Ecology

Korea is located between 33˚ and 43˚ north latitude in a temperate climate region with four seasons. Precipitation in Korea is abundant, and each season shows diverse climate characteristics. Mountain areas, which are mostly distributed around the northern and eastern regions, cover about 64% in the land of South Korea in 2015. In the southern and western areas, large rivers run, and various erosional or depositional landforms surround the rivers. Three sides of the Peninsula are surrounded by the sea with a rias coast and many islands in the South Sea; even and flat tideland resulting from a vast tide range in the Yellow Sea; and sand dunes and lagoons alongside a smooth coastline in the East sea.

The complexity and variety of ecosystems formed by the diverse climate and complicated topography affect the biodiversity inhabiting the Peninsula. Sub-alpine coniferous forests are common in the northern region, deciduous broadleaf forests are common in the central region, and warm, temperate evergreen forests are common in the southern and island regions. The natural conditions and variety of vegetation also derive variations in ecosystem productivity, resulting in distinct micro-habitats for a wide diversity of faunal communities.

The rich and diverse ecosystems in the Korean Peninsula have attracted people for centuries. People of Korea have been provided with abundant ecosystem services. They have developed a unique lifestyle that merges the marine culture of the Pacific with the continental culture of Eurasia. They have also established a watershed-based traditional view of nature with the Baekdudaegan mountain ridge as the backbone of the Peninsula, and have developed numerous unique ecological cultures such as village forest, acorn jello, Song-gye (traditional social institution for sustainable forest management), and Hyangyak (local rules).

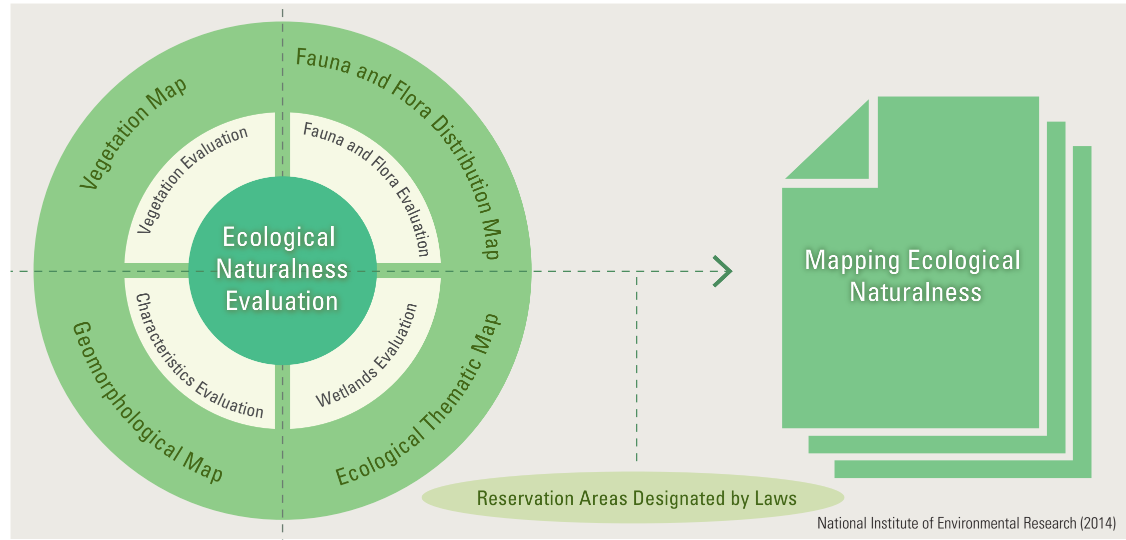
Although the rapid industrialization and land development has expanded the national economy, Korea now faces significant environmental issues such as pollution of air, water, and soil, reduction of biodiversity, and ecosystem degradation. To take action against these issues, natural environments and biota have been investigated nationwide. The collected data have been comprehensively assessed and used for the formation of Ecological Naturalness Maps. Ecological Naturalness Maps visualize the ecological value of each spatial unit—mountains, rivers, inland wetlands, lakes, farmland, and urban areas—according to a rating system.

For the Ecological Naturalness Maps, environmental investigations are carried out to evaluate ecological naturalness through field surveys under 9 categories (geographical features, vegetation, flora, benthic macro-invertebrates, insects, freshwater fish, reptiles, birds, and mammals). The results are stored as GIS database. Based on this data, assessments of vegetation, animals and plants, geographical features, and wetlands are carried out for the comprehensive evaluation of the Ecological Naturalness Maps.

Final results are illustrated on the maps according to a 4-grade ranking system. In Grade 1 areas, the highest grade, development activities are limited in order to preserve or restore the natural environment. In Grade 2 areas, measures are required to minimize impacts on the natural environment due to development and land use. In Grade 3 areas, systematic development and land use are permitted. Reservation areas such as national parks and cultural heritage protection sites designated as reservation areas by laws such as the Natural Environment Conservation Act are classified as special management areas.

Ecological Naturalness Maps are used in national and local environmental plans, as well as in the process of making and implementing development plans, environmental impact assessments, and in consultations requiring referential data.

Mapping Procedure for Ecological Naturalness Map



National Institute of Environmental Research (2014)

Ecological Soundness

Ecological Naturalness Map

National Institute of Ecology (2015)

Nationwide Natural Environment Survey

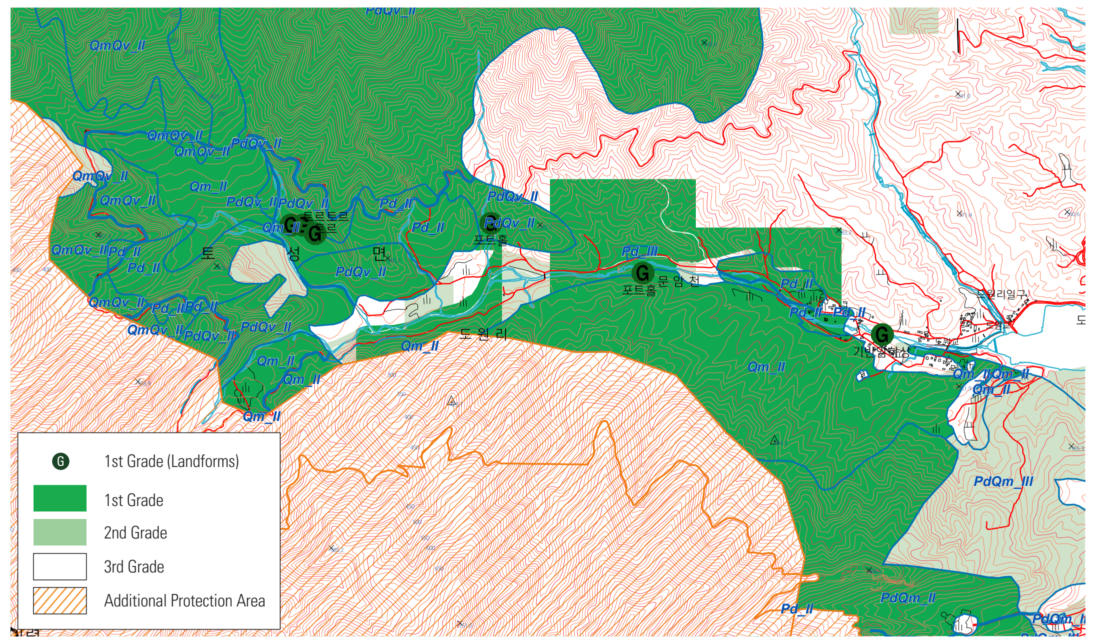
The Ministry of Environment has been conducting a nationwide survey of the natural environment every 5 years. The first Natural Environment Survey started in 1986. Since 2014, the 4th survey has been carried out. The produced maps range from sectoral thematic maps such as valuable geomorphological feature maps, actual vegetation maps, and floral and faunal distribution maps, to comprehensive environmental evaluation maps such as ecological maps that utilize the sectoral thematic maps. They are now publicized and widely used by various users such as environment-related governmental agencies, industries, academics, and the public.

Geomorphological Feature Survey

Vegetation Survey

Fauna and Flora Survey

Example of Natural Environment Survey (Ganseong Map Sheet)



National Institute of Ecology (2015)

Nationwide Natural Environment Survey

1986 – 1990 – 1997 – 2005 – 2006 – 2012 – 2014

The 1st
- Administrative Units

The 2nd
- Mountain-Centered Ecosystem Units

The 3rd
- Topographic Map Sheet Units
- Detailed Mountain-Centered Ecosystem Units

The 4th

The 1st Survey
(1986 – 1990: A 5-Year Plan)

For the very first national survey of the natural environment across the whole country, investigation on the habitat status of flora and fauna was carried out by using the administrative units as survey regions. The results of this survey were used to map the naturalness of the national green belt.

