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Sharing Korea's Experience in Sustainable Forestry: Possible Applications in Developing Countries

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Executive Summary

South Korea is among the only four countries that has succeeded in rehabilitating its forests after World War II. The combination of South Korea's experience in reforestation and rapid economic growth is a good example that developing countries striving to achieve sustainable development can learn from. This paper presents the reforestation activities of South Korea during the twentieth century to help develop strategies to sustain forest management and their utilization in developing countries.

Forests in South Korea were severely devastated due to Japanese colonization and the Korean War, which intensified the shortage of livelihood options and the crises resulting from natural disasters. Prior to 1973, the South Korean government attempted to develop a foundation for reforestation. The government created a legal foundation to promote public participation for planting trees and fuelwood forests during this period. However, reforestation activities only took off during the implementation of the First National Forest 10-Year Plan (1973-78), a long-term reforestation project in South Korea. This project featured the active application of community-based forestry and the integration of reforestation activities with rural economy improvement (i.e., *Saemaul Undong*). Further reforestation activities have followed the first plan, sustaining the effect of reforestation on a national scale.

An important element for successful reforestation in South Korea was the effective implementation of community-based forestry. The Forest Law pushed local villagers to organize community-based forestry cooperatives called *Sallimgye*. During South Korea's reforestation period, this local group led public participation in all reforestation activities, including seedling production, tree planting, forest patrol, and forest product harvesting. Public participation provided substantial labor and helped the government continue reforestation efforts. In turn, it contributed to ameliorating the rural economy as a principal component of the economic development project, titled *Saemaul Undong*. For example, the community-based seedling production, namely the *Saemaul* nursery program, played a role in meeting seedling demand for reforestation and providing incentives for villagers through extra remuneration.

The South Korean government continues to address the growing needs for forest protection along with climate change mitigation and adaptation. In particular, attention has been placed on the prevention of forest fires and the restoration of burnt forest lands. There is also growing interest towards systematic control of forest pests such as pine wilt disease. Moreover, the government promotes carbon offset by legalizing the emission trading system and supporting activities that help maintain and improve carbon sequestration of the country's forests.

In addition to carbon sequestration, South Korea evaluates other public benefits of reforested lands, notably biodiversity conservation, disaster risk reduction, and water resource management. Forest

researchers have assessed the value of reforestation in South Korea, and found that the economic benefits of reforestation highly exceeded the total cost of reforestation, making it an economically desirable and viable proposition. Currently, South Korea is implementing forest policies and practices for various purposes, such as improving the urban environment (urban forests), encouraging leisure spaces (recreation forests), and piloting new forestry systems (forest management in Jeju experimental forests) along with traditional timber and non-timber forest products. Research and development also continuously address on-going issues such as climate change and environmental management. These outcomes and the current state in South Korean forestry highlight the significance of reforested lands for society.

In the past, South Korea received a significant amount of official development assistance (ODA) for reforestation and economic development. As Korea became an OECD-DAC country, it places high importance on contributing to environmental protection and economic progress in developing countries. Considering the unique experiences of South Korea's reforestation history, sharing and piloting the implementation of programs based on the South Korean experience in developing countries can be a practical strategy for ODA in the forestry sector. Specifically, Korea's community-based forestry approach (e.g. the traditional *Songgye* in Korea), piloted to the context of each country's specific circumstance can be a useful method of cross-border knowledge sharing in sustainable forest management.

1. Introduction

Forests are the most productive and biologically-diverse ecosystems on land. The sustainability of forests is an inter-sectoral issue that contributes to several goals under the 2030 agenda, including Goal 13 (Climate Action), and Goal 15 (Life on Land). Forests not only provide shelter for more than 80% of terrestrial species of animals, plants, and insects (FAO, 2011), they also provide conditions that are essential for sustainability, including disaster risk reduction, carbon sequestration, soil erosion control, and water yield enhancement (UNDP, 2017). Along with the environmental benefits, the importance of forestation increases as it provides economic benefits through timber, and non-timber forest products, and as sources of energy. Furthermore, technological advancement has allowed for improved sustainable management and efficient use of forest resources. Recently, the social benefits of forests have been recognized and projects are being developed to enhance the contribution of forests to social welfare. Investment into forest sustainability provides socio-economic and environmental gains worth many times the initial cost: 2.5 trillion USD of potential benefit when investing 30 billion USD (UNEP, 2018).

Due to global efforts to decelerate the annual net loss of forest area, deforestation has decreased from 7.3 million ha in 2000 to 3.3 million ha in 2015. Nonetheless, this trend is not seen to the same extent across all countries. Deforestation rates remain high in developing regions, especially in Africa and Latin America. One of the main drivers behind deforestation is agriculture. Approximately 80% of forest loss is caused by transition from forest to agricultural use. During 2000-2010, the annual net loss of forests globally was 7 million ha, whereas the annual net gain of land for agricultural use was 6 million ha (FAO, 2018). Along with agriculture, there are other factors that contribute to the loss of forests, such as illegal logging, the unsustainable management of commercial logging, large-scale construction projects, forest fires, disease, and pests. To achieve forest sustainability, we should consider these factors through a holistic lens.

This paper focuses on the concrete case of South Korea and the success of its reforestation efforts. It explores notable elements that can be applicable and effective for counteracting deforestation in developing countries. According to the FAO, South Korea is one of only four countries (and the only former developing country) that has a successful history of forest rehabilitation following World War II (Korea Forest Service, 2014a). South Korea managed to balance the livelihood needs of the disenfranchised and vulnerable sections of the population, and still rehabilitate its old forest ecosystems while maintaining biodiversity. Through the National Forest 10-Year Plans, South Korea has managed to rehabilitate its forests. Moreover, its forest investments have provided net benefits since 1982 (UNDP, 2017). Lessons from the South Korean case can provide a holistic vision for developing countries when planning their own forestry policies.

2. National reforestation programs during the twentieth century in South Korea

Since the ceasefire treaty from the Korean War took effect, the government of South Korea has tried to rehabilitate land destroyed during the war, including forests. Before the First National Forest 10-Year Plan was initiated in 1973, the government strived to build a legal foundation for the effective management of its forests. After 1973, the plan was launched, and greatly contributed to the success of national reforestation in South Korea.

2.1. Reforestation activities before 1973

Before the first 10-year planning period, the South Korean government went through a process of establishing a legal foundation for its active engagement in forest rehabilitation. In 1951, the temporary forest law was enacted to set the forest protection area and authorize the Minister of Agriculture and Forestry to enforce the establishment of the local forestry cooperative, *Sallimgye* (Lee et al., 2018a). Forest owners and residents of rural areas or mountain villages comprised these forestry cooperatives, of which the basic concept was inherited from the traditional community-based forestry group, *Songgye* (Lee et al., 2018a). Although *Sallimgye* contained several participatory features, it was mainly aimed at the preservation of forest resources according to the governmental policies during this period. The primary activity of *Sallimgye* was patrolling the forests against poachers. It prohibited people from illegal trespass and logging in local forests, whereas reforestation activities and forest utilization by *Sallimgye* were of relatively low importance during this period (Choe, 2008). To enhance forest protection, management, and utilization practices, the Forest Law was officially enacted in 1961. The Forest Law took the economic and public benefits of forest resources into account so that the significance of reforestation and forest management could be recognized. Accordingly, reforestation activities became one of the core strategies in the economic development plans since 1962, which acted as a basis for subsequent engagement on national reforestation (Korea Forest Service, 2014b). The government also initiated the establishment of fuelwood forests during this period to overcome the shortage of primary energy sources, which posed a threat to the country's forests (Korea Forest Service, 2014a).

2.2. Reforestation activities after 1973

After the Korea Forest Service was transferred to the Ministry of Interior in 1973, the Korea Forest Service implemented the First National Forest 10-Year Plan, as a long-term plan for the country's reforestation goals (Figure 1). There were three strategies in this plan, namely: quick forestation, national forestation, and economic forestation (Korea Forest Service, 2014a). The quick forestation plan included the planting of fast-growing trees (e.g., alder, black locust, poplar, and paulownia) on

deforested lands to achieve rapid reforestation and prevent further land degradation. The national forestation plan encouraged public participatory reforestation activities and promoted the local forestry cooperatives (*Sallimgye*). The economic forestation plan was based on the planting of economically valuable trees (e.g., chestnut, Korean pine, and walnut) on relatively fertile lands to support the income of local people. Although the plan was originally meant to be implemented by 1982, its goal was accomplished four years early in 1978. The activities under this national reforestation plan resulted in 1.08 million ha of reforested lands (Korea Forest Service, 2014b). In particular, non-stocked forest land decreased by 57% from 377,000 ha to 217,000 ha, barren land without vegetation, reduced by 65% from 120,000 ha to 78,000 ha, and growing stock per ha increased from 9 m3 to 17 m3 (Korea Forest Service,2014a).

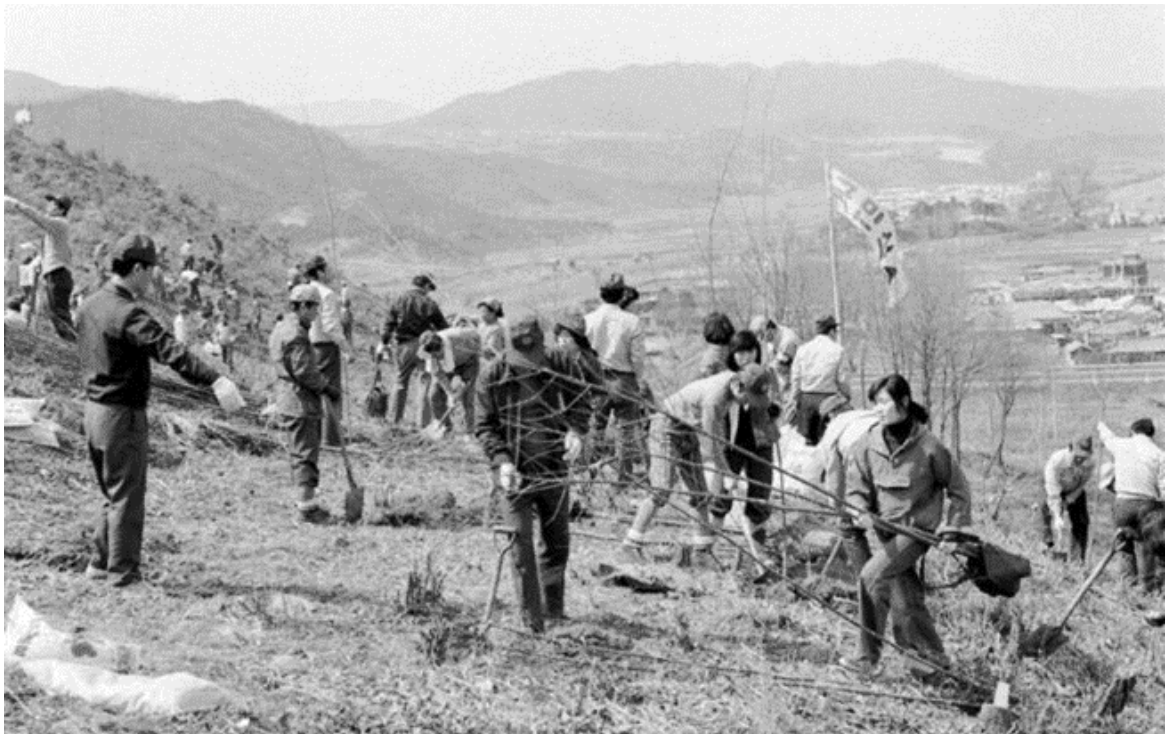

Figure 1. Tree planting event hosted by Korea Forest Service

(Source: National Achieves of Korea, 1977)

The South Korean government approached reforestation with a balance between promotion and regulation. The government incentivized public participation by providing subsidies and food for people who participated in reforestation activities (Ministry of Strategy and Finance, 2013), and authorizing villagers who contributed to reforestation to gather their livelihoods from local forests (Lee, 2015). Conversely, the protection of reforested lands was enforced under strict regulations. The Forest Law banned the poaching of trees and fallen leaves, and penalized logging without permits and also slash-and-burn cultivation (Lee, 2015). Government officers and *Sallimgye* members actively patrolled local forest resources, including not allowing trespassers in the reforested areas (Choe, 2008).

