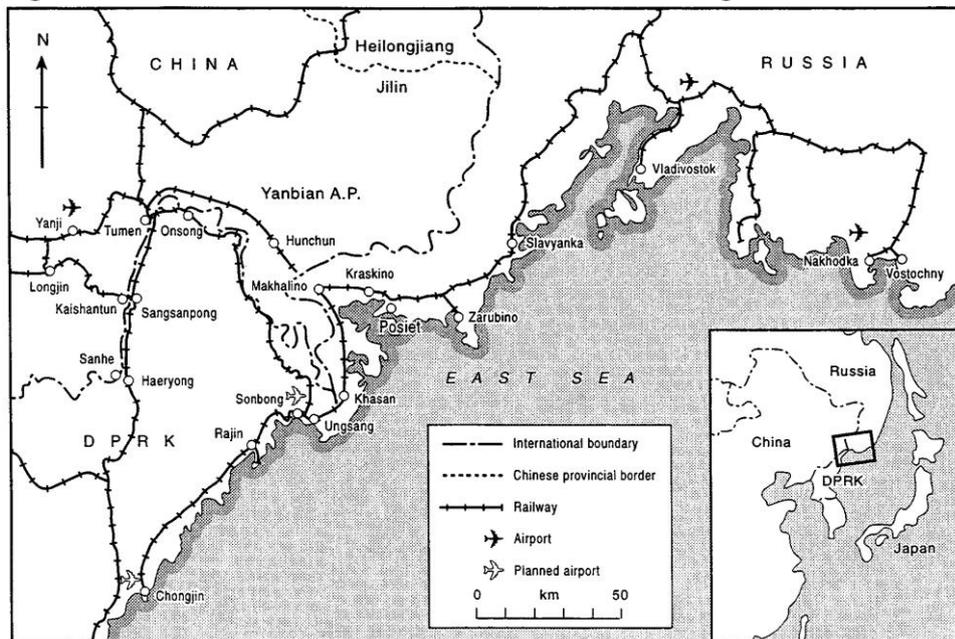
Figure 5. The Tumen River Basin



Source: Palmer (2015). <http://rg21.jp> (accessed 28 September, 2016).



Figure 6. The North Korea, China, and Russia Border Region



Source: Pomfret (1997).

The river basin boasts numerous animal and plant families and species. There are 87 animal families and 422 species, and 134 plant families and 2,091 species. However, this rich biodiversity and ecosystems have been under threat owing to three major phenomena; loss (land use change and reclamation), fragmentation (increase of built environments and urbanization), and environmental degradation (pollution and disturbance). Vast areas of forest (525,506 km²) and grassland (91,200 km²) have disappeared, and the number of animals has decreased. For instance, the number of recorded Amur Tigers in the Tumen River region was 150 in the 1970s, 20-30 in the 1980s, 16-22 in the 1990s and around 20 now (Cai, 2014).

The primary functions of the river are to supply water for the agricultural sector and industrial development and to preserve biodiversity in the Tumen Delta. The river's capability to perform these functions has been seriously hampered by water pollution, especially the rampant discharge of industrial sewage from paper and pulp mills in Longjin, Jilin Province, China and residue from the Musan mines in North Korea. The water pollution is even more acute in winter because of less rainfall (K-Water, 2016).

According to the report on the State of the Environment in Jilin Province, China in 2006, the water quality of the river was estimated to be Class V (Class I being the cleanest and Class V the most polluted), with 75% of the river deemed unsuitable for domestic, industrial, and agricultural use and natural reserves (Marsden, 2010). In 2012, the six Chinese monitoring stations on the river showed somewhat different results. Three stations reported the water quality as Class III, two stations as Class IV, and one station as Class V, which demonstrates that the water quality of the river, at least within the Chinese section, has been enhanced (Jilin EPB, 2013).

Various natural resources are abundant in the river basin, such as oil, gas and minerals. Adequate transport infrastructure such as railways, roads, and sea routes to potential markets, which include



Northeast China, South Korea, Japan, and Mongolia, would make these minerals easily accessible and result in increased economic growth. Recognition of this potential led to calls for multilateral cooperation in resource management and economic development, which culminated in the launch of the UNDP Regional Program for the Tumen River Basin (TRADP) in 1991.