The 2nd Survey
(1997 – 2005: A 9-Year Plan)

In this survey, the nation was divided into a total of 206 ecological regions (mountainous areas bounded by rivers). The spatial distributions of the valuable geomorphological features, flora, terrestrial entomofauna, fish, benthic macro-invertebrates, amphibian and reptile species, birds, and mammals were investigated. The results of this survey were used to make the Ecological Naturalness Map for land-use and development planning.

The 3rd Survey
(2006 – 2012: A 7-Year Plan)

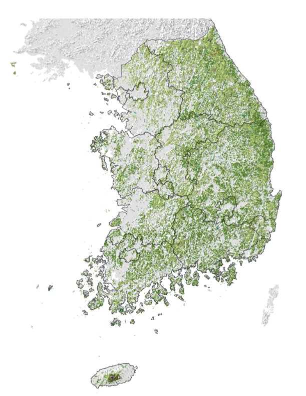
The spatial distributions of valuable geomorphological features, flora, and fauna of the nation were surveyed for 824 topographic maps (1:25,000 scale). The whole nation was divided into the 811 evaluation units, which were further subdivided from the ecological regions used in the 2nd survey, consistent with the previous survey results. The results of this survey were used as data for the revision of the Ecological Naturalness Maps from the 2nd survey.

The 4th Survey
(2014 – 2018: A 5-Year Projection Plan)

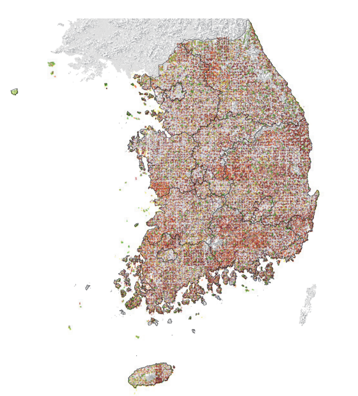
This survey investigated the topography and the spatial distributions of flora and fauna at 144 survey areas from 824 maps, the distribution status of vegetation at 141 evaluation units out of 811, and the distribution status of fish and benthic macro-invertebrates at 144 standard watersheds out of 811. In 2015, however, the investigation method used in the 4th survey was reorganized from a conventional, species-oriented approach to a new theme-oriented approach. Four separate themes (naturalness of vegetation, valuable geomorphological sites, endangered wildlife habitats, and biodiversity) were selected, in order to evaluate the ecological value of regions and to enhance the reliability of the Ecological Naturalness Maps.

National Institute of Ecology (2015)

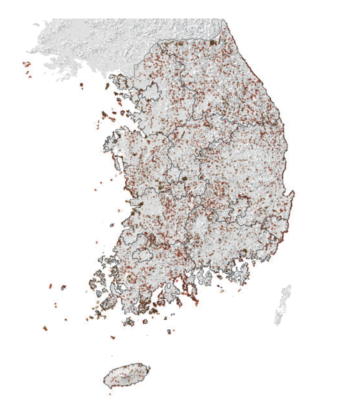
Basic Thematic Maps → Analysis, Estimation → Integrating Maps → Editing Maps → Publishing



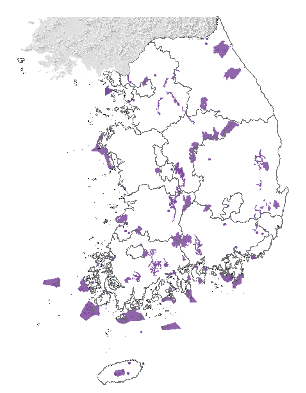
Vegetation Map



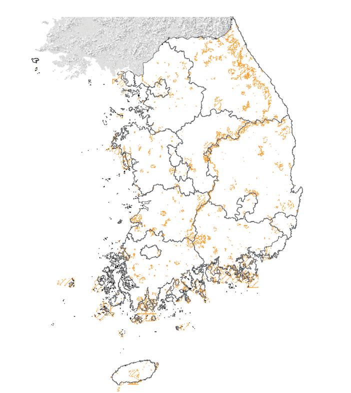
Fauna and Flora Maps



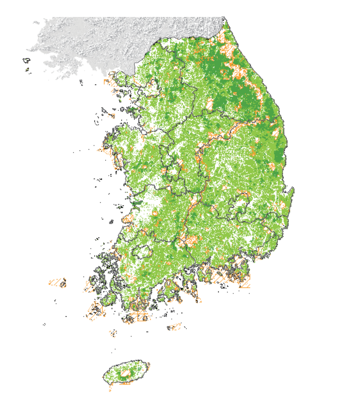
Geomorphological Feature Map



Detailed Survey Map



Special Management Areas Map



Ecological Naturalness Map

Nationwide Natural Environment Survey
- Fauna and Flora
- Vegetation
- Geographical Features

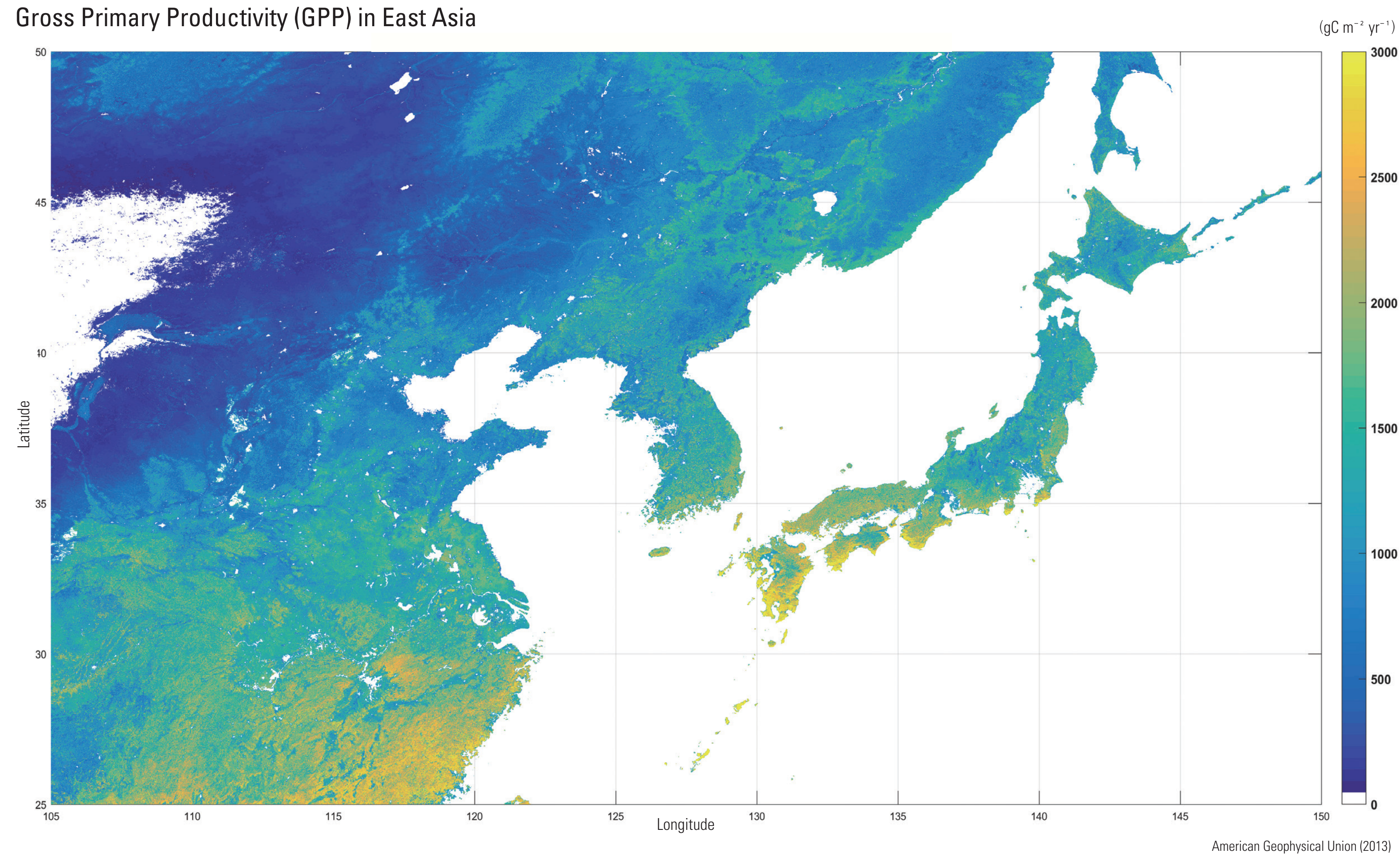
Detailed Ecological Survey
- Winter Waterbird Census of Korea
- Detailed Survey for Coastal Dunes
- Detailed Survey for Estuaries
- Detailed Survey for Specific Islands
- Detailed Survey for Wetland Protection Areas
- Detailed Survey for Baekdudaegan
- Detailed Survey for Endangered Species
- Nationwide Survey for Natural Landscapes
- Nationwide Survey for Uninhabited Islands