To sustain reforestation activities, the South Korean government used several practices. One of them was establishing fuelwood forests to prevent illegal logging and to provide heating sources for low-

income villagers. Fast-growing tree species such as black locust, poplar, and paulownia were planted to establish fuelwood forests (Korea Forest Service, 2014a). The government received a loan of 4.16 million USD from the International Bank for Reconstruction and Development (IBRD) for the *Saemaul Undong* project and used it to plant 127,000 ha of fuelwood forests, which was the specific objective in 1976 to 1977 (Ministry of Strategy and Finance, 2013). Along with the establishment of fuelwood forests, the collection of fuelwood resources was allowed only in designated areas.

Another practice was to apply a community-based nursery system. The South Korean government renewed community-based nurseries by *Sallimgye* in 1973 as a part of *Saemaul Undong,* the economic development project (Ministry of Strategy and Finance, 2013). *Sallimgye* members led the participation of local people in the nursery operation who served and grew seedlings of major plantation species, including black locust, chestnut, poplar, and pine. The government also aided the operation of the nurseries by providing technical support and buying all of the produced seedlings. Such community-based nurseries earned a total of 12.3 billion KRW (equivalent to 23.0 million USD[1]) between 1973 and 1979, which significantly contributed to the local economy (Ministry of Strategy and Finance, 2013).

From the late 1970s, the national economic development project focused on export-led industrialization and heavy chemical industry. Correspondingly, economic development and urbanization proceeded rapidly with a significant reduction in the number of people living in rural areas, especially among the youth. This caused a shortage of both laborers and skilled experts available for the forestry sector, which substantially raised forest management costs. Building on this experience, the Second National Forest 10-Year Plan (1979-1987) revised the direction of forest policy from a quantitative increase in forest lands to improvement of the commercial value of forest resources (Korea Forest Service, 2014b). During this period, the government created a total of 80 commercial forest complexes, and utilized economically valuable trees rather than fast-growing trees for planting (Korea Forest Service, 2014a). A nation-wide soil survey was simultaneously conducted to solidify the scientific foundation supporting such reforestation activities (Korea Forest Service, 2014b).

During the first two planning periods, the government was able to rehabilitate the country's damaged forests from the post-war period. Considering the success of reforestation and the rapidly growing economy, the government focused more on enhancing the quality of forest resources and aimed at maximizing the public benefits of forests after the completion of the second plan. The country's forests were divided into three categories, production (3,554,000 ha), public interest (1,503,000 ha), and semi-reserve (1,395,000). These forests were managed by distinct policies and practices based on the management objectives (Korea Forest Service, 2014a).

1 USD = 532.54 KRW, mean of the currency rate between 1972 to 1979. (Source: Nam, S.-W., Kim, S.-J. 1999. Evaluation of Korea's exchange rate policy. In: Ito, T., Krueger, A.O. (Eds) Changes in exchange rates in rapidly developing countries: theory, practice, policy, and policy issues. NBER Books, Cambridge, MA, USA. pp. 235- 268.)

Moreover, the government provided subsidies for rural residents, as their income depended on forest products and industries, which were vulnerable to urbanization and related pressures. Public welfare and recreation became another concern after the first two plans. To account for this expansion, the government formalized the legal standards necessary for recreation forests. This standard of assessment included factors that can be roughly translated to scenery, life, drainage, development condition, accessibility, and recreation (National Law Information Center, 2017).

As the average income for forest owners continuously decreased due to a rise in workers' wages combined with stagnant timber prices, it became difficult for forest owners to keep the industry sustainable. Rapid urbanization and industrialization also forced the government to seek alternative ways to use forests and sustain the rural economy. The Korea Forest Service initiated policies encouraging agroforestry under the management of the Ministry of Agriculture and Forestry. Agroforestry ensured more stable incomes for forest workers through the support of short-term income businesses[2] in addition to timber production. The number and value of recreation forests steadily increased from 68 in 1998 to 115 in 2008 and the number of users rose to 7,627,000 people in 2008 (approximately three times more than the number of users in 1998), while annual incomes increased by five times from 5.3 billion KRW (equivalent to 3.8 million USD[3]) in 1998 to 26.9 billion KRW (equivalent to 22.4 million USD[4]) in 2008 (Korea Forest Service, 2014a). Meanwhile, increasing international interest in measures for environmental protection, such as the Convention on Biological Diversity, United Nations Framework Convention on Climate Change, and the United Nations Convention to Combat Desertification, triggered a change in the government's position regarding forest resource utilization, and promoted reevaluation of the ecosystem services from the reforested lands (Korea Forest Service, 2014a). Table 1 presents a brief summary of the policies and practices under the five National Forest 10-Year Plans in South Korea.

2 The term "short-term income business" means the jobs from which local residents can earn profit fast (Source: Korea Forest Service. 2014. 2013 Modularization of Korea's Development Experience: Forest Resource Development in Korea. Ministry of Strategy and Finance, Sejong, South Korea.).

3 1 USD = 1400 KRW in 1998 (Source: https://tradingeconomics.com/south-korea/currency)

4 1 USD = 1200 KRW in 2008 (Source: https://tradingeconomics.com/south-korea/currency)

Table 1. Summary of the National Forest 10-Year Plans established in South Korea (Sources: Korea Forest Service, 2014a, 2014b)

Period	Major policies and practices
First (1973-1978)	• Engagement of the national reforestation program • Establishment of fuelwood forests • Promotion of participatory activities in tree planting and seedling production • Readjustment of slash-and-burn cultivation fields • Substitution of fuelwoods to fossil fuels
Second (1979-1987)	• Forest soil survey to select the area to establish commercial forests • Creation of commercial forest complexes • Encouragement of forest tending works for the reforested lands • Official completion of the national reforestation program
Third (1988-1997)	• Subdivision of the reforested lands according to the management objectives • Implementation of alternative crop trees and forestry-related machineries • Enhancement of infrastructure for forest management, including forest roads • Establishment of the first recreation forest in the country • Initial consideration of sustainable forest management
Fourth (1998-2007)	• Thorough revision of the forest law to account for socio-economic changes • Legalization of forest utilization for recreational purposes • Promotion of agroforestry in rural areas • Diversification of short-term income forest products[5]
Fifth (2008-2017)	• Extensive evaluation of public benefits of the national forest ecosystems • Pilot application of direct payment systems for the forest environment

5 Similar to the term "short-term income business," this indicates the forest products such as mushroom, nuts, seeds, etc., potentially providing the fast profit to local people.

2.3. Saemaul Undong and reforestation

Saemaul Undong started in 1970, under the slogan 'live well,' combining the dual desire for the reduction of poverty and national modernization. The project name came from the combination of the words "*Saemaul* (new village)" and "*Undong* (movement)," which reflects the primary goals of the project. *Saemaul Undong* aimed to reinforce the country's economy, and in particular, modernize rural societies. Since reforestation was one of the key strategies for the economic development during this period, *Saemaul Undong* involved forest-related policies and practices. It also played an important role in containing rural-urban income inequality thereby contributing to social sustainability.

Saemaul Undong contained several projects on greening the villages (Table 2). During this project, 3,453 villages participated in planting trees on 5,884 ha with a project cost of 186 million KRW (equivalent to 0.5 million USD[6]) (Ministry of Strategy and Finance, 2013). In the following year, the project was scaled up to cover the entire country under the name of *Saemaul* Tree Planting, in which 1.2 million people participated planting a total of 29.2 million trees on 23,091 ha. The government incentivized the public participation to *Saemaul* Tree Planting by providing subsidies and food for being involved in reforestation activities (Ministry of Strategy and Finance, 2013). Even though such participatory reforestation primarily came from the activities of local forestry cooperatives (*Sallimgye*), a diverse group of people were involved in *Saemaul* Tree Planting. People from the military, students, governmental officers, and industrial laborers also planted trees in various areas, including villages, office buildings, and around their houses (Korea Forest Service, 2014b). The government further disseminated the importance of reforestation by advertising the reforestation projects though mass media and designating a legal tree-planting period from March 21 to April 20 (Ministry of Strategy and Finance, 2013). Table 2 shows the tree planting policy from the initial stage of *Saemaul* Tree Planting (Ministry of Strategy and Finance, 2013).

Other activities within *Saemaul Undong* influenced the sustainability of the reforestation projects. *Saemaul* Nursery was one of them. The program was a community-based nursery, which was operated from 1973 to 1994 (Lee et al., 2018a). Seedling production through *Saemaul* Nursery boosted not only the economy by creating workplaces for rural people, but also reforestation activity by accounting for approximately 32% of seedling demand during the period under the First National Forest 10-Year Plan (Ministry of Strategy and Finance, 2013). Also, the government supplied the modified fire places that could produce more heat using less fuelwood than conventional fire places (Ministry of Strategy and Finance, 2013). The nursery went through the substitution of energy sources, from fuelwoods to fossil fuels (Bae et al., 2012). These activities resulted in a decrease in demand for fuelwood and charcoal, which were major reasons behind forest overexploitation dur-

6 1 USD = 347.1 KRW in 1971. (Source: Nam, S.-W., Kim, S.-J. 1999. Evaluation of Korea's exchange rate policy. In: Ito, T., Krueger, A.O. (Eds) Changes in exchange rates in rapidly developing countries: theory, practice, policy, and policy issues. NBER Books, Cambridge, MA, USA. pp. 235-268.)

during this period. In addition to rapid growth in household income and a decrease in the rural population, this initiative significantly helped conserve reforested lands from illegal logging (Bae et al., 2012).