TRADP went through three phases: 1) a preparatory period from 1991 to 1996; 2) an interim period from 1997 to 2000; and 3) the final phase from 2001 to 2004. TRADP became the Greater Tumen Initiative (GTI) in 2005 as an inter-governmental cooperation mechanism to promote socioeconomic and environmental cooperation in the Greater Tumen Region and Northeast Asia as a whole. The original member countries were North Korea, China, Russia, South Korea, and Mongolia, and Japan also participated as an observer. This new initiative has not necessarily been successful due to a series of setbacks that will be discussed later (Marsden, 2010).

Critical Challenges

The Yalu River

Kim et. al (2013) address a myriad of challenges in water resources management on the Yalu River, with a particular focus on North Korea. First, flood prevention measures are urgently needed, not only to reduce human and economic losses, but also to provide sound development conditions for new special economic zones in Sinuiju City, North Korea, which have been jointly developed by North Korea and China. Specific measures for preventing floods in the Yalu River Basin, particularly mid and downstream, include dredging the river bed, modernizing the levees, and reforesting the upstream portion of the river.

Second, the four dams along the river are old and in need of serious repairs. It is imperative to thoroughly assess the condition of the dams, and this assessment should be conducted through an agreement reached beforehand between South and North Korea. The total cost of repairing the four aged dams is estimated to be as much as \$531 million USD (KW 620 billion).

Another issue is linked to the functionality of the dams in terms of meeting diverse demands in the river basin. The dams are designed for the single purpose of hydropower generation and have not been useful in preventing floods or supplying water to the agricultural sector. These dams would be more useful if they were converted for multi-purpose use in the future under collaboration between South Korea, North Korea, and China.

Fourth, considering the positive potential of hydropower generation, it is plausible to envision construction of additional dams to provide hydroelectricity to energy-hungry Northeast China and North Korea. At the moment, three additional dams are in the pipeline, which could bring about socio-economic benefits to a unified Korea and China. However, it is necessary to take into serious account the possible negative impacts of the dams, especially on ecosystems and the livelihoods of local residents. The two Koreas and China should discuss sustainability issues in the river basin, including the implementation of a transboundary Environmental Impact Assessment (EIA).



The Tumen River

The issues surrounding the Tumen River Basin appear to be more complicated and enigmatic compared to those facing the Yalu River Basin due to Tumen's strategic significance (both geopolitical and economic), the number of concerned countries (Four member countries of the Greater Tumen Initiative (GTI), which are the Republic of Korea, China, Russia, and Mongolia; North Korea, and Japan), and different vested interests between the riparian countries. The relationships between the GTI member countries have fluctuated, and a number of tensions exist between the Tumen riparian countries. China has fretted over North Korea's unilateral use of upstream water. Russia has heavily criticized the irresponsibility of North Korea and China over water pollution downstream, which negatively affects ecosystems in Primorsky, Russia (Kang and Lee, 2005).

There are several challenges that must be overcome to achieve international cooperation on socio-economic development and environmental protection in the Tumen River Basin. First, the GTI lacks a clear, long-term vision. TRADP attempted to create a free trade economic zone (Rason) to induce stability in the region through economic cooperation. The purpose of GTI is to promote economic development and trade in the Greater Tumen Area. However, the initiative has not yet been able to successfully produce a collective long-term vision with a detailed plan.

Second, lack of funding is a chronic issue for the GTI. The member countries agreed to set up a Common Fund to support the initiative. However, the financial contributions that have been made by the member countries have not met the goals that were set, which in turn has slowed project planning and implementation and placed a heavy strain on the day-to-day operations of the secretariat in Beijing, China. As seen in Table 4, the amount of the Common Fund between 2008 and 2012 held steady at around \$650,000 USD, and increased to \$675,000 USD between 2013 and 2014, which was spent on the operation costs of the secretariat, salaries for local staff, and other maintenance fees. The Trust Fund is the other financial source that can be utilized by a member state for its own purposes. South Korea is the only country that has contributed to the Trust Fund, which accumulated \$5 million USD as of 2014 (Park, 2014).

Table 3. Overview of the Common Fund of GTI from 2008 to 2014

Country	2008	2009	2010	2011	2012	2013	2014
China	260,000	260,000	260,000	260,000	260,000	260,000	260,000
South Korea	181,000	181,000	181,000	181,000	152,500	152,500	152,500
Russia	159,000	159,000	159,000	159,000	212,500	212,500	212,500
Mongolia	25,000	25,000	25,000	25,000	25,000	50,000	50,000
North Korea	25,000	0	0	0	0	0	0
Total	650,000	625,000	625,000	625,000	625,000	675,000	675,000

Remarks: North Korea withdrew from GTI in 2009.