Special Management Areas
- Natural Parks
- Forests Genetic Resources Reserves
- Cultural Heritage Protection Zones
- Natural Monuments
- Wildlife Protection Areas
- Ecological and Landscape Conservation Areas
- Water Source Protection Areas
- Wetland Protected Areas
- Baekdudaegan Conservation Areas

National Institute of Ecology (2015)

Ecosystem Productivity

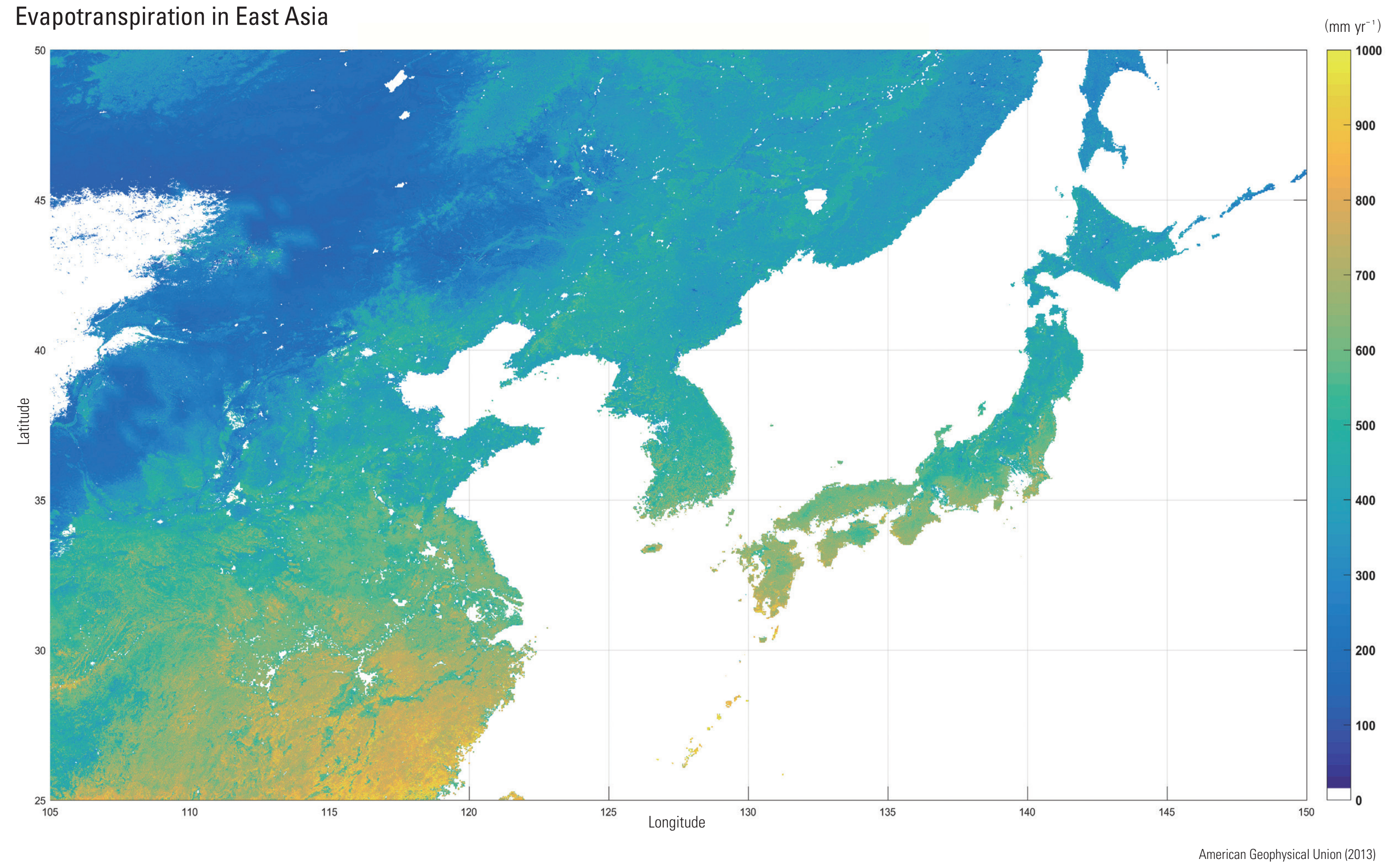
Gross Primary Productivity (GPP) in East Asia



American Geophysical Union (2013)

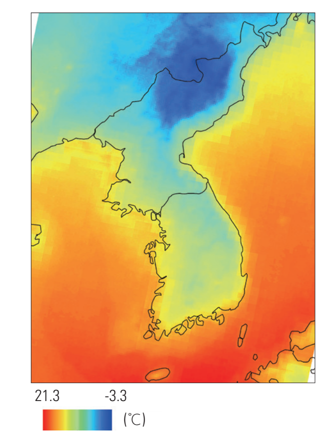
Climate and biota influence the photosynthesis and evapotranspiration, resulting in distinctive spatial differences in ecological functions. The fraction of photosynthetically active radiation (fPAR) is the ratio of PAR absorbed by plants to the total incident PAR in the atmosphere. The number of fPAR approaches 1 as the number of leaves increases. Stomata closure is mainly controlled by minimum temperature and vapor pressure deficit. Incident solar radiation is the main driver of photosynthesis and evapotranspiration. Daily minimum temperature and solar radiation vary with the length of the growing season while mean daily temperature controls plant respiration. These climatic variables show different seasonal and spatial patterns with latitude, altitude, topography, and land cover types, which mainly determine soil-vegetation-atmosphere carbon and water cycles. Consequently, these environmental variables are the main factors that cause the differences in the processes of the water cycle and the carbon cycle in atmosphere-biota-soil.

Evapotranspiration in East Asia

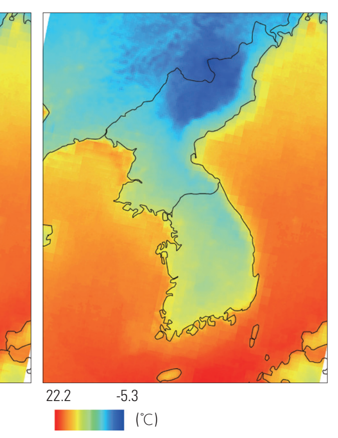


American Geophysical Union (2013)

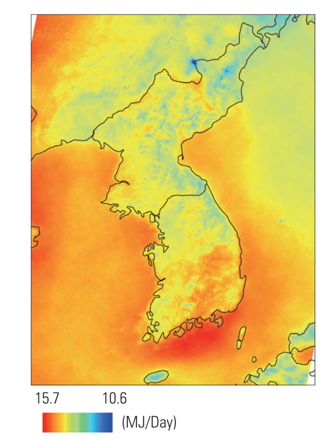
Average Temperature



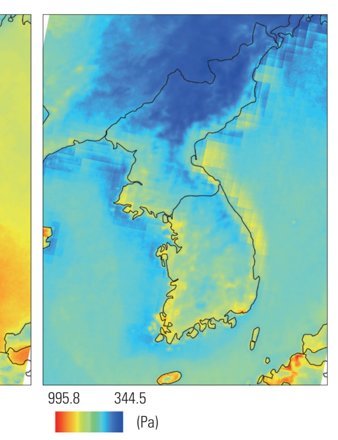
Minimum Temperature



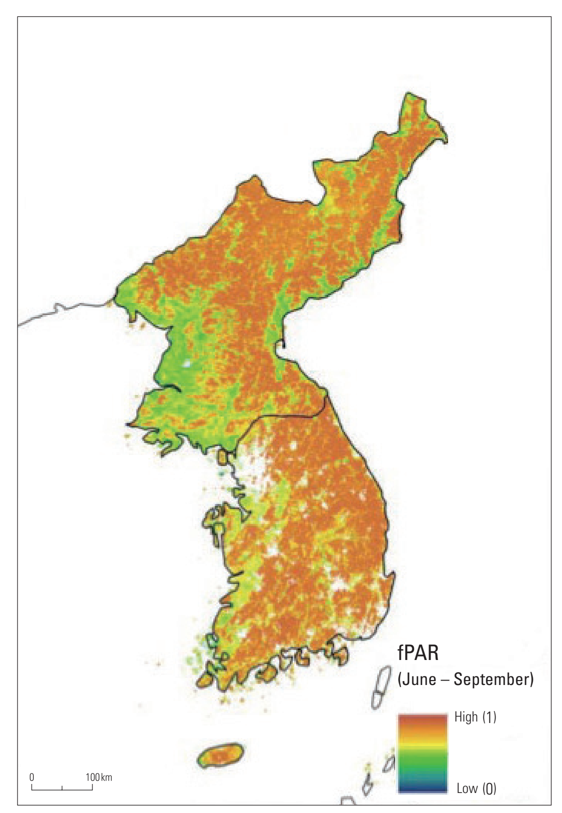
Solar Radiation



Vapor Pressure Deficit



Fraction of Absorbed Photosynthetically Active Radiation (fPAR)



Korea has a significantly high degree of ecological diversity considering the size of its land. Likewise, ecosystems display considerable spatial variation due to the different levels of photosynthesis and evotranspiration in plants according to the climate and biota of the area.