Table 2. Initial tree planting policy of Saemaul Tree Planting from 1972 (Sources: Korea Forest Service, 2014a, 2014b)

Project Name	Project Content
Afforesting the Hill in Back of the Village	Project Entity: li, dong[7]* village forestry association
	Planting Unit: Village
	Planting Location: Fruit trees near village, Fuel trees at upper side of the village
	Species: Fruit trees (Chestnut tree, Persimmon tree, Nut pine, Walnut tree, Ginkgo tree), Gangwon Province (Apricot tree), Jeollanam-do Province (Citron tree), Chungcheong Province (Jujube tree), Fuel trees (Black locust, Alder)
Greening the Village	Species: Inner street (Italian poplar, *Populus tomentiglandulosa*, Ginkgo tree), Hedge (Forsythia, Mugunghwa, Thuja, Trifoliate orange tree)
Planting Trees at Work, School, Home	Planting one tree per person Planting on special occasions: Birth, Entering school, Marriage, 60th Birthday, Anniversary
Making a Flower Garden	Making a flower bed

7 'li' refers to the smallest unit of local self-government and 'dong' to the second smallest unit of local self-government in South Korea.

2.4. Benefits of the reforested lands

The reforestation program succeeded in restoring forests in South Korea. This is reflected by the increase in stand volume, a primary indicator of revegetation. The average stand volume per unit area (m^3 ha^{-1}) was 9.6 in 1960, but it increased to 150.2 in 2016 (Korea Forest Service, 2017). As a result of reforestation, the area of un-stocked[8] forests continuously decreased from 3.32 million ha to 0.17 million ha between 1952 and 2007 (Korea Forest Service, 2014b). In addition to the increase in forest area and volume, reforestation affected the forest landscape; the increase of the canopy cover gradually ameliorated ecosystem functions.

In particular, reforestation in Korea, has fostered ecosystem carbon storage and sequestration, the principal function of forest ecosystems. South Korean forests stored 422.4 Tg of carbon in 1954 (just after the Korean War), which increased to 903.5 Tg in 2012 as a result of national reforestation (Lee et al., 2014). This resulted from the accumulation of carbon into both the tree biomass and soil. In terms of carbon sequestration, the forests changed from carbon sources to carbon sinks, which sequestered 25.6 Tg year-1 of the atmospheric carbon in 2012 (Lee et al., 2014). This carbon sequestration rate currently corresponds to approximately 15% of the total emission of greenhouse gas from South Korea (Greenhouse Gas Inventory and Research Center, 2017). This pattern in the carbon storage and sequestration rate indicates that large-scale reforestation significantly contributed to mitigating Korea's contribution to climate change.

The reforestation program also induced the rehabilitation of ecosystem and biodiversity. Initial reforestation efforts in Korea using fast-growing and nitrogen-fixing tree species enhanced soil fertility and stability on the degraded lands, which created the foundation to grow other plant species (Korea Forest Service, 2014b). The animal population also increased because changes in vegetation supported additional habitats and foraging areas (Korea Forest Service, 2014b). In accordance with the national survey, animal populations in forests have notably risen following reforestation; the populations of pheasant, dove, hare, and deer (100 individuals per ha) increased from 3.4, 1.3, 9.0, and 7.0 in 1970 to 19.4, 35.4, 9.1, and 4.1 in 2000, respectively (Figure 2). This indicates the positive effect of reforestation in terms of biodiversity restoration. However, some animal populations decreased since 2000 because of extensive urbanization (Figure 2).

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8 The meaning of the term slightly differs from that of 'unforested land.' According to the Korea Forest Service's definition, 'un-stocked forest' indicates 1) forest containing canopy cover lower than 50% and 2) forest converted to the other land use types such as road, cemetery, pasture, mine, and military facility. Source: Korea Forest Service. 2016. Primary Statistics of Forests. Daejeon, South Korea. (In Korean)

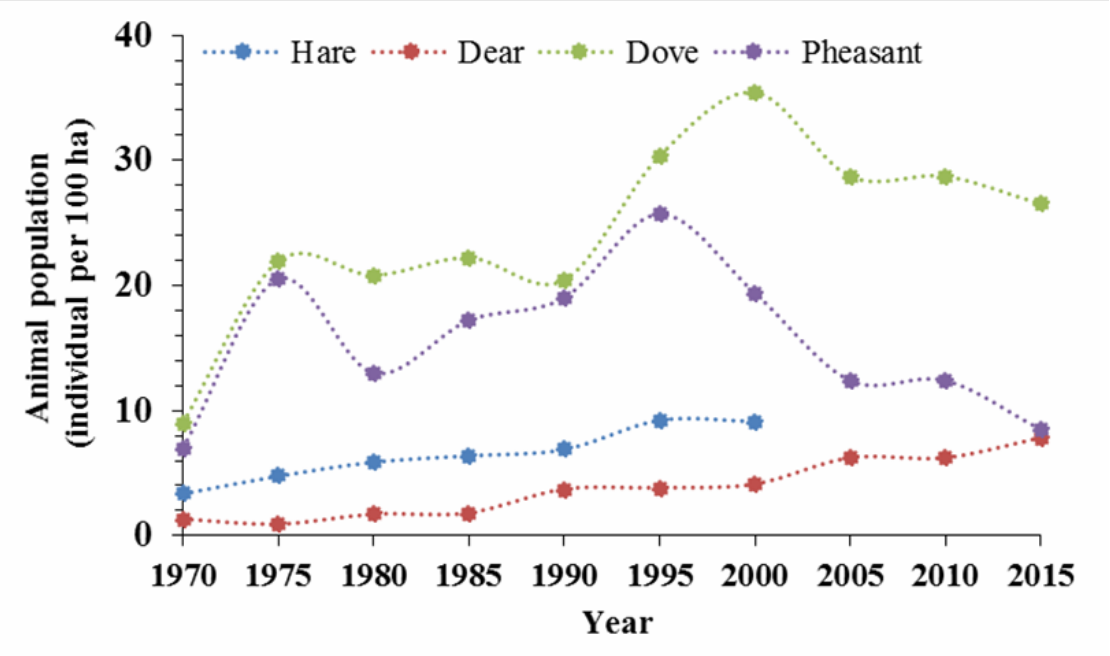

Figure 2. Shifts in pheasant, dove, hare and deer populations in South Korea between 1970 and 2015 (Sources: Korea Forest Service, 2000; National Institute of Environmental Research, 2000, 2005; National Institute of Biological Resources, 2017)[9]

According to the Korea Forest Service and the Korea Forest Research Institute, the total value of the function of forests in South Korea was evaluated to be around 100 billion USD (Korea Forest Service, 2014a). This constituted of categories such as biodiversity conservation (4.8%), forest landscape (13.9%), forest therapy (1.5%), forest recreation (13.4%), watershed conservation (18.5%), water purification (6%), landslide prevention (6.1%), forest animal protection (2.2%), carbon sequestration, oxygen production and air purification (20.2%), and erosion control (13.2%) (Figure 3). Meanwhile, a modeling study evaluated the average annual public benefit of reforestation in South Korea as 1,337 million USD per year, and the average annual cost for reforestation as 220 million USD per year, both of which have been gradually increasing (Figure 4). Of the functions of forests, carbon sequestration exhibited the greatest annual benefit (614 million USD per year), followed by disaster risk reduction (464 million USD per year) and soil erosion control (278 million USD per year). Until 2010, reforestation in South Korea created 54.3 billion USD of the total net benefit. The ratio between benefit and cost increased from 0.07 in 1972 to 5.84 in 2010. These estimates indicate that investments in reforestation are economically viable, and on average generated more than 1 billion USD per year of net benefits (Lee et al., 2018b).

9 The Ministry of Environment and the related research institutes have investigated the population of quarry or endangered animal species since 1967, and published the annual report "Wildlife Survey." The references used for this figure include Korea Forest Service (2000) which summarizes the data between 1969 and 1997. The other references contain the data for 2000 (National Institute of Environmental Research, 2000), 2005 (National Institute of Environmental Research, 2005), and 2010 and 2015 (National Institute of Biological Resources, 2017).

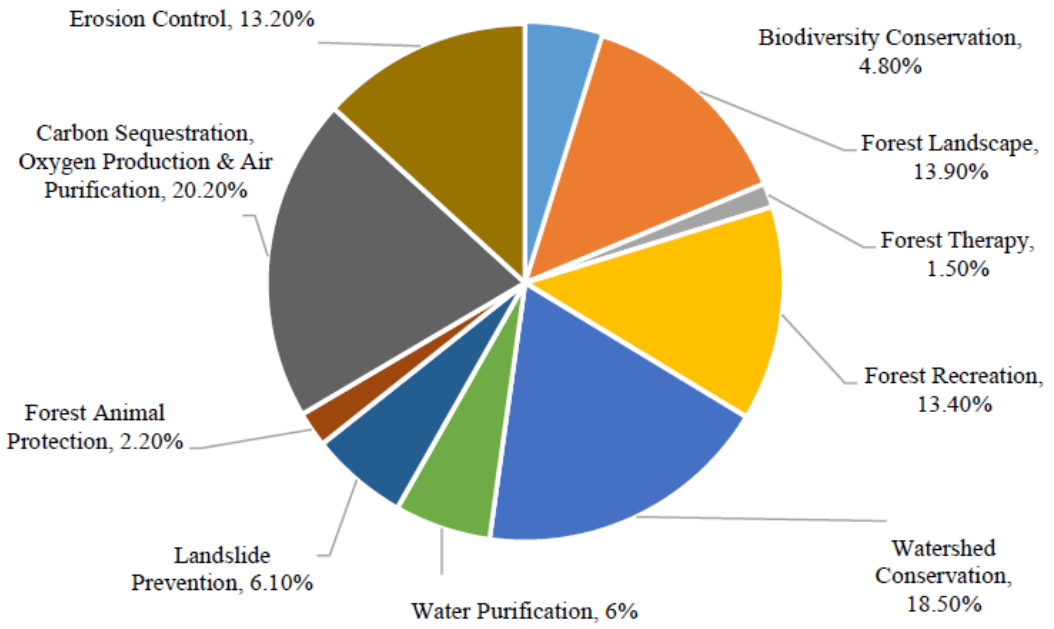

Figure 3. Proportion of each public benefit of the South Korean forests (Source: Korea Forest Service, 2014a)