Source: GTI, Consultative Commission Meeting Progress Report 2008-2014 (Park, 2014).



Third, the issue of engagement with North Korea and Japan needs to be sorted out. North Korea decided to step out from the GTI in May 2009, and Japan has been reluctant to join the GTI because of uneven sharing of costs and benefits between the GTI members. Japan is not directly connected to the GTI region by land and understands that the GTI could bring in some benefits, but the benefits currently offered are not large enough to merit Japan's active engagement on the issue. Finding incentives that would encourage North Korea and Japan to join the GTI could be the key to the success of the GTI in the future (Koo et al., 2011).

Transboundary Cooperation

The Yalu River

North Korea and China have continued to collaborate in the Yalu River Basin in resource management and development for several decades. The two countries have equally shared hydroelectricity, although the responsibility of operation and maintenance for each hydropower dam is taken on independently depending upon the location (Yang, 2012). It is unclear as to whether this is truly the view of both parties, as there have been virtually no comments on the matter of benefit sharing from the North Korean side, and this view only reflects the Chinese side.

It was in 1951 that the first North Korea-China Border Meeting was held, and since then, the two countries have held this meeting in turn biennially. The meetings generally deal with an array of issues along the Yalu and Tumen Rivers, such as the location of the border, use of islands in the river, installation of various facilities, and treatment of illegal migrants or travelers on the border (K-Water, 2016).

In April 1955, the North Korea-China Hydropower Board was established, and board meetings have been convened every year since either in Pyongyang or Beijing. A constellation of relevant issues are discussed, including dam operation and management, the construction of new dams, and joint operation stations. In addition, the two countries made an agreement on inland navigation, The Border Inland Navigation Cooperation Agreement, and decided to create The North Korea-China Border Inland Navigation Cooperation Committee, which holds annual meetings (K-Water, 2016). The border has not been set within the main channel of the river, giving both countries navigation rights for vessels and boats along the entire width of the river (Yang, 2012).

Joint efforts have been made to protect endangered fish species in the river since the late 1950s, including the release of one million baby bighead carp and three million eggs each year. In 1972, the two governments agreed to protect fish species in the Shuifeng Dam Reservoir, an effort that intensifies annually between May and June with the deployment of 30,000 artificial fish nests.

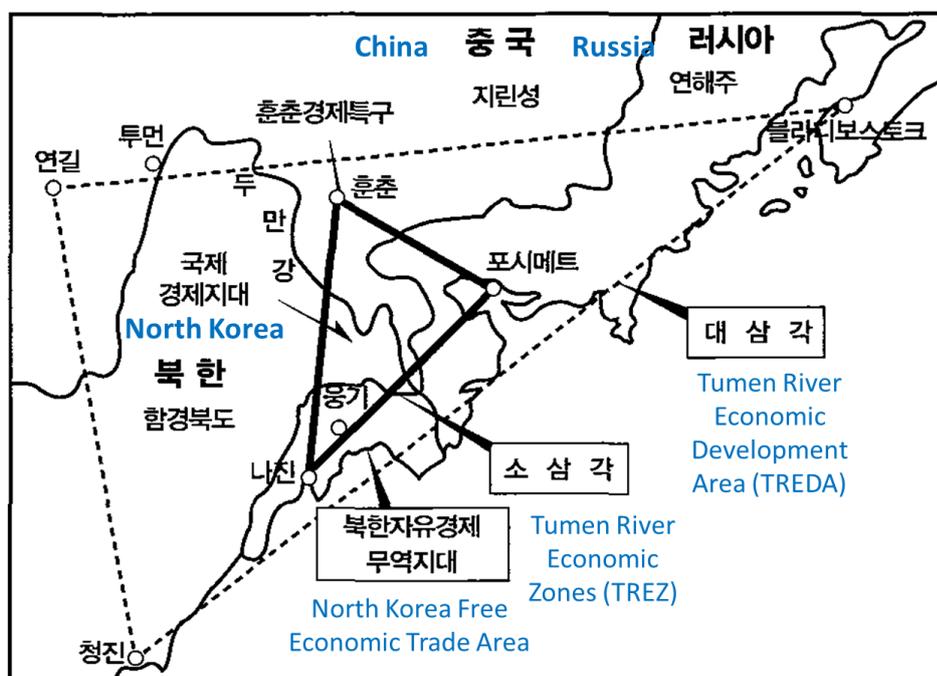
Transboundary cooperation is also found in border patrol and human rescue campaigns during floods. When the river begins to melt in the spring, a spring flood occurs. Flooding often triggers human and economic losses, and in order to prevent such losses, the two countries have run joint rescue missions (Yang, 2012).