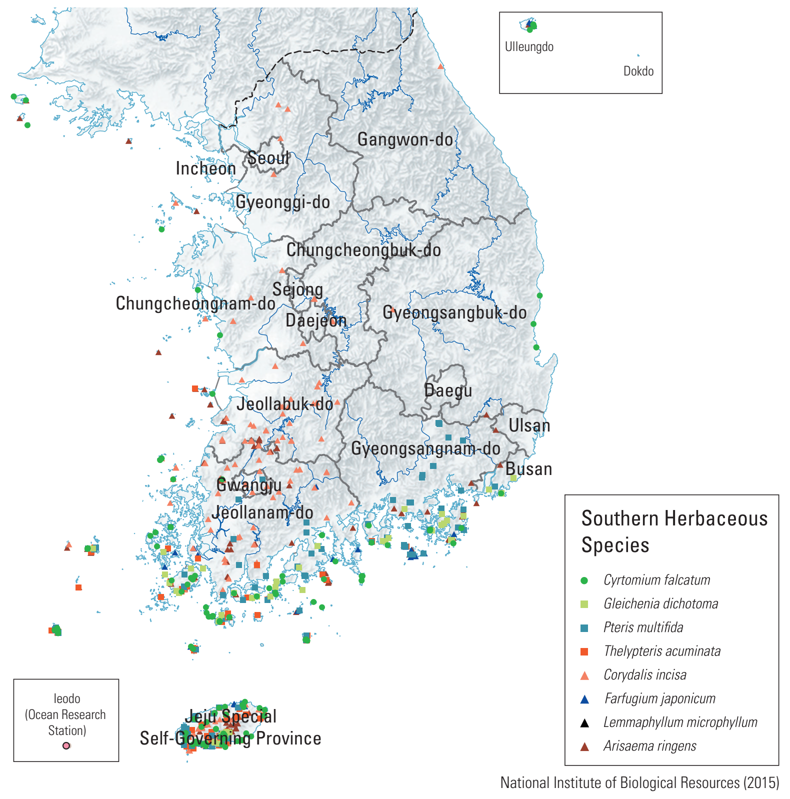
Net Primary Productivity (NPP) is the difference between Gross Primary Productivity (GPP) and autotrophic respiration of a primary producer, mostly plants. NPP determines photosynthetic products that are available to humans, animals, and microbes. The annual means of NPP and GPP from 2000 to 2009 reveal that the values vary with latitude, distance from the sea, and land cover. This is because factors such as local climate, length of the growing season and biomass affect the rate of photosynthesis in plants and the consumption rate of animals and microorganisms. Thus, NPP and GPP values are higher in lower latitudes than in higher latitudes, decrease with distance from the sea, and are very low in dry regions such as western China and the Mongolian plateaus.

Evapotranspiration includes evaporation from water bodies such as seas, lakes, and rivers and transpiration through the stomata in leaves. Evapotranspiration returns around half of the precipitation received on land to the atmosphere; thus, it is an important ecological component which regulates regional and global climates. Plants lose water vapor through stomata openings but gain atmospheric carbon dioxide which is essential for photosynthesis. Thus, evapotranspiration and photosynthesis are physiologically coupled and show a positive correlation. Therefore, the annual evapotranspiration map of Northeastern Asia shows a spatial pattern similar to that of the region's GPP; evapotranspiration increases with latitude and decreases with urbanization.

GPP and evapotranspiration in Korea show intermediate values compared to those of Japan and China at similar latitudes. Japan, which experiences high temperatures and high humidity of a marine climate, shows higher values, whereas China, which experiences a continental climate, exhibits lower values. Western China, located far from the sea, shows lower GPP and evapotranspiration compared to the other regions at equal latitudes. Korea shows an increased GPP and evapotranspiration at lower latitudes and at regions closer to the Pacific Ocean. This is caused by the climatic characteristics of the southern and eastern coasts and by comparatively high temperatures and humidity, which cause the wide distribution of evergreen broad-leaved trees and evergreen needle-leaved trees.

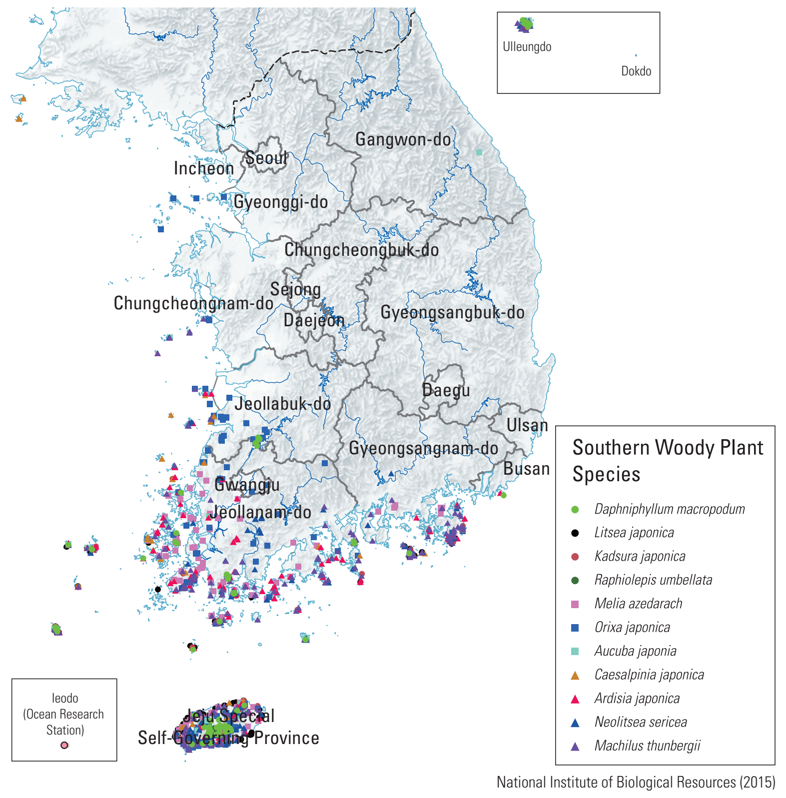
Climate Change and Ecosystems

Distribution of Southern Herbaceous Species



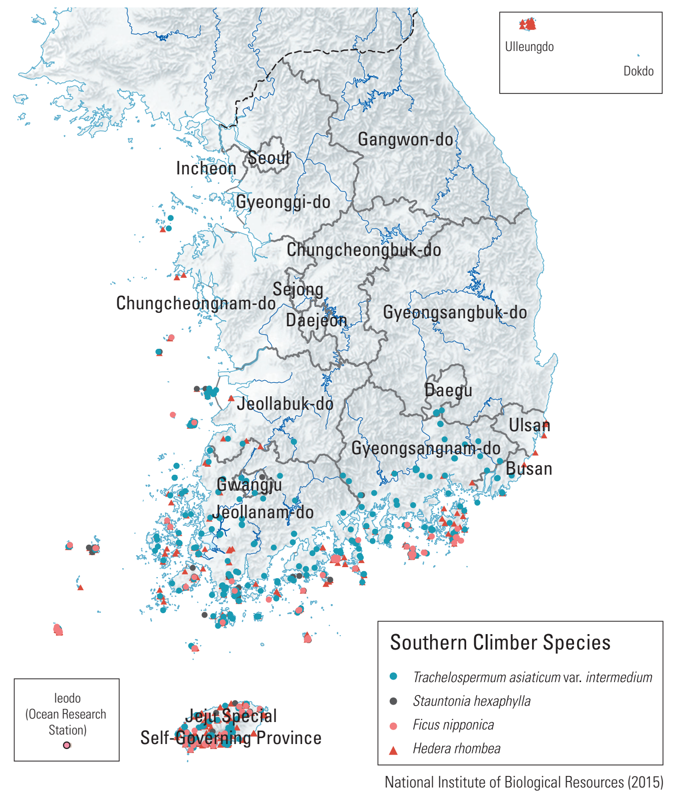
National Institute of Biological Resources (2015)