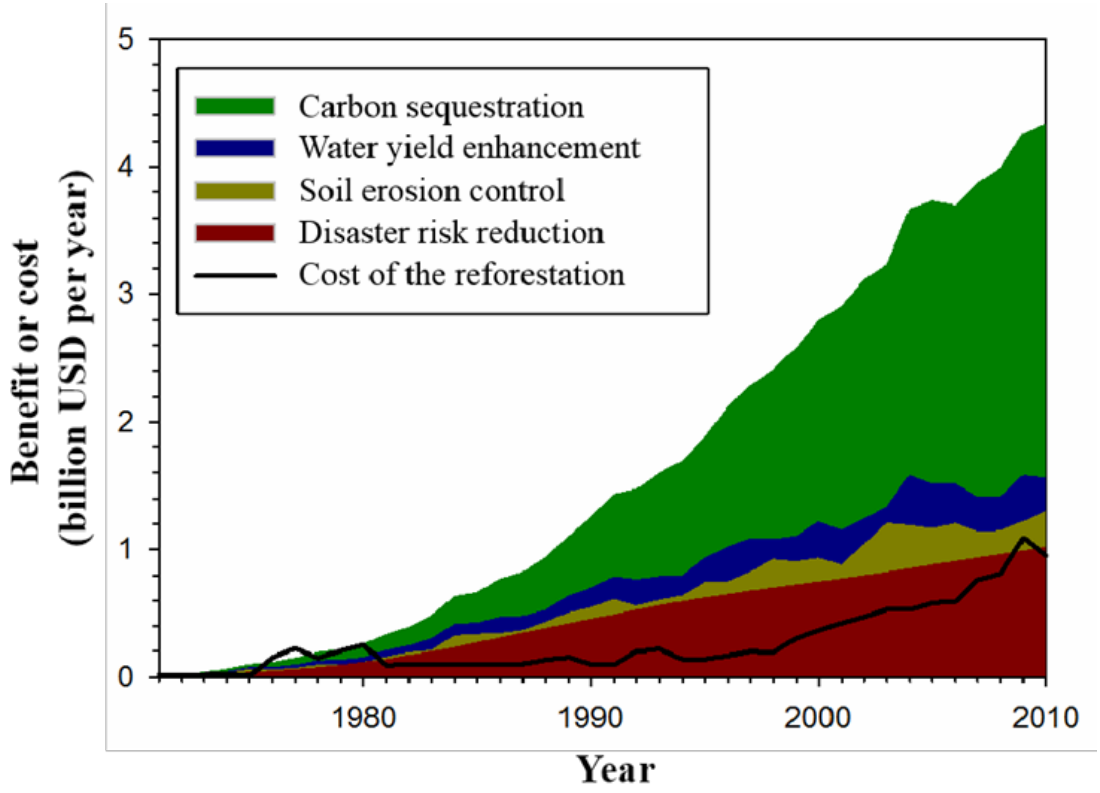

Figure 4. Changes in the annual benefit and cost of the reforestation in South Korea (Source: Lee et al., 2018b)

3. Current forest policies in South Korea

3.1. Sustainable forest management practices

Conventional forest management focused on the utilization of forest resources, such as the production of timber products. However, sustainable forest management (SFM) shifted the paradigm from the primary focus to use of forest resources to a balance between utilization and preservation of those resources (Korea Forest Research Institute, 2009). The concept of SFM was first laid out in legislation in South Korea in 1994. It defined and held the Korea Forest Service responsible as a promoter of SFM (Korea Forest Service, 2014c). In the Fourth Forest 10-Year Plan (1998-2007), the government focused on the 'establishment of SFM foundation' and made an effort to improve the value of forest resources, nurture the forest industry, and create healthy and pleasant forest environments (National Archives of Korea, 2007). To assess the effectiveness of SFM practices in South Korea, Korea Forest Service publicly developed and announced seven criteria and 36 indicators (Korea Forest Service, 2014c). Moreover, the forest sustainability index (FSI) is used to quantitatively score SFM effectiveness (Korea Forest Service, 2014c). Table 3 illustrates SFM criteria and FSI.

Table 3. SFM criteria and forest sustainability index (FSI)
(Sources: Korea Forest Service, 2014c)

SFM criteria	• Conservation of biodiversity • Maintenance of productive capacity of forest ecosystems • Maintenance of forest ecosystem health and vitality • Conservation and maintenance of soil and water resources • Maintenance of forest contribution to global carbon cycles • Maintenance and enhancement of socio-economic benefits of forests to meet the needs of societies • Legal, institutional, and economic frameworks for SFM
FSI	**Forest Health (6 indicators):** • Area of forest/ Percent of mature forest area / Percent of arboretum area / Area of forest genetic resources reserves / Forest tending area/ Area of healthy forest **Economic Value (7 indicators):** • Percent of potential timber production area/ Growing stock of potential timber production area/ Percent of forest area under SFM plan / forest production amount per ha / Ratio of annual cutting to annual growth increment / Percent of budget in the forest sector / Forest contribution to GDP **Public Value (6 indicators):** • Percent of protection forest area / Carbon storage in forest biomass / Carbon budget in forest biomass / Recreation forest area per thousand population / Urban forest area per thousand population / Percent of forestry employment in economically active population

The Jeju Experimental Forests (JEFs) illustrate a relevant example of recent achievements in South Korea on SFM as well as basic forest research (Figure 5). They are the first South Korean forests to be certified as “Forest Stewardship Council-Forest Management” (FSC-FM) in 2006, which is a hallmark of SFM (Korea Forest Research Institute, 2009). These forests aim to “protect natural forest ecosystems, promote forest productivity, enhance benefits of forests, and increase public participation in forest management” (UNDP, 2017).

Located on Jeju island at the southernmost point of South Korea, JEFs consist of Hannam (1,231 ha) and Seogwipo (1,550 ha) experimental forests established in the 1920s, and the Gotjawal (576 ha) experimental forest established in 2015. In recent years, scientists and policy makers gave special attention to Jeju Island due to its ecological significance as a natural home of indigenous, endangered animal and plant species, and because there are a high number of well-preserved forests there (Korea Forest Research Institute, 2014). The Jeju forests are considered an ideal location for research initiatives, and most importantly, allowed for the implementation of the first ever “Long Term Management Plan” from 2006 to 2015 within the experimental forests. This plan aimed to protect natural forests and implement SFM practices. During the implementation of this plan, several concrete results were achieved: 64.3 ha of newly established forests along with 894.9 ha of pre-existing forests saw enhanced value through replanting, fertilization, weeding, and thinning tasks (UNDP, 2017).

These SFM practices aimed at increased rates of timber production, recreation and ecotourism, local employment, and improved ecosystem services e.g. climate change adaptation and soil erosion control, water storage, and water and air purification (UNDP, 2017). Important data gathered by research and nursery studies conducted recently in the experimental forests continue to aid the development and modification of forestry practices nationally, with special focus on ecosystem monitoring, seedling production, and ecosystem service estimation (Korea Forest Research Institute, 2014). Therefore, the Jeju Experimental Forests would help fulfill the dual purpose helping achieve SFM while providing social and economic benefits to local people.

The experimental forest model in Jeju could be adapted to developing country contexts. It is likely that such forests could be successful if the experimental forests are planned according to respective purposes or functions (e.g. biodiversity conservation, seed development, timber production, ecotourism, and so on (Korea Forest Research Institute, 2009).

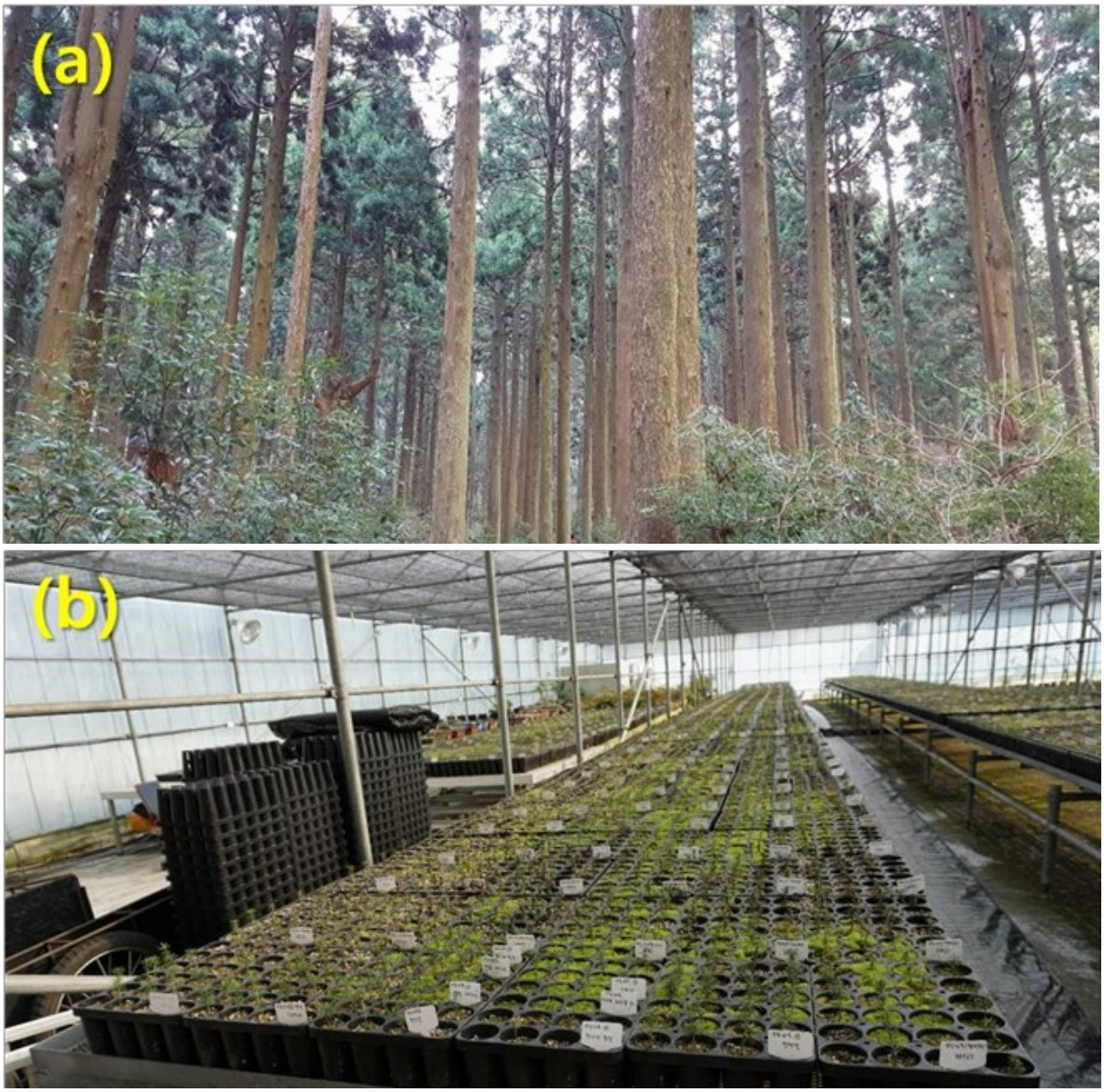

Figure 5. Two snapshots from the Jeju Experimental Forests: (a) Japanese cedar forest (b) A greenhouse

3.2. Carbon offset schemes

While forests and other wooded lands store more than 485 Pg of carbon globally (biomass: 260 Pg, deadwood and litter: 37 Pg, soil: 189 Pg) (UNFCCC, 2018), deforestation and the degradation of forests are the second largest source of carbon emissions, accounting for 17% of total carbon emissions (UN-REDD, 2018). Recognizing the critical role that forests play as a carbon sink, diverse mechanisms have been developed to enhance forests' functions and to increase carbon sequestration.