The Tumen River

A joint effort to develop the Tumen River Basin, the Tumen River Area Development Program (TRADP), was officially embarked on by UNDP in 1991 with a 20-year budget of \$30 billion USD (later raised to \$80 billion USD) as a response to conflict and the development of trade in the region. The program consisted of two major areas, one small and one large triangular area. The small area is called the Tumen River Economic Zone (TREZ), which links Rajin in North Korea, Hunchun in China, and Posiet in Russia. 1,000 km² were designated for TREZ. The large area was designated the Tumen River Economic Development Area (TREDA), and connects Chungjin in North Korea, Yanji in China, and Vladivostok in Russia. 10,000km² were designated for TREDA (Cho and Kim, 2010) (see Figure 7). The initial inter-governmental cooperation was established with five member countries; South Korea, North Korea, Russia, Mongolia and China.

Figure 7. The Tumen River Area Development Program Areas



Source: Modified based on Jeon (2006).

The governing structure and rules of TRADP were specified in December 1995, based on the documents “Agreements on the Establishment of the Tumen River Area Development Coordination Committee” and “Establishment of the Consultative Commission for the Development of the Tumen River Economic Development Area and Northeast Asia”. The Rason Special Economic Zone was subsequently created to facilitate economic development through international cooperation in the river basin (Cho and Kim, 2010; Koo et al., 2011; Marsden, 2010; Wang, 2014; White, 2010).

TRADP lasted until 2004, when the member countries reached an agreement in 2005 in Changchun, China that cooperation would be extended for another 10 years and TRADP would be rebranded as the Greater Tumen Initiative (GTI) (Koo et al., 2011; Wang, 2014). The GTI has become an in-



ter-governmental cooperation mechanism supported by UNDP to promote socio-economic and environmental cooperation in the Greater Tumen Region and Northeast Asia as a whole.

In the Changchun Agreement of 2005, the member countries adopted a Strategic Action Plan (2006-2015) with five priority areas for implementing projects: 1) transport; 2) trade and investment; 3) tourism; 4) energy; and 5) the environment. Major projects between 2006 and 2014 are as indicated in Table 3.

Table 4. Major Projects of GTI (2006-2014)

Sector	Project Name	Main activities	Overall cost/investor
Transport	Creation of ferry routes in North-east Asia	Zarubino-Sokcho-Nigata Route	\$50,000 USD/private
	Modernization of Zarubino Port in Russia	Construction of a container terminal in Zarubino Port	\$800 million USD/private
	Mongol-China railway Feasibility Study	Economic feasibility study & detailed railway plans	\$50,000 USD/private
	China-North Korea border road & port utilization	Creation of a border logistics facilitation agency	\$50,000 USD/private
Energy	GTI energy industry capacity building	Creation of an energy council & reduction of trade barriers for energy	\$250,000 USD/private
Tourism	GTI tourism industry capacity building	Creation of a tourism council, production of GTI tour guide materials and tour programs	\$200,000 USD/private
Investment	Market economy education for GTI member country government officials	Market economy workshops for government officials from low-income GTI countries	\$200,000 USD/South Korea & concerned countries
Environment	Environmental Impact Assessment of the Greater Tumen Railway & standardization	EIA of GTR & standardization	\$300,000 USD/GEF Fund & concerned countries
	Tumen Water Resources Protection Feasibility Study	Multilateral cooperation for environmental protection in the Tumen River Basin	\$50,000 USD/ Tohiba, Japan

Source: Shin (2014).

The GTI agreement embraced new features, such as the reinforcement of regional cooperation with local governments, partnerships with the private sector, and an expansion of the geo-



graphical scope to represent less developed areas including landlocked regions. In 2007, the GTI established three boards for local cooperation, including the Energy Board, the Tourism Board, and the Environmental Board, and also decided to establish a Business Advisory Board to strengthen public-private partnerships (GTI, 2011).