Distribution of Southern Woody Plant Species



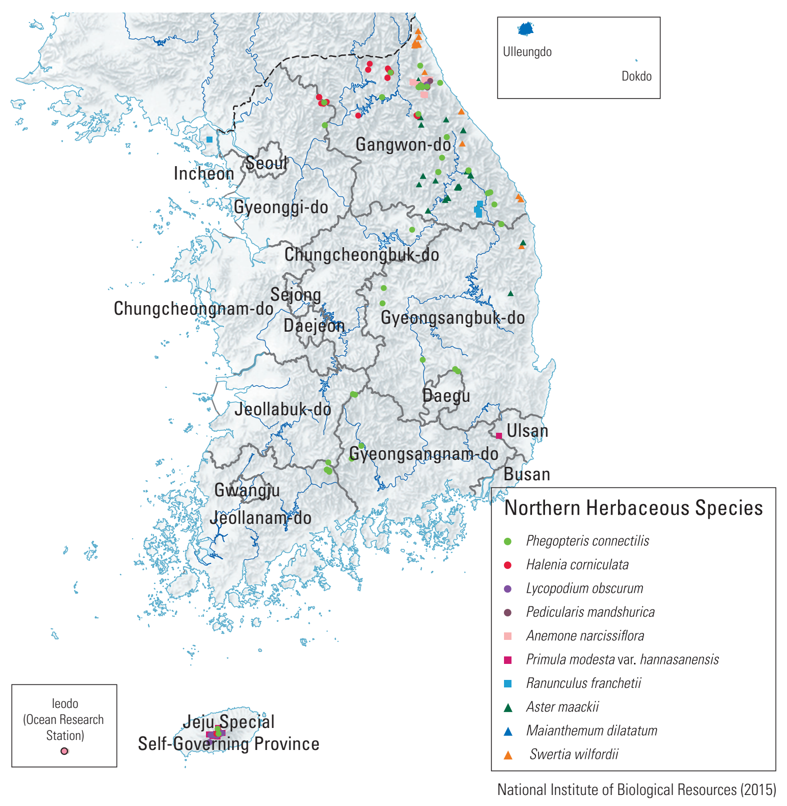
National Institute of Biological Resources (2015)

Distribution of Southern Climber Species



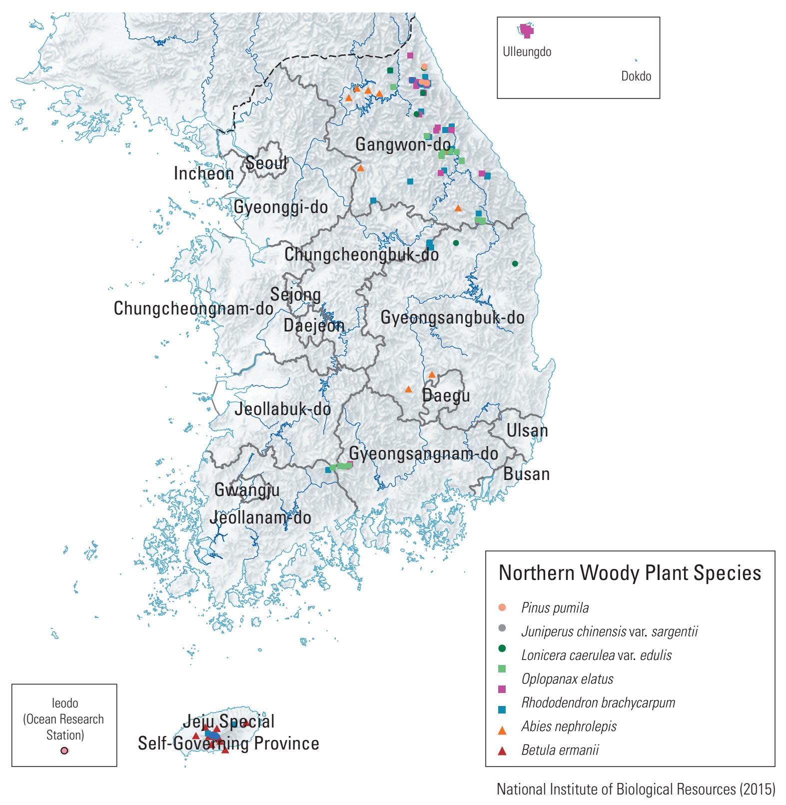
National Institute of Biological Resources (2015)

Distribution of Northern Herbaceous Species



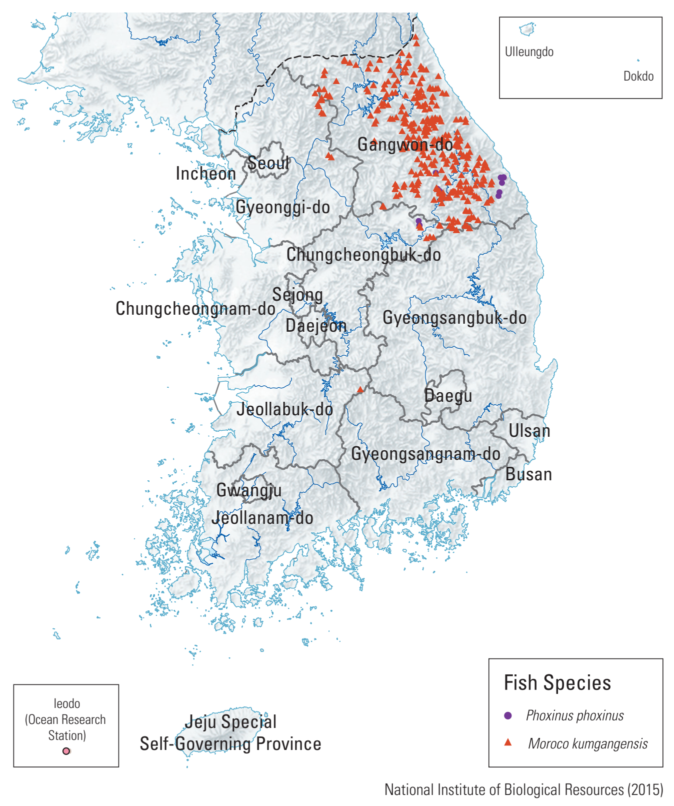
National Institute of Biological Resources (2015)

Distribution of Northern Woody Plant Species



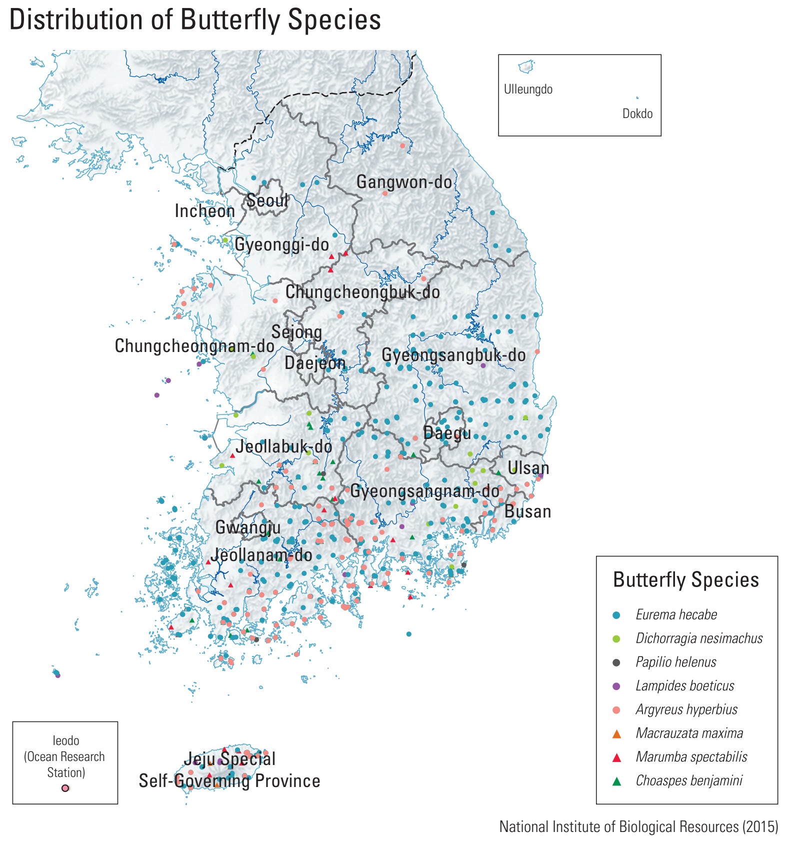
National Institute of Biological Resources (2015)