After the adoption of the Kyoto Protocol, market-based mechanisms have been introduced for climate change mitigation and adaptation. Including the Emission Trading System (ETS), based on the value of credits. Another mechanism is titled Reducing Emissions from Deforestation and Forest Degradation (REDD+) (UN-REDD Programme, 2018). Although ETS under the Kyoto mechanism is legally binding, other projects like REDD+ are being actively operated in the voluntary carbon market. (REDD+ adopts a two- track approach: reducing emissions and providing compensations and incentives.) The ETS approach aims to reduce the rate of forest reduction and increase carbon sequestration. It tackles direct drivers of deforestation and forest degradation, such as logging, and indirect drivers, such as poor governance. The latter approach of REDD+ addresses reduction of carbon emissions and the elevation of forest carbon sequestration by providing developing countries with incentives and technical support (European Forest Institute, 2014).

The South Korean government launched the forest carbon offset scheme in 2010 and subsequently enacted the Act on the Management and Improvement of Carbon Sink (Carbon Sink Act) in 2012 (National Law Information Center, 2017). The Carbon Sink Act specifies activities for maintaining and improving forest carbon sink functions: 1) expanding the carbon sinks, including "afforestation," "management and improvement of carbon sinks in protected zones," and "management of carbon sinks for prevention of disasters," 2) promoting the use of wood products and biomass energy, including "promotion of use of harvested wood product," "fact-finding surveys on use of harvested wood products," "greater efficiency in use of energy in timber industry," and "advancement of utilization of forest biomass energy," and 3) preventing deforestation and forest degradation, including "research on prevention of deforestation and support for the research" and "management and improvement of multiple carbon sinks." Participants of successful carbon sink activities can trade in credits that are equivalent to the reduction amount through the forest carbon offset scheme (National Law Information Center, 2017).

There are two types of forest carbon offset projects, including: achieved reduction (credit) and social contribution. The achieved reduction type targets entities with reduction obligations under the South Korean ETS or the greenhouse gas target management system. However, the social contribution type targets entities that voluntarily reduce carbon emissions. When the system was originally designed, the achieved reduction plan was not acknowledged under the South Korean ETS, even if projects were recognized to be feasible as carbon offsetting projects under the Korea Forest Ser-

vice's forest carbon offset scheme. However, in May 2016, an amendment to the Carbon Sink Act enabled the registration of achieved reduction types of forest carbon offset projects to the South Korean ETS offset market, and the trade of offset credits earned from forest carbon offset projects.

Social contribution forest carbon offset projects can take two forms, namely transaction and non-transaction types. The transaction type undergoes a feasibility assessment and registration, and allows for the trade of forest carbon uptake on the voluntary market. While the non- transaction type is used for promotional purposes. As the transaction type provides credits for carbon uptakes, which can be traded on the voluntary market, it is subjected to verification procedures before receiving certification from the Korean Forestry Promotion Institute. In contrast, the non- transaction types are not subject to formal verification as they use carbon uptake only for promotional purposes. By providing incentives for entities to be involved in forest carbon offset projects, these activities in South Korea are expected to accelerate the simultaneous realization of SFM and mitigation of greenhouse gas emissions.

To support the carbon offset scheme, South Korea has periodically surveyed national resources, infrastructure, and utilization of forests, and accumulated the forest inventory data (Korea Forest Service, 2017). With such data from the national survey, the Greenhouse Gas Inventory and Research Center of South Korea has annually disseminated the country's baseline of greenhouse gas inventory. The recent annual report (Greenhouse Gas Inventory and Research Center, 2017) denotes that land use, land use change, and the forestry (LULUCF) sector sequestered 42,429.8 Mg CO_2 of greenhouse gas in 2017, which account for 6.1% of the greenhouse gas emission from four other sectors including energy, industrial processes, agriculture, and waste. This baseline information is directly applied to report whether South Korea achieves the target amount for greenhouse gas reduction. This information is also useful in evaluating and verifying the contribution of forests to climate change mitigation (Greenhouse Gas Inventory and Research Center, 2017).

3.3. Forest protection

3.3.1. Forest fires

The Korean peninsula is vulnerable to forest fires due to its geographic characteristics. Known as the "East-high-west-low type," the eastern part of the Korean peninsula consists of a series of mountain ranges, including the backbone of the Korean peninsula, Baekdudaegan, which runs between North and South Korea and several other mountain ranges. In addition to this topography, the presence of dry periods during the spring and fall increases the probability of forest fires if not properly managed during the early stages. Figure 6 demonstrates the total damaged area by forest fires between 2001 and 2017.

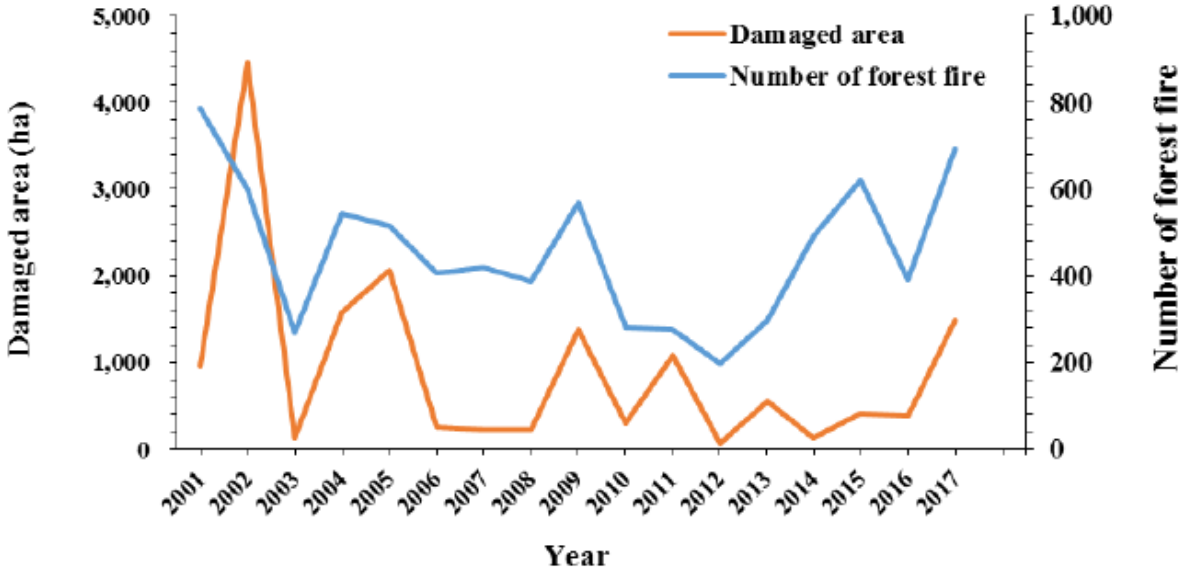

Figure 6. Number of forest fire and damaged areas (Source: Korea Forest Service, 2018a)

To prevent forest fires, South Korea primarily relied on strict monitoring and early warning systems. To monitor and prevent forest fires, the Korea Forest Service (KFS) operates a temporary headquarters during the dry period (Korea Forest Service, 2018a). It has also established an early observation and warning system run by local residents. The KFS also piloted a remote forest fire watching system using drones (Korea Forest Service, 2018a). Before the dry period starts, local officers remove agricultural and daily waste, and the military implements prescribed fire treatments around shooting ranges to eliminate combustible materials near the forests (Korea Forest Service, 2018a). Meanwhile, there are periods of intensive forest fire prevention and monitoring between March and May in the spring; and between November and December in the fall, when access to vulnerable forests (especially those in national parks) is precluded along with restrictions on the possession of inflammable objects during mountain climbing activities.

While the prevention of forest fires is the most important aspect of forest fire management, fire-fighting and follow-up actions are also important. During a forest fire, headquarters sets up a command center at the site and combats forest fires in close cooperation with forest firefighters, forest public servants, municipal fire fighters, volunteer fire fighters, and even the military (Korea Forest Research Institute, 2010). As a follow-up measure, Korea Forest Service makes sure that the fires are completely extinguished and tracks the cause of ignition. Furthermore, Korea Forest Research Institute has developed and implemented a site-specific restoration manual according to the intensity of fire hazards and the location of each site (Korea Forest Research Institute, 2010).

3.3.2. Diseases and pests

In 2016, more than 87,000 ha of South Korean forests were threatened by disease and pests (Korea Forest Service, 2017). As most forests host insect pests (e.g. coccids, mosses, and pine midges), the control of these pests is very important to the forestry of South Korea. Currently, the most noteworthy disease that harms South Korean forests is the Pine Wilt Disease (PWD, *Bursaphelenchus xylophilus*), which infected a total of 6,764,741 pine trees between 2012 and 2016 in the country (Korea Forest Service, 2017). A PWD outbreak in South Korea was first detected in Busan in 1988 and has since become widespread throughout the entire country (Kwon et al., 2011). Out of the 115 areas that were affected, only 13 areas were able to exterminate PWD by January 2018 (Korea Forest Service, 2018b).

To counteract this situation, a special act on the extermination of PWD was enacted in 2005 (Kwon et al., 2011). Since then, a Pine Wilt Disease Monitoring Center was established under the Korea Forestry Promotion Institute. The Korea Forest Service sets up a disaster management center during the months between June to August when the PWD is active to provide constant feedback on issues related to disease management. The National Institute of Forest Service is also attempting to develop an effective strategy to control PWD by applying the silvicultural methods as well as utilizing insecticides and/or nematicides (Kwon et al., 2011). Moreover, it collects data for future research and utilization and to award institutions that successfully control PWD (Korea Forest Service, 2018b).

3.4. Forest utilization

3.4.1. Forest product

South Korea has prioritized developing heavy industry and information technology, and the forestry sector accounts for a small proportion of the South Korean economy (approximately 1% of GDP; Korea Forest Service, 2017). Nonetheless, South Korea continuously produces diverse forest products with the country's restored forest lands (Table 4). In particular, timber production has increased by 459% between 1992 and 2016 (Korea Forest Service, 2017). This drives the simultaneous elevation of self-sufficiency rates in terms of timber supply, from 12% to 57% throughout that period (Korea Forest Service, 2017). In 2016, a total of 86,953 households (204,300 persons) worked full-time or part-time jobs in the forestry sector, and in occupations related to forestation, forest product collection, and forest tending; and 1,194 units (7,487 persons) of forest workers were operational (Korea Forest Service, 2017). The average net income of forestry households from this sector was 11.3 million KRW per household per year[10] in 2016(equivalent to 10,285 USD per household per year), which account for 33.7% of the total net income of those households (Korea Forest Service, 2017).

Table 4. Total amount and value of major forest product of South Korea, produced in 2016 (Source: Korea Forest Service, 2017)

	Timber	Nut and fruit	Wild vegetable	Mushroom	Fuel	Medicinal herb
Total amount	5,175,148 m^3	276,163 Mg	43,213 Mg	24,013 Mg	439,116 Mg	1,121 Mg
Total value (thousand USD *)	446,000	643,000	369,000	216,000	40,149	30,000

* 1 USD is equivalent to 1,100 KRW.

3.4.2. Urban forests

Urban forests are created and managed for recreational activity, relaxation and as, parks, school forests, and forest parks. In addition to the concept of legal and physical forest space, the concept of urban forests can cover cultural, traditional, and community aspects, as well as environmental and ecological. South Korea has gone through rapid urbanization and more than 90% of the total population lives in urban areas. Consequently, environmental quality is declining in these urban spaces with deteriorating heat, noise and air pollution levels .