A noteworthy change in recent years is North Korea's withdrawal from the GTI in May 2009 due to its frustration over failure to achieve its desired project outcomes such as increasing domestic economic development and trade, the nuclear missile issue, and as a strategy to promote the Rason Economic Zone for Russia and China. Getting North Korea back on board to revitalize the program has been one of the most elusive challenges for the member countries of the GTI (Cho and Kim, 2010; Koo et al., 2011; Park, 2015).

It is useful to delve into the performance of TRADP and the GTI since 1991 in order to identify major achievements and challenges in sustainable development in the Tumen River Basin. First, the inter-governmental mechanism has succeeded in improving confidence in the institutional capacity, ownership, and political and financial commitment of the member countries for socio-economic development and environmental protection. Successful implementation of priority projects within the TRADP and the GTI are noted, and the programs have enhanced the policy environments for mutual understanding between the member countries.

Second, the GTI has enabled Northeast Asian countries to consider establishing a regional institutional architecture for cooperative projects in the future. For instance, the GTI has enlarged its funding base via the establishment of the Export and Import Banks Association and expansion of partnerships with other international organizations, such as the Asian Development Bank, GIZ (German Development Agency), and World Trade Organization (WTO). This outcome is expected to enhance the feasibility of GTI projects in the pipeline. Participation of local governments in the GTI has been encouraged to improve the feasibility of project implementation and collaboration (Wang, 2014).

Third, the water quality enhancement project of the GTI has received major attention. As mentioned earlier, the water quality of the river has deteriorated because of rampant wastewater discharge from paper and pulp mills in China and residue dumped from the Musan mines in North Korea. The GTI commissioned the Tumen River Area Water Quality Assessment in 2010 after the establishment of the Environmental Board in 2007. Their other water-related activity was the 2nd Scientific Workshop for the Feasibility Study of the Tumen River Water Protection Project held in 2011 (Kang and Lee, 2005; Koo et al., 2011; Wang, 2014).

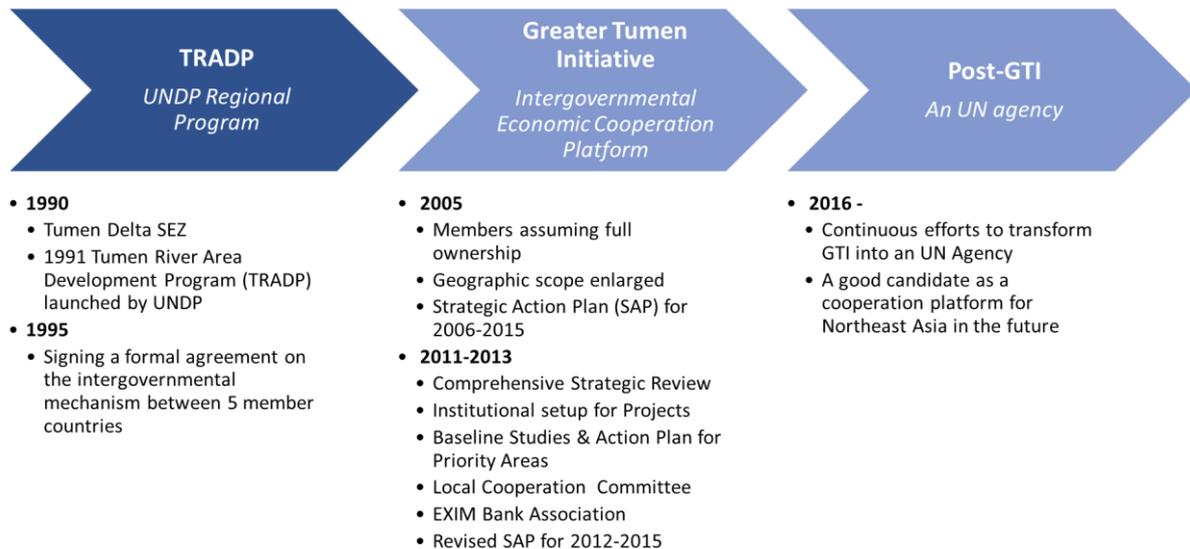
Fourth, compared with the GTI's other focus areas, such as trade and investment and energy, tourism-related projects have been successfully implemented owing to requiring relatively smaller budgets, their apolitical nature, and the renowned biodiversity and ecosystems of the border areas between North Korea, China and Russia (Shin, 2014).