Distribution of Fish Species



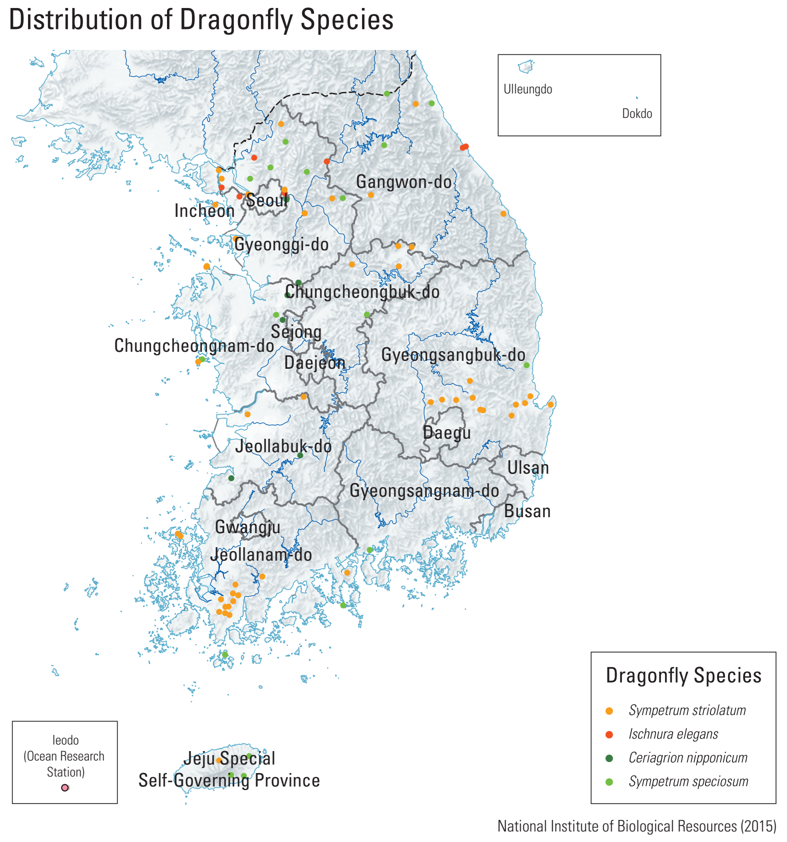
National Institute of Biological Resources (2015)

Distribution of Butterfly Species



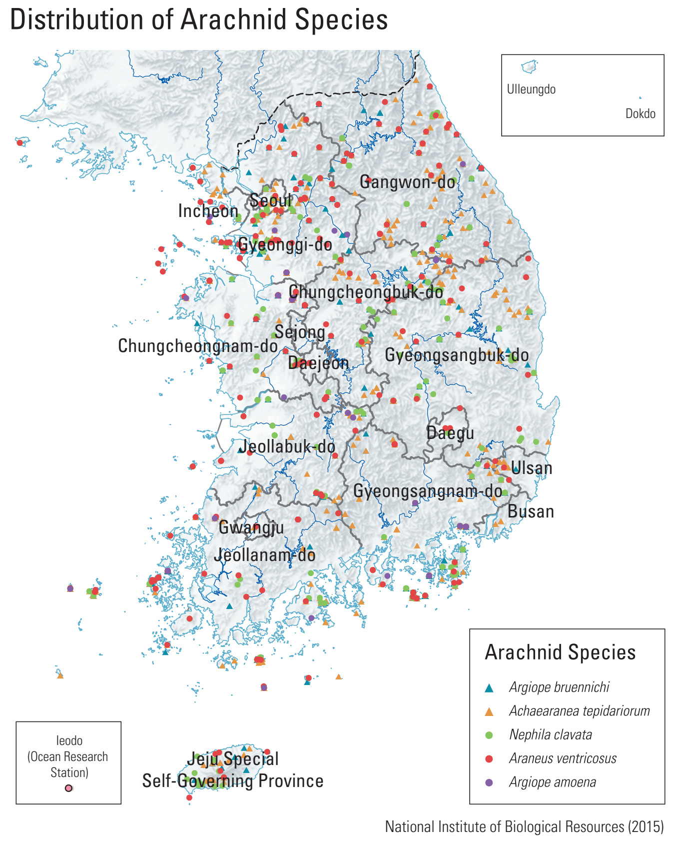
National Institute of Biological Resources (2015)

Distribution of Dragonfly Species



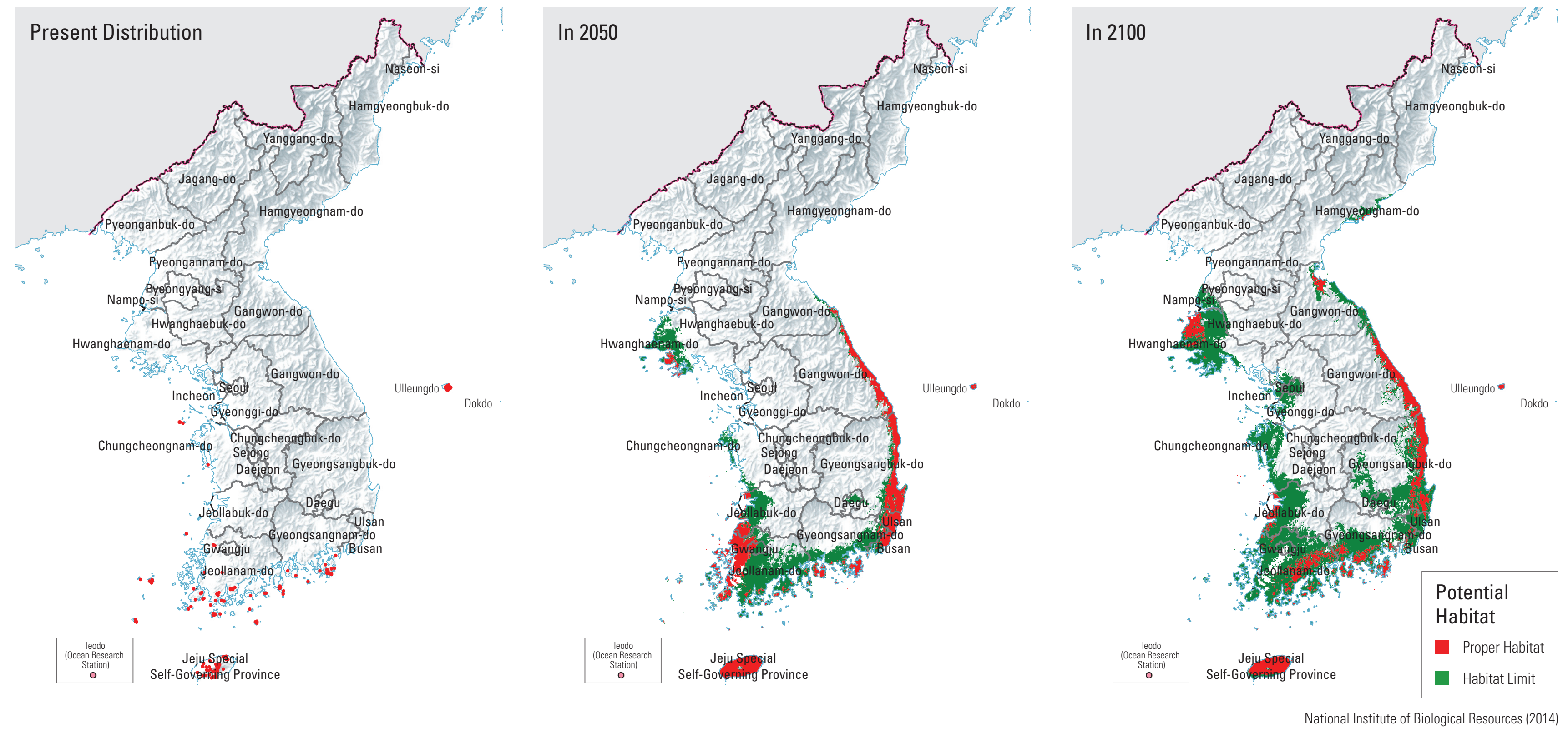
National Institute of Biological Resources (2015)

Distribution of Arachnid Species



National Institute of Biological Resources (2015)