10 USD = 1100 KRW in 2016 (Source: https://tradingeconomics.com/south-korea/currency)

Accordingly, the South Korean government and NGOs (e.g., Forest for Life and Seoul Green Trust) have used forests to improve and control urban environmental aspects, such as temperature, moisture, noise, and air quality (Lee and Krasny, 2015).

Urban forests are useful in reducing the ambient temperature in the summer and reduce the burden on buildings by providing shade and allowing for cooling and evapotranspiration (Jo, 2002). In the case of Seoul, trees planted on the roadside appeared to cool down the surrounding air temperature, on average, by 2.38°C (Jung et al., 2015). This shows that urban forests can also lessen cooling demand, which in turn reduces carbon emissions associated with fossil fuel use. Furthermore, urban forests can help in noise reduction. While the effect of urban forests can differ due to the physical structure and the tree species planted, they did appear to reduce road noise by 3.21-9.93 dB (Kim et al., 2015). Another study by Shin et al. demonstrated that environmental noise was negatively related to per capita rate of urban forest area (2009). Urban forests play an important role in purifying the urban air as well. When trees absorb carbon dioxide from the air for photosynthesis, they improve air quality by releasing oxygen and sequestering pollutants such as SO_2 and NO_2. In Daegu, for example, urban forests were estimated to sequester an average of 11.4 kg per hectare per year of the atmospheric SO_2 and 26.0 kg per hectare per year of the atmospheric NO_2, which was 36% and 68% higher than national average rates (Choi et al., 2012).

Due to the growing interest on the environmental role of urban forests, the area of urban forests in South Korea increased to a total of 1,253,573 ha (9.91 m2 per capita) as of 2015 (Figure 7). This urban forest area fulfills the World Health Organization (WHO) criteria of 9.0 m2 per capita, even though it is lower than that of other large cities such as London (27 m2 per capita), New York (23 m2 per capita), and Paris (13 m2 per capita) (Korea Forest Service, 2016).

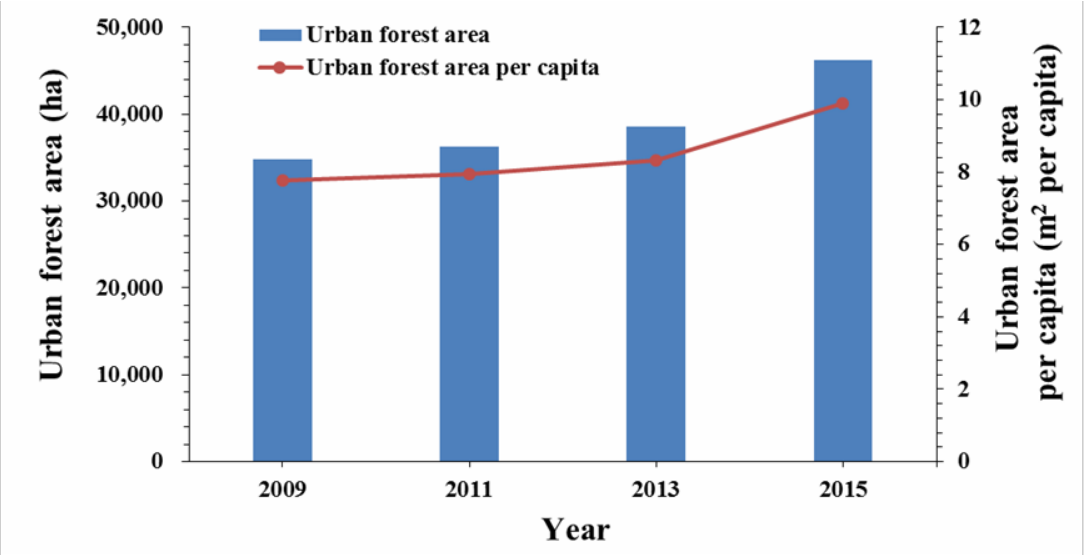

Figure 7. Total area and average per capita of residential urban forests in South Korea (Source: Korea Forest Service, 2016)

3.4.3. Recreation forests

Most urban residents in South Korea have limited access to green spaces in their daily life, and thus tend to participate in outdoor recreational activities during their leisure time. The Korea Forest Service responded to the growing demand for outdoor recreation facilities by establishing recreation forests within national forests, and also by subsidizing the efforts to develop recreation forests by private forest owners and local governments. Since the late 1980s, South Korea has created various recreational facilities such as natural recreation forests and forest parks, starting with the "*Daegwallyeong* Natural Recreation Forest" (Ha, 2012; Figure 8). In 1990, the Forest Law was revised, and in 2005, the Forest Culture and Recreation Act was enacted to help establish a full-scale enforcement system. All these timely measures resulted in the continuous increase in the number of recreation forests and also in the number of visitors to these forests (Figure 9).

Figure 8. View of the Daegwallyeong Natural Recreation Forest (Source: Korea Forest Service, 2016)

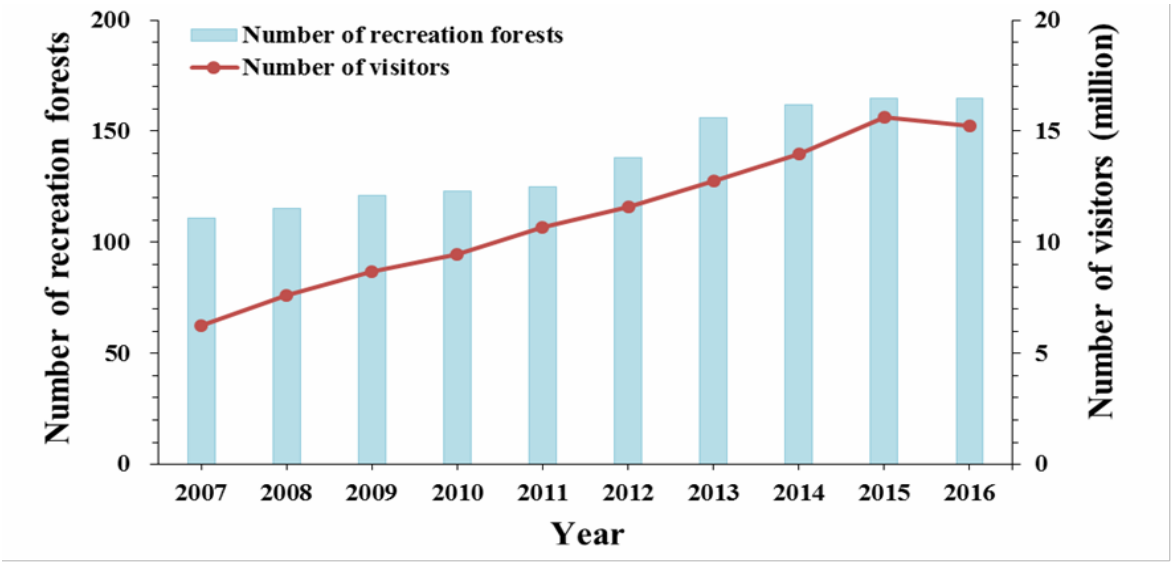

Figure 9. Number of recreation forests and visitors to the recreation forests in South Korea (Source: Korea Forest Service, 2016)

Recreation forests provide various benefits, such as public health and recreation, mental well-being, and forestry education. They are recognized for their health and recreation functions, which include therapeutic use (Yoo, 2007). Accordingly, forest therapy can be defined as any activity meant to restore, maintain, and promote health, including refreshing activities and medical effects (Table 5). There is a case study demonstrating the implementation of forest therapy during the planning of one of South Korea's forests, Mount Manyeon's eco-forest. Various treatments were introduced when organizing its forest space. For example, for exercise therapy, a path was made to help people maintain their health and energize their bodies. Also, foot reflexology massages were introduced by creating acupressure pavements in the forest. By walking on this pavement, people can overcome physical fatigue and clear their heads (Kim et al., 2008).

Table 5. Factors of forest therapy and their effects (Source: Yoo, 2007)

Factors	Effect
Phytoncide	It has antibacterial, insect controlling, and deodorizing effects. The scent gives a pleasant feeling of mind and body and relieves fatigue.
Sunlight in forests	It refreshes and vitalizes the mind and body, protects the bones, regulates cell growth, and inhibits the proliferation of cancer cells.
Anion	It relaxes the body to increase alpha waves of the brain, which stabilizes the mind.
Sound	It gives pleasure by relaxing one's body and easing tension.
Landscape	It provides emotional stability.
Oxygen	It helps to stabilize the metabolism and provide optimal brain function.

Recreational forests also provide other benefits to people. Kim et al. (2008) surveyed users' perceived benefits of recreational forests by asking the question, "How much health benefit did you gain from recreational forest activities during the last year?" When they converted the results of the survey into an economic equivalent, the benefit was evaluated to amount to 1,275,000 KRW[11] (equivalent to 1385.9 USD[12]) per year per capita, and the total benefit of using recreational forests, including self-examination, landscape, etc., was estimated to be 2,493,000 KRW (equivalent to 2710 USD[13]) per year per capita (Table 6).

11 This evaluation was based on a survey to the users of recreation forests with questionnaires. Thus, direct extrapolation of this result to other countries may not be appropriate.

12, 13 USD = 920 KRW in 2007 (Source: https://tradingeconomics.com/south-korea/currency)

Table 6. Benefits per capita from the utilization of recreation forests (Source: Kim et al., 2008)

	Benefits (KRW*)	Percentage
Health benefits per capita	Below 100,000	13.6
	100,000 – 500,000	22.4
	500,000 – 1,000,000	18.4
	1,000,000 – 2,000,000	5.7
	2,000,000 – 3,000,000	7.1
	3,000,000 – 4,000,000	10.6
	More than 4,000,000	9.6
	Other responses	12.6
	Average health benefits = 1,237,050 KRW per year	
Total benefits per capita	Below 500,000	21.5
	500,000 – 1,000,000	20.1
	1,000,000 – 2,000,000	12.4
	2,000,000 – 4,000,000	5.9
	4,000,000 – 6,000,000	7.2
	6,000,000 – 8,000,000	7.3
	More than 8,000,000	11.2
	Other responses	14.3
	Average total benefits = 2,394,280 KRW per year	

3.5. Research and development

South Korea has produced extensive research concerning forest management and utilization (Lee et al., 2017). Since the official establishment of national research institutes and the Korea Forest Service, developing silvicultural techniques have been promoted in the country. In the 1950s, Dr. Hyun Sin-Kyu invented numerous genetically-modified tree species, including *Pinus rigida* x *Pinus taeda* (a hybrid of pitch pine and loblolly pine) and *Populus alba* x *Populus glandulosa* (also known as *Populus tomentiglandulosa*; a hybrid of white poplar and Suwon poplar) of these various species,. *P. alba* x *P. glandulosa,* in particular, featured a greater tolerance to dry weather and a higher growth rate than the original species so that it could be broadly applied to reforestation during the middle of the twentieth century. Recent studies have genetically improved the growth rate of black locust, a fast-growing and nitrogen-fixing tree species, which is potentially applicable to land rehabilitation in developing countries (Lee et al., 2017).