The latest attempt to rejuvenate the GTI as a cooperative platform in Northeast Asia has been to transform the GTI into a UN agency. This was agreed to in 2014 in order to reposition the GTI as an international entity able to make agreements with NGOs, establish funds, implement projects, conduct legal action, and recruit new employees. All of the details necessary to become a



UN agency are scheduled to be finalized by the end of 2016 (Park, 2014). Figure 8 sketches the development of TRADP and GTI from 2005 to 2016.

Figure 8. Development of TRADP and GTI from 2005 to the Future



Source: Modified based on Wang (2014).

The Way Forward

The Path to Cooperation in the Imjin River and the North Han River

There are several tasks that should be undertaken in order to facilitate cooperation between the two Koreas on the Imjin River and the North Han River Basin. First, the two Koreas should work together on the basis of a shared vision to help achieve socio-economic development, ecosystem protection, and cultural viability beyond the benefits that can be gained through the utilization of the water resources from the two rivers. This shared vision should be embodied by political consensus on the sustainable development of the two river basins.

Second, it is imperative to prepare relevant legal instruments for inter-Korean cooperation on the shared rivers. The South Korean government should consider enacting special laws to support inter-Korean government cooperation on the Imjin and the North Han River, such as a Special Law for South-North Korean Cooperation on the Imjin River Basin and a Special Law for South-North Korean Cooperation on the North Han River. These laws should encompass the geographical boundaries of cooperation, related projects, implementing agencies, financing, and the power and responsibilities of South and North Korean authorities (K-Water, 2016).



Third, the shared river basins should be developed based on a cooperation mechanism under the framework of sustainable development. The mechanism can encourage development in a variety of fields, such as ecosystem protection in the De-Militarized Zone (DMZ), cultural heritage, and tourism in the border areas. A DMZ World Ecological Peace Park in the upper reaches of the North Han River has recently been proposed by South Korea, which would aim to symbolize the efforts of both Koreas to bring peace by reconnecting the North Han River (K-Water, 2016). These efforts can eventually synergize cooperation in environmental services, socio-economic development, and culture (Lee, 2015).

Fourth, the two Korean governments should consider water resources management issues in an integrated fashion rather than through a sectoral approach. The Integrated Water Resources Management (IWRM) approach should be introduced to tackle water use, flood prevention, river basin management, ecosystem protection, and forest management (Lee, 2015). For instance, deforestation in North Korea, which is highly susceptible to flooding, has been ongoing for several decades. South Korea can help North Korea implement reforestation projects based on its own successful reforestation policies and projects in tandem with flood prevention projects along the two shared rivers (K-Water, 2016).

Fifth, stakeholder participation should be emphasized in order to establish water governance in the river basins. Even though political bargaining and negotiations occur at the national level, local stakeholders, such as local governments, private companies, local NGOs, and other civil society groups, should be invited to contribute their views and opinions, which will entail practical solutions for local problems in the border areas.

Sixth, the South Korean government should prepare diverse options that are attractive to their North Korean counterparts. This can incentivize the North Korean government to take an active part in negotiations on the two river basins. For instance, efforts can be made to retrofit and/or upgrade basic infrastructure for water and sanitation services, i.e. the piped water supply and sewage treatment facilities, to help modernize agricultural practices and housing in rural areas, and to offer public health management programs. Technology transfer projects should also be considered. Financing various projects is another potential way to invite North Korea to cooperate.

Seventh, the two Koreas can collaborate to promote culture and history tourism in the two river basins. The archaeological sites associated with one of the old dynasties in Korea, Taebong or the later Goguryo Dynasty (911-918), can be developed as a place to learn history and culture. The DMZ area can also be developed as a venue for sport activities and ecosystem education.

Finally, there should be an agreement between South and North Korea on joint projects, i.e. hydrological monitoring, environmental impact assessments, and dam operation and maintenance. At the same time, water managers in the two Koreas must consider sharing basic information and data on hydrology, dam operation, and other river management issues (Lee, 2015).

Cooperative projects can be made more feasible through the establishment of a joint water resources management entity, a 'South-North Korea Shared River Joint Management Committee', which tackles only apolitical matters in its early stages, such as technology transfer and joint research projects. As time goes on, the committee can be upgraded to a Border Commission that



not only deals with water issues but also other issues, including socio-economic development, energy supply, transport enhancement and environmental conservation. The activities of the East and West Germany Border Commission (Grenzkommission) are an example of such cooperation (K-Water, 2016; Son, 2006).