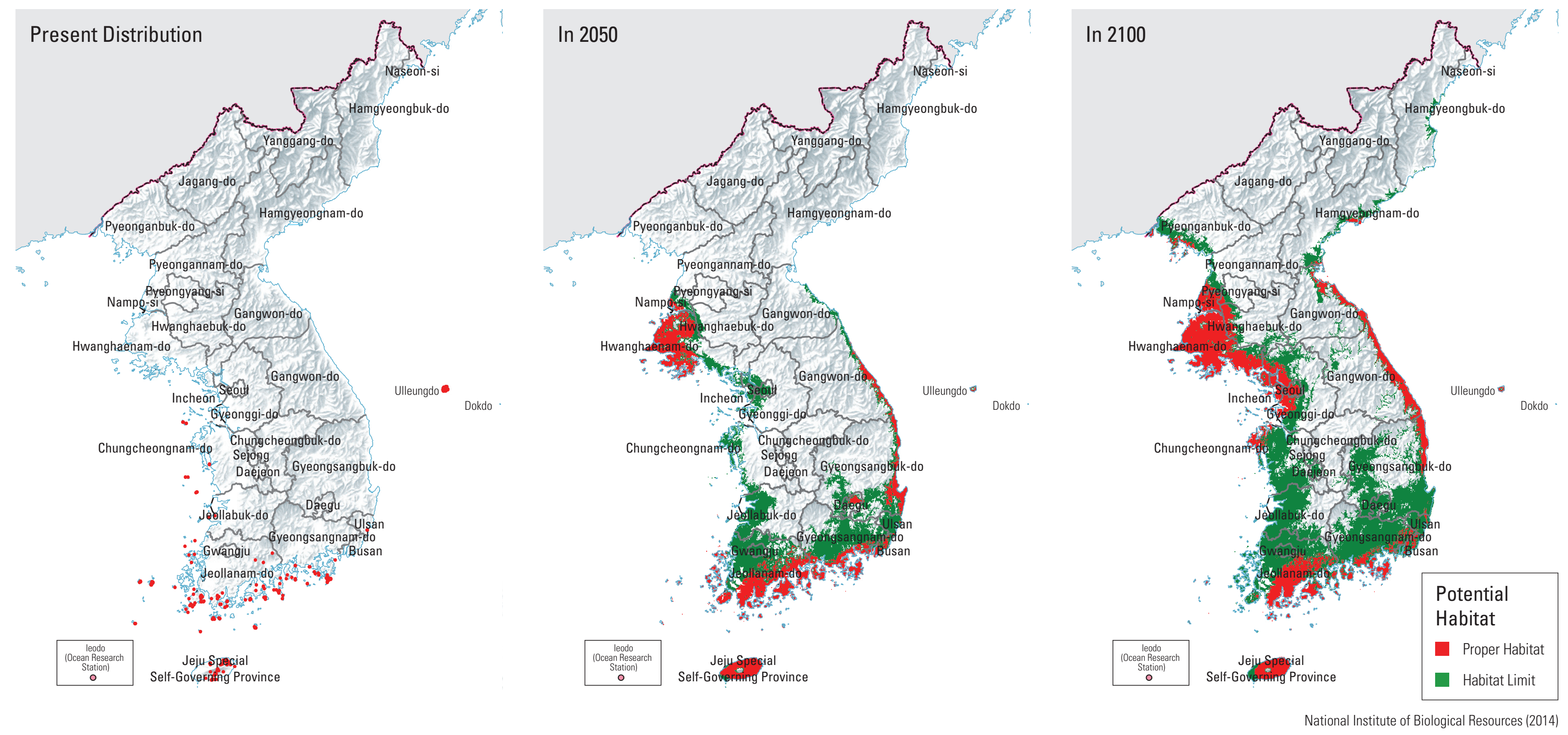
Predicted Distribution of Japanese Silver Tree (*Neolitsea sericea*) with Time



National Institute of Biological Resources (2014)

Japanese Silver Tree (*Neolitsea sericea*)

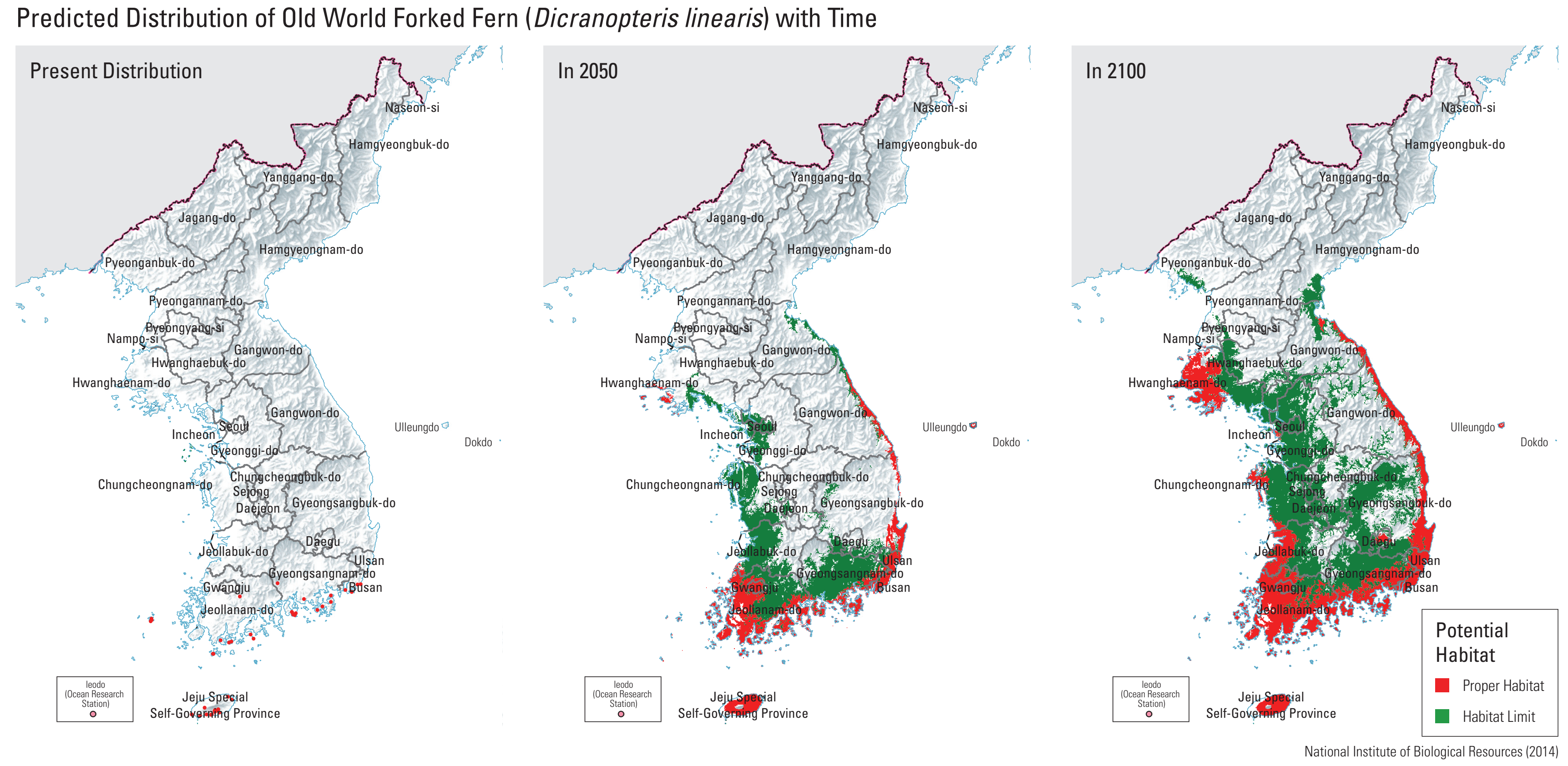
Predicted Distribution of Japanese Bay Tree (*Machilus thunbergii*) with Time



National Institute of Biological Resources (2014)

Japanese Bay Tree (*Machilus thunbergii*)

Predicted Distribution of Old World Forked Fern (*Dicranopteris linearis*) with Time



National Institute of Biological Resources (2014)

Old World Forked Fern (*Dicranopteris linearis*)

In Korea, it is predicted that rise in temperature and increase in precipitation will continue, and that the frequency and intensity of extreme weather events will also be reinforced. Climate-sensitive Biological Indicator Species (CBIS) are species that need to be consistently monitored as indicators because they show clear changes in activity, distribution, or population size when affected by climate change.

In 2010, the National Institute of Biological Resources (NIBR) announced a total of 100 Climate-sensitive Biological Indicator Species (CBIS) to effectively monitor and prepare the estimation approaches for the impacts of climate change on the distribution of biodiversity and vulnerability of ecosystems. The selected species include 18 vertebrate species, 28 invertebrate species, 44 plant species, and 10 algae and fungi species. Moreover, a spider species, one of the poikilotherms, showing sensitivity to the changes in the ambient temperature, was added to the list in 2015.