South Korean forest research primarily searched for the most effective method to reforest highly degraded lands. In particular, factors affecting the efficiency of reforestation activity have been investigated, including the physical control of soil erosion, the selection of tree species, and the utili-

zation of soil microbial activity (Lee et al., 2009, 2017). Furthermore, research focused on the management practices for reforested lands. In the 1970s and 1980s, experimental fertilizations explored nutrients limiting the survival and growth of seedlings that were planted in degraded forests, and the optimal amount of fertilizer for young plantations and mature forests (Lee et al., 2009). More recently, economic and environmental influences of thinning (partial logging) have been evaluated on the basis of alterations in crop tree growth and the ecosystem carbon storage (Lee et al., 2015).

The South Korean government has surveyed the properties of forest soil throughout the whole country to produce the basis for deciding suitable plantation species for each local environment. Combined with the First National Forest 10-Year Plan, the government carried out a soil survey project in national forests between 1974 and 1976 (Lee et al., 2009). This was the largest soil survey project in South Korea, which measured topography (e.g., slope) and soil properties (e.g., soil depth, texture, moisture, and hardness) related to tree growth. Moreover, there has been an ongoing soil survey since 2009 to map national forest soil classifications and properties at a resolution of 1:5,000 (Korea Forest Research Institute, 2011). This soil survey consists of re-segmenting the grid of the previous forest soil map (1:25,000 resolution) and assessing soil properties in the field for each grid (Korea Forest Research Institute, 2011).

The government established several experimental forests to boost research projects in the forestry sector. One important example is the Gwangneung experimental forest, the oldest experimental forest in the country. Since its establishment in 1913, this forest has acted as the foundation for piloting new technologies on seedling production, tree planting, forest management, and mechanization (Korea Forest Research Institute, 2009a). Given the growing national priority to strategize climate change adaptation and mitigation, experimental forest related research also included long-term monitoring of the ecosystem carbon cycle (Figure 10a) and simulating the consequences of the climate change scenarios (i.e., changes in air temperature and precipitation levels) in terms of tree growth and soil microbial community (Figure 10b).

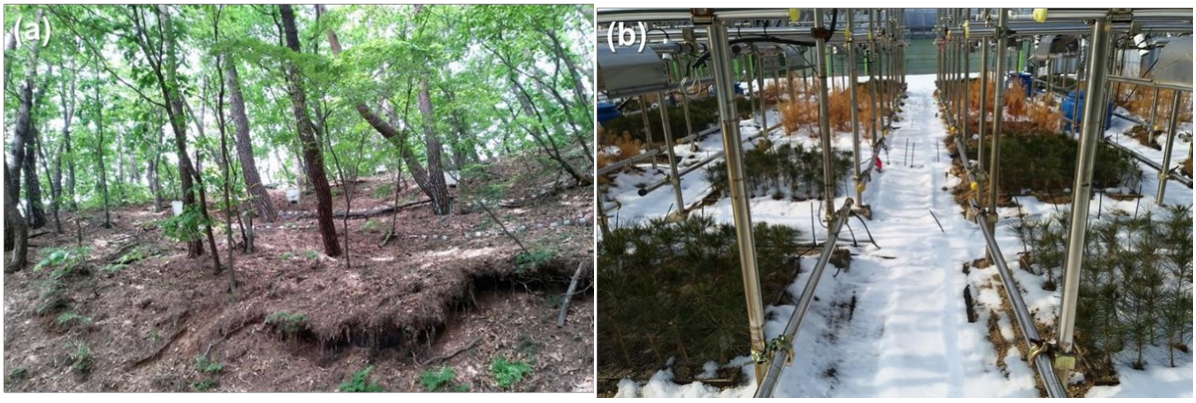

Figure 10. A long-term monitoring site (a) and an open-field nursery simulating the impacts of climate change (b) in the Gwangneung experimental forest

4. Cross-border experiences in sustainable forest management

Forest management was once considered a task for the government rather than civil societies. Moreover, human activity in forest-vicinity communities was considered destructive, harming the sustainability of forests. However, these beliefs are changing as communities near forests play an increasingly significant role in realizing SFM. To foster the sustainability of forests, forest-vicinity communities are included as essential partners in forestry policies. Based on this idea, community-based forestry became a highlighted practice for SFM.

Community-based forestry refers to the "processes and mechanisms that enable key direct stakeholders in forestry to be part of decision-making in all aspects of forest management, from managing resources to formulating and implementing institutional frameworks" (FAO, 2018). It involves small-holders, community-companies, small-scale forest-based enterprises, and indigenous management of forests (Gilmour, 2016). Community-based forestry encompasses participatory conservation, joint forest management, community forestry, and private ownership.

Its importance has been steadily increasing in developed countries and expanding its reach to developing countries as they closely interact with the market. Specifically, 50% of forest land in Europe is managed by small holders who closely interact with the market by utilizing favorable institutional arrangements. An estimate from FAO's Global Forest Resources Assessment 2017 indicates that around 732 million ha, or 28% of forests in 62 countries, are community-based forestry (Gilmour, 2016).

4.1. Traditional knowledge and forest management in South Korea

Current forestry policies in South Korea are highly influenced by traditional ecological knowledge and forest management practices. There exists record of well-maintained forest systems dating as far back as the fourteenth century. Academic interest in the modern-day application of ancient forestry insights has been growing (Kim et al., 2017). Traditional forestry practices have been significant to the South Korean government's efforts in forest rehabilitation and conservation, as it conserved crucial forest resources and areas in which research and policy experimentation could take place. Providing the conditions necessary for forestry policies to become successful, traditional forestry practices – including community participatory methods – could provide useful policy lessons for developing countries.

4.1.1. Historical governance of forest resources

Ancient Korean kingdoms managed forests using inherited experience and beliefs to harvest resources, store building materials, and perform religious ceremonies. For example, kingdoms established plantations with due consideration of local conditions. During the Joseon Dynasty (1392–1910), governmental officers selected fruit tree species, which suited the local environment and had economic value (Kang, 2003). This kingdom used abandoned or dry and infertile lands to plant dry-tolerant species, such as Korean red pine (*Pinus densiflora*). This practice decreased the competition between Korean red pine seedlings and broadleaf trees, and minimized the disturbance from illegal slash-and-burn cultivation (Han, 2013).

Figure 11. Culturally protected Korean red pine forest enclosing the royal tomb, West Five Royal Tombs in South Korea

Ancient Korean kingdoms paid specific attention to protecting Korean red pine forests because this species was commonly used as material for palaces and battleships (Han, 2013). During the Joseon Dynasty, the kingdom set up forbidden forests ("Geumsan" and "Bongsan"), in which the harvesting of woods was strictly banned (Kong et al., 2014). The kingdom also sheltered Korean red pine forests enclosing palaces and royal tombs from private logging and fire setting (Figure 11). Additionally, the kingdom promulgated laws defining penalties associated with illegal utilization of forests, and periodically monitored the number of trees in the forbidden forests (Kwon, 2007). For pest control, this kingdom forced local officers to contribute to the extermination of pine caterpillars (Kong et al., 2014).

As the kingdom did not have enough royal laborers to maintain all the forests, the ancient kingdom promoted cooperation with local villagers (Kim et al., 2017). The kingdom lent several Korean red pine forests to local villager groups so that they could collect timber, fuel, compost, and other resources in provinces with abundant Korean red pine forests (Kwon, 2007). Local villagers received fees and labor for the management of these forests (Kwon, 2007). Such governance encouraged the participation of local village groups in forest management, which catalyzed the development of community-based forestry.

4.1.2. Community-based forestry

There is a long history of community forestry in South Korea . Ancient Korean societies relied highly on local forests. For example, in accordance with the concept of "Fengshui[14]", ancient Korean people forested the "entrances" and "backyards" around residential lands. Such forested lands in Korea are called *Maeulsoop* (village groove), which ancient Koreans respected from religious and spiritual perspectives. *Maeulsoop* included shrines dedicated to a native god, and was often utilized for ceremonies (Youn et al. 2012). In addition, local villagers gathered organic matters such as fallen leaves, twigs, and branches from *Maeulsoop* for timber, fuel, fodder, and compost (Youn et al. 2012). This relationship between *Maeulsoop*, and the local livelihoods resulted in residential and paddy lands in ancient Korea to be located close to Maeulsoop to ease the provision of agricultural and daily resources.

Ancient Koreans felt the need for cooperatives in labor to collect timber, fuel, and compost for their livelihood. There was also a need to prevent illegal monopolies and poaching and people utilized participatory activities for this purpose (Kang, 2009). The strict governance of the kingdom allowed the ancient Koreans to organize local forestry cooperatives, called *Songgye,* mentioned earlier in the brief around the seventeenth century (Chun and Tak, 2009). The term "*Songgye*" originates from a combination of the words "song" (pine trees) and "gye" (local community cooperatives). Although *Songgye* was primarily operated by the participation of local villagers, the *Songgye* members frequently worked within government forest policies and requirements (Gillett, 1913; Kang, 2009).

Essentially, *Songgye* aimed to allocate quotas for the collection of forest resources to each villager, who had duties and rights regarding local forest resources . The members of *Songgye* worked together to collect fuelwood and compost and to distribute resources to other members fairly (Chun and Tak, 2009). When harvesting timber, villagers asked for permission from *Songgye* and paid a fee based on the size and species of harvested trees (Kang, 2009). *Songgye* members also utilized local forests for ancestral tombs with agreement from the cooperative, and paid in accordance to the target forest area (Kang, 2009). Villagers who were not members of *Songgye* were also able to use local forest resources with permission. However, they paid higher fees compared to the *Songgye* members.

Songgye strictly protected local Korean red pine forests. Forests in ancient Korea were severely threatened due to warfare and natural disasters during the middle and late Joseon Dynasty (Chun and Tak, 2009). This situation resulted in a shortage of forest resources which forced *Songgye* to set strict self-regulations to shelter local forests from illegal monopolies and poaching (Chun and Tak, 2009). The regulation of *Songgye* covered various issues related to forest management and utilization, and penalized people who violated the regulations (Box 1). Although *Songgye* insufficiently

14 Fengshui is an old Chinese concept concerning the circulation of vital substances and forces throughout landscape. In the ancient Northeast Asia (China, Japan, and Korea), landscape was often 'adjusted' in accordance with this concept. (Source: Youn, Y.-C., Liu, J., Sakuma, D., Kim, K., Masahiro, I., Shin, J.-H., Yuan, J. 2012. Northeast Asia. In: Parrotta, J.A., Trosper, R.L. (Eds) Traditional forest-related knowledge. Springer, Dordrecht, Netherlands. pp. 291–313.)

focused on the reforestation, it contained a participatory patrol system for local Korean red pine forests. The cooperative assigned forest areas to each member in which they had to watch for forest fires, and created an emergency contact network to enable the joint extinguishment of forest fires (Chun and Tak, 2009). The cooperatives also led pest control efforts by mandating participation in exterminating pine caterpillars (Box 1). Since such self-regulations were strictly enforced, forests managed by *Songgye* were sustained better than forests without the management of *Songgye* (Chun and Tak, 2009; Kang, 2009).