An Increase of Transboundary Cooperation on the Yalu and Tumen Rivers

The Yalu River

The Yalu River Basin has recently witnessed accelerated socio-economic development, led primarily by China. North Korea attempted in recent years to launch two special economic zones on its own in the downstream part of the river (near Sinuiju and Hwanggeumpyong Island), but was unsuccessful. It seems that North Korea has decided to opt for its own version of an 'open door policy' in its collaboration with China on the border cities in the downstream part of the Yalu River. In these circumstances, harnessing water resources in the river basin is one of the basic fundamentals needed to enhance Northeast China's border trade and economic growth and to support North Korea's leapfrogging socio-economic development and modernization.

Trilateral cooperation between South Korea, North Korea and China are instrumental in the various fields of water resources management in the Yalu River Basin. First, as an initial step, South Korea should propose offering technical support for the out-dated and ill-maintained hydropower stations, such as the Shuifeng and Yunfeng dams. These dams have been in operation for over 40 years and urgently need retrofitting and upgrades. South Korea's active participation in the North Korea-China Hydropower Development Board would make this possible (K-Water, 2016).

In addition, there is an immediate need for flood prevention measures. Such measures include both structural and non-structural measures. Levees along the river have to be carefully assessed and adequately retrofitted, and short- and long-term plans for protecting local residents, major infrastructure, and agricultural fields near the river must be established. Joint monitoring and research through conferences and expert exchanges should be undertaken in order to monitor and analyze the flow regime and frequency of floods (Kim et al., 2013).

Second, the three countries should collaborate to establish a transboundary cooperative mechanism and undertake joint projects for sustainable water resources management. These projects should also be associated with the plans for special economic zone development in the downstream part of the river, ensuring the removal of flood risks and a steady supply of water and electricity to special economic zones.

Third, it would be wise to consider establishing a partnership with international donor agencies, such as the World Bank, the Asian Development Bank (ADB), and the newly created Asian Infrastructure Investment Bank (AIIB). The China-led AIIB can play a particularly vital role in pumping in large amounts of infrastructure funds into dam retrofitting projects and the creation of special economic zones downstream. Influential international environmental NGOs can partic-



ipate in protecting biodiversity and endangered species, such as the World Wildlife Fund (WWF), IUCN, and International Rivers.

Fourth, an appropriate level of transboundary river basin governance should be established. At the international level, the governments of South Korea, North Korea, and China should set up a 'Yalu River Basin Development Committee' where country representatives handle both water related issues and others to promote socio-economic development and ecosystem conservation.

Transboundary cooperation between civil society groups should also be encouraged through the development of a 'Yalu River Basin Development Forum,' where diverse non-state stakeholders can share their views, opinions, and understanding of socio-economic, cultural, historical, and environmental agendas. It is also suggested that public companies engaged in development projects in the river basin should create a 'Yalu River Basin Development Company' in order to accelerate the planning and implementation of projects in the river basin (Kim et al., 2013).

The Tumen River

The Tumen River Basin has recently been drawing more attention from riparian countries than ever before. Russia and China are committed to invigorating economic development through the enhancement of inland transport and sea routes, while South Korea is keen to seek opportunities to let North Korea come out of isolation and provide a path for reunification. The Korea Research Institute for Human Settlements (2014) suggests four priority projects to achieve transboundary cooperation for socio-economic development and sustainability between South Korea, North Korea, China, and Russia. These projects would develop: 1) transport and logistics; 2) the Rason International Industrial Complex/Special Economic Zone; 3) international tourism belts; and 4) international environmental cooperation in the Tumen River Basin (Kim et al., 2014).

International environmental cooperation projects in the river basin can embrace monitoring and evaluation projects for the environment, afforestation and reforestation projects, and joint research on water resources development and management. In addition to these, Kim et al. (2014) recommends that the member countries should agree to establish environmental standards and build environmental pollution abatement facilities, including water pollution control facilities and systems along the river basin.

The earlier analyses and policy suggestions from K-Water and UNDP (2004) are worth paying attention to. The study produced by K-Water and UNDP (2004) suggests five priority areas for water resources management. First, South Korea and other GTI member countries should dedicate themselves to the enhancement of water quality through river basin management, water quality control, waterfront area rehabilitation, proper management of sewers, and adequate treatment of wastewater from livestock farms and domestic households. Second, joint efforts should be made to protect nature reserves and habitats for migratory birds and endangered species of flora and fauna.

Third, adequate plans and practices are required to implement river basin management. These include not only policies, plans, and programs related to the water supply and water quality



control, but also preventive measures against water related natural disasters, including typhoons, flash floods, landslides, and drought, as well as programs for the protection of wetlands, swamps, and soil environments. Fourth, thorough joint research and studies should be carried out on the water supply, water quality, floods and drought, and water consumption, and the information and data should be shared equally. Fifth, integrated flood management plans must be jointly established and implemented throughout the river basin (K-Water and UNDP, 2004).

Sixth, one of the soft approaches to facilitating inter-governmental cooperation is to embark on small-scale projects, especially projects that focus on capacity building and expert exchange programs in the water sector. Doing so will bridge the knowledge and technology gap between the member countries and improve mutual understanding, which can in turn lead to trust building. Such programs match the priority project areas and activities of the GTI, which are capacity building, research and studies, policy advisement, and knowledge-sharing (Wang, 2014).

In order to implement these projects, it is urgent to strengthen the capacity of the GTI as a transboundary cooperation mechanism. The GTI should play a pivotal role in facilitating discussion and dialogues between its members regarding water resources management. The GTI Environmental Board needs to reinforce its research and planning capacity to be able to conduct studies on the water environment and achieve an adequate level of water allocation, water quality monitoring and analysis, and flood and drought management planning. On top of this, it would be beneficial to establish a 'River Basin Management Commission in the Tumen River Basin' to implement IWRM, share information and data, and carry out joint research and scientific monitoring projects (Koo et al., 2011; Marden, 2010).

Conclusion

This article presents an evaluation of the current circumstances, challenges, and opportunities surrounding the two shared rivers between South and North Korea and the transboundary rivers between North Korea, China, and Russia. The relationship between the two Korean governments regarding the Imjin River and the North Han River has been bumpy, and it seems unlikely that there will be close cooperation between them in the future without significant changes to the status quo. The incident on the Imjin River in 2009 indicates the typical behavior of an uncooperative upstream country (North Korea). Nevertheless, South Korea appears to be willing to encourage its North Korean counterpart to come back to the negotiation table and discuss future cooperation projects.

Cooperation on the shared rivers has been highly susceptible to the political atmosphere between the two Koreas over the last several decades, and mistrust between the parties still prevails. More time and patience will be required for the two Koreas to return to the negotiating table and discuss important issues that impact the local population that lives along the border areas.

The primary challenges that face the Yalu the Tumen Rivers are somewhat different. In addition to concerns about flood and ecosystems, hydropower development has been a major issue in



the Yalu River Basin between North Korea and China. The bilateral cooperation between North Korea and China has notably maximized the hydropower potential of the river since the 1950s, and such mutual development continues through the building of new dams. China has stressed that its hydropower generation in collaboration with North Korea in the Yalu River is a good model of benefit sharing based on mutual agreements. However, a unified Korea may need to have a closer look at what has been done in the agreements between North Korea and China to ensure that there is an even share of benefits accrued to both sides from the utilization of the Yalu River.

Water quality deterioration and biodiversity protection have drawn attention in the Tumen River Basin, together with the promotion of trade and investment, energy, and tourism. More complexity and uncertainty remain in the Tumen River, since the GTI encompasses a greater number of parties in Northeast Asia, including South Korea, Mongolia, China, and Russia, coupled with North Korea and possibly Japan. The future of the GTI has not yet been determined, but the GTI may be able to serve as a useful platform to rejuvenate international cooperation on sustainable development in Northeast Asia despite and beyond political uncertainties.

The reunification of the two Koreas may come in the future. In the course of socio-economic and political transformation, the unified government of Korea should ensure equal access to clean water and proper sanitation services alongside adequate water-related disaster prevention. Such efforts would enable the new Korea to achieve a second Miracle of the Han River which would not only embrace eye-catching economic growth, but also environmental sustainability. At the international level, unified Korea should encourage trust building with its neighboring countries, especially China, Japan, Russia, and Mongolia, with regards to the Yalu River and the Tumen River. In order to facilitate international cooperation based on benefit sharing, it is important to establish joint river basin management committees and ensure that there is ongoing, productive dialogue between the riparian countries. With this as a foundation, detailed projects can materialize and be implemented, leading to socio-economic well-being and sustainability in the Korean peninsula and beyond. ■



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