Box 1. Self-regulation by Songgye for Korean red pine forest conservation (Gillet, 1913)

"We plan to keep pine-trees growing in the forest in order that they may be used hereafter.

- Any one who cuts down a large pine tree shall be brought to the Magistrate and punished. If he cuts down from one to ten young trees he shall be given 50 blows and fined 200 nyang (currency of Korea during Joseon dynasty). If he cuts down large branches of pine trees he shall be given 30 blows. For cutting small branches he shall be given 15 blows.
- Any one who cuts down a large tree, not of the pine variety, shall be given 30 blows and fined 100 nyang.
- If any one makes an arrangement with the wood cutter he shall be punished equally with the cutter.
- Any one who shakes the leaves from the pine trees and collects them shall be fined 50 nyang.
- When there are pine grubs coming out in the forest the villagers must destroy them before they become abundant. One person from every house must take a part in the work of destroying the grubs for three day periods in turn. Any one who is absent at the time of destroying the grubs shall be fined 20 nyang. Any one who comes at that time must bring his food with him."

Although *Songgye* does not exist in current Korean society, its key concepts of traditional community-based forestry were adopted to overcome deforestation due to many subsequent events including Japanese colonization, the Korean War, and decades of poverty, private monopoly, and poaching during the mid-twentieth century. When South Korea began efforts to rebuild its forests during the 1960s, the government relied heavily on the modern adaptation of traditional ecological knowledge and the cultivation of participatory, community forestry cooperatives called *Sallimgye*, which were similar to *Songgye* (Kim et al., 2017) and acted as self-governing "mutual aid" associations that promoted cooperation between local villagers and forest owners. Members of this new type of cooperative participated in tasks which included site preparation, tree planting, seed collec-

tion, nursery operation, forest management, and area patrols (Ministry of Strategy and Finance, 2013). The *Sallimgye* movement was implemented nation-wide and operated at the local level and grew earnestly, beginning in the 1970s under the government's direction (Lee et al., 2018a). An incentive system of economic benefits and technical support introduced in the *Sallimgye* cooperatives helped boost public participation in South Korea's forest rehabilitation programs, and upscaled the impact of its forestation efforts.

4.2. Community-based forestry in other countries

A brief review of community bases forestry initiatives in other countries may be useful at this stage. Nepal, aimed to improve the livelihoods of rural communities through this initiative. Since the 1970s, the Government of Nepal has implemented Community Forest (CF) programmes. In 1987, the government started to transfer full rights of sustainable management and use of forest resources to local communities with the intention of strengthening livelihoods of rural populations while simultaneously promoting SFM. Under the CF programme, the state holds ownership and the District Forest Office (DFO), a district level administrative unit that deals with forestry, provides access to forests to local communities and supports their overall management. In 2017, 1,813,478 ha of government-owned forests were handed over to local communities by DFO, which involved 19,361 Community Forest User Groups (Aryal and Pandey, 2017).

Under the CF programme, Community Based Forest Enterprises (CBFEs) were fostered and contributed to improving the livelihood of socially disadvantaged groups. Several studies have indicated a positive correlation between CBFEs and income at household levels. According to Acharya (2005), three CBFEs in Dolakha District, Nepal, contributed to an average 11% increase of income at the household level, with 194 households receiving benefits. Moreover, Subedi et al. (2002) and Subedi (2006) concluded that enterprise-based forest development has a high potential for improving the livelihoods of rural populations.

The Philippines has also adopted community-based forest management since 1971. During its first period (1971-1980), the Government of Philippines focused on three major forestry programs: forest occupancy management, family approaches to reforestation, and communal tree farming. These programs utilized the rural community as a source of labor, but did not consider them as management partners in forestry. During the second period (1981-1989), the rural community started to become managers. Through the Integrated Social Forest Program, people were granted the rights to manage and use forest resources for 25 years if they are used for private consumption purposes. In contrast, the Community Forestry Program allowed the commercial use of forests for 25 years. Most importantly, the Community Based Forestry Management Agreement (CBFMA) was established in the third period (1990-present) based on Executive Order no. 263 of the President and Administrative Order no. 96-29 within the Department of the Environment and Natural Resources (DENR). This CBFMA is a 25-year sharing agreement of products between the Department

and the participating People's Organization. This agreement secures the rights and incentives to develop, utilize, and manage forests (Min et al., 2014).

In Canada, a community-based forestry program, known as the Indigenous Forest Initiative (IFI), "provides funding to support the economic development of indigenous peoples in Canada." The activities funded promote greater participation by indigenous communities in all-natural resource sectors, especially the forest sector (Natural Resources Canada, 2018). In June 2017, the Canadian government expanded the program with an additional 10 million USD in funding over three years (2017 – 2020). This initiative fund supports community-based forestry including 1) preparing plans/ assessments that cultivate economic opportunities in forestry, 2) training and skills development to support forestry projects, 3) business planning, including startup or expansion, and 4) development of forestry related tools, technology, products, and services (Natural Resources Canada, 2018).

4.3. Implications

There remains many challenges to successful reforestation in developing countries. Poverty in rural areas intensified forest overexploitation to acquire fuelwood, timber, and to establish agricultural lands (Hosonuma et al., 2012). Additionally, forests in developing countries have been threatened by natural and anthropogenic disasters such as pests and forest fires (Konecny et al., 2016). Developing countries that face political instability, are not able to enforce policies and laws against the poaching of forest resources (Innes, 2010). Such situations lead to an increasing demand for diverse information and technologies that counteract forest overexploitation, forest transition, and disaster. While improved economic growth is a priority, many developing countries have also begun prioritizing finding alternative income sources to substitute intensive forest utilization by cooperating with developed countries and participating in climate change mitigation programs (e.g., REDD+).

South Korea has a broad range of experiences on SFM, namely traditional and modern community-based forestry, success of national reforestation activities, integration of reforestation activities with economic development, and on-going research and development for sustaining the forestry sector. These experiences acted as drivers which South Korea utilized well to become the only former developing country to overcome deforestation and poverty after World War II. Thus, sharing forestry focused knowledge and utilizing South Korea's experiences can be useful in the context of developing countries faced with deforestation challenges.

As noted before, community-based forestry can be successfully integrated into national reforestation activities. The traditional *Songgye* and the modern *Sallimgye* exhibit effective examples of such integration. These two community-based forestry cooperatives related to the country's forest policies on forest restoration, protection, and utilization (Chun and Tak, 2009; Lee et al., 2017). Participatory activities by cooperative members provided labor for conducting large-scale forestry activi-

ties, such as tree planting, forest patrol, nursery operation, and forest resource collection and allocation to each villager on a local scale. Literature review suggests that in terms of local community-based forestry's labor provision, the South Korean government could broaden the scale of its reforestation projects (Ministry of Strategy and Finance, 2013). As briefly explained above, many countries have their own community-based forestry systems. Therefore, revisiting community-based forestry may be useful as a cross-border strategy toward SFM.

Another notable aspect of the Korean experience is the necessity of connecting reforestation with the local economy and livelihoods. This aspect is critical for sustaining reforested lands, given that villagers may overexploit reforested lands for their own livelihoods unless continuous reforestation activity is deemed worth investing in. When the South Korean government commenced the national reforestation project during the middle of the twentieth century, the government combined rural economic development (i.e., *Saemaul Undong*) with reforestation activities. Along with extensive tree planting, the rural economic development projects led to the reduction of forest exploitation by creating extra income from the forestry sector (e.g., the operation of the community-based nursery) and improving energy efficiency of end use (e.g., by providing improved fireplaces and alternative fuels) (Bae et al., 2012; Lee et al., 2017; Ministry of Strategy and Finance, 2013). Such approaches will be a prerequisite for sustaining reforestation activity, considering poaching and illegal logging are common threats to reforestation across developing countries.

While top-down governance incentivized participatory activities, the South Korean government compensated tree planting in the national forests and provided food and livelihood to enhance small-scale community-based reforestation (Ministry of Strategy and Finance, 2013). It also indirectly promoted people's participation in reforestation activities by utilizing seedlings produced from community-based nurseries. Forestry-related research and development programs technically supported reforestation policies and activities on nursery operation, tree planting, forest management, and alternative fuel utilization (Ministry of Strategy and Finance, 2013). The strong leadership of policy makers and systematic governance by forestry agencies further enabled such promotion of reforestation activities (Lee, 2015). Additionally, reforestation programs included strict enforcement of forest protection measures. To conserve reforested lands, the government penalized any person who trespassed or utilized forest resources without permission (Choe, 2008). An allowable quota for collecting fuel and timber was set so that forest resources could be harvested sustainably (Lee, 2015). These regulations limited any unintended forest exploitation under the governmental promotions.

The bottom-up motivation of participants reinforced the top-down governance. In particular, rural people actively contributed to governmental policies for tree planting and forest management because there was an inherited respect for the forest due to historical governance of forests (Fengshui-based forest management) and community-based forestry (*Maeulsoop* and *Songgye*) (Chun, 1999; Lee, 2015). The presence of the old forest cooperative (*Songgye*) also aided the government in enforcing forest protection as a traditional knowledge system from community-based

tree planting and forest management (Chun and Tak, 2009).

Overall, the South Korean experience demonstrates that both top-down governance (governmental incentives and regulations) and bottom-up motivation (traditional knowledge and practices) can reinforce each other when implementing reforestation programs.

South Korea's case convincingly illustrates that national reforestation has the potential to foster sustained and substantial ecosystem services. Current South Korean society has benefited from restored forests in terms of carbon sequestration, biodiversity conservation, disaster management, and water resource management. Overall, reforestation programmes have been economically beneficial in the long-term. As noted before, South Korean policies activated the use of the country's forests for diverse purposes with a focus on Sustainable Forest Management (SFM), such as improving the urban environment (urban forests), encouraging the creation of leisure areas for people's welfare (recreation forests), and piloting new forestry systems (SFM in Jeju Experimental Forests) as well as traditional wood production. Research institutes continue to utilize forests for research and development for meeting various global challenges (e.g., climate change) as well. These benefits highlight the importance of the country's forests for society.

Since South Korea has received official development assistance (ODA) from around the world during its period of reforestation and rapid economic development, as a member of OECD-DAC, the country considers contribution to the environment and economic growth in developing countries as an important responsibility. Also, there is an increasing demand for South Korea's knowhow on successful economic growth and environmental management practices. Given South Korea's extensive knowledge in reforestation and SFM, sharing and piloting this knowledge to developing countries in need can be a very useful strategy for ODA in the forestry sector. This would allow forest management strategies in developing countries to be structured and guided by policies and scientific knowledge developed by South Korea. Additionally, South Korea's case can provide guidance on a viable REDD+ strategy for developing countries while moving towards more sustainable management of forests.

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