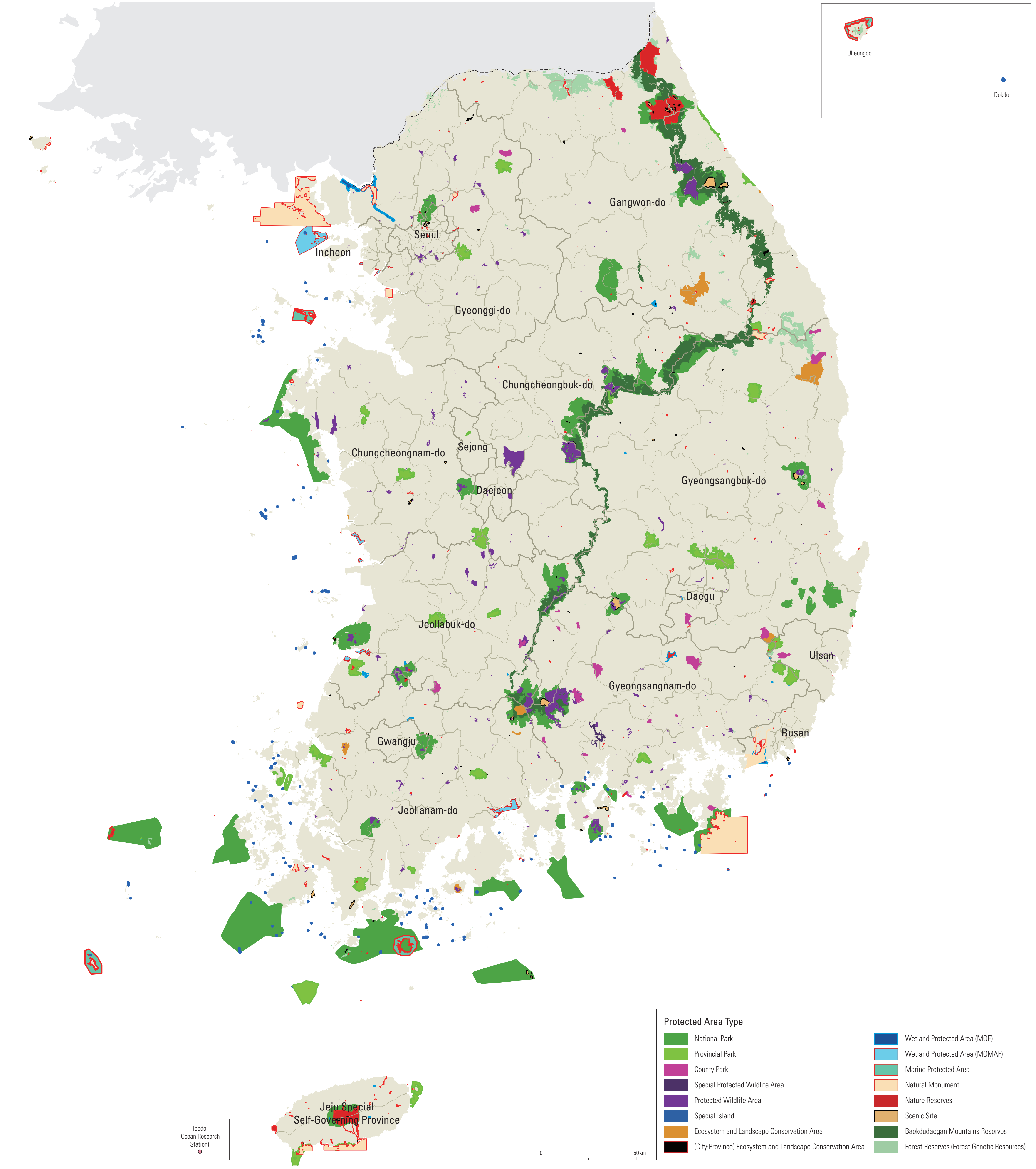
NIBR has expanded its research activities on the climate change biological index in various ways, such as monitoring the changes in the biological and ecological characteristics caused by climate change. To effectively predict such trends in changes, NIBR has been operating the Korea Biodiversity Observation Network (K-BON) since 2011. By 2015, 30 organizations were actively engaged in the KBOB. NIBR is collaborating with international biodiversity programs such as the Asia Pacific Biodiversity Observation Network (AP-BON) and the Group on Earth Observations Biodiversity Observation Network (GEO BON).

Concerns about the impacts of global warming and extreme weather events call for the preparation of adaptive measures against climate change for biota in Korea. As a result of these requirements, studies on future changes of some species' distributions are being carried out to scientifically analyze and estimate the impacts and risks of climate change on the distribution of the Korean biota. These studies include the prediction of the future changes of some species' distributions and the development of future habitat suitability maps for those species that are Climate-sensitive Biological Indicator Species (CBIS) and candidates for CBIS status. Future climate projections for this process are based on the climate change scenarios of the Intergovernmental Panel on Climate Change (IPCC).

Japanese silver tree (*Neolitsea sericea*), Japanese bay tree (*Machilus thunbergii*), and Old World forked fern (*Dicranopteris linearis*) are some of representative subtropical evergreen plants in the southern provinces of Korea. These subtropical species are expected to undergo a nationwide spread in their distribution due to accelerating global warming. Therefore, subtropical species are expected to result in a serious competition with the temperate plants formerly inhabiting the region. Continuous monitoring and long-term research for future prediction are proposed to mitigate the expected damage to the biodiversity in Korea. The results of the study are planned to be used in the development of climate change adaptation policies for biodiversity in East Asia and in the establishment of the selection criteria for climate change index species.

Ecosystem Management

Protected Areas



Korea National Park Service (2015)

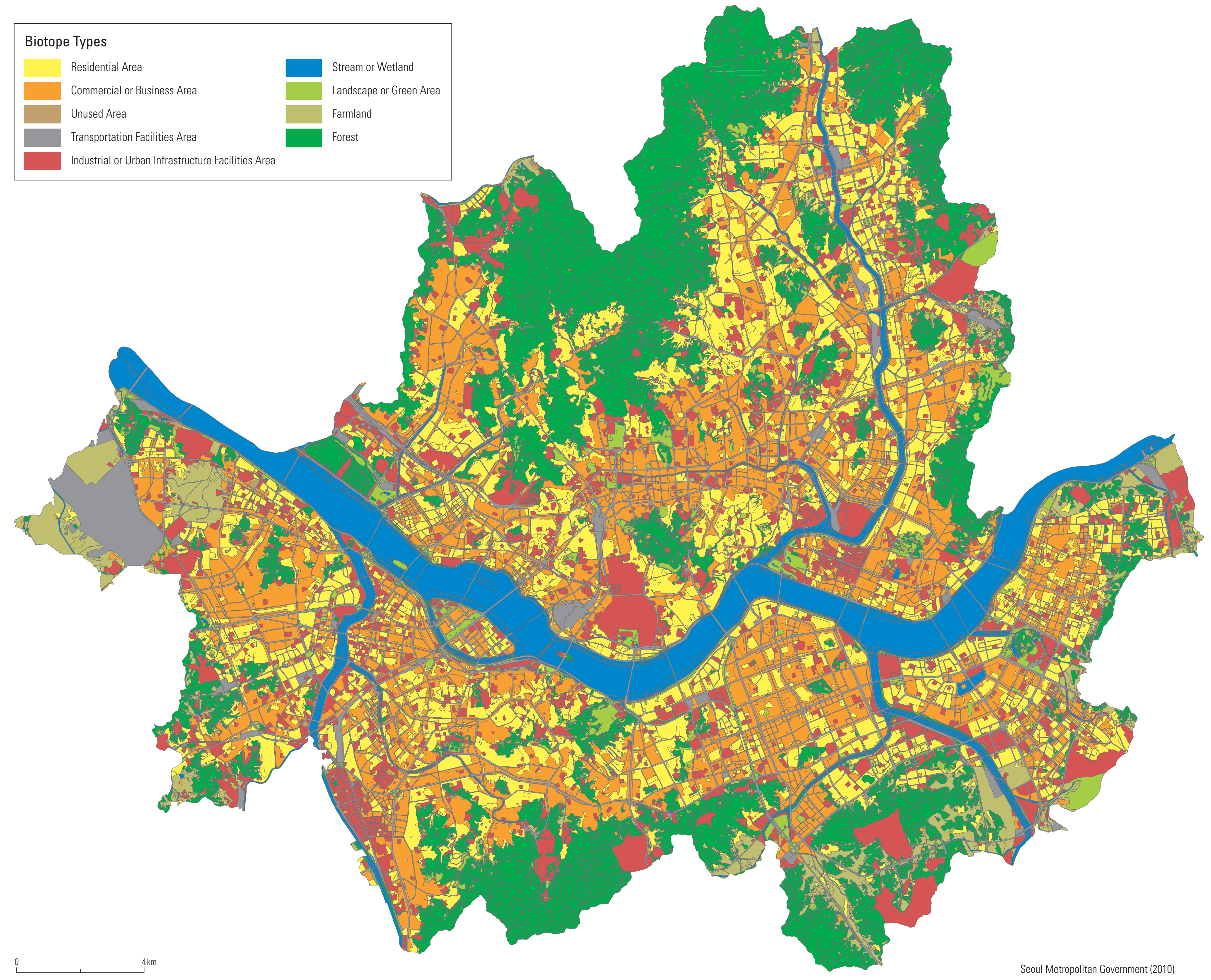
The modern concept of protected areas was primarily implemented in Korea through the establishment of the Forest Act, Parks Act, and Cultural Property Protection Act in the 1960s. Hongdo and Seoraksan were designated as the first nature reserve in 1965 and Jirisan was designated as the first National Park in 1967. There are 10 related Acts regarding protected areas in Korea. Three of the 10 Acts, Natural Environment Conservation Act, Marine Environment Management Act, and Cultural Property Protection Act, deal with general matters of environmental and cultural property protection, regulating relevant provisions for these protected areas. The remaining 7 Acts mainly contain provisions focusing on the designation and management of protected areas.

BIOSPHERE

Ecology

Ecosystem Management

Biotope Map of Seoul (2010)



Seoul Metropolitan Government (2010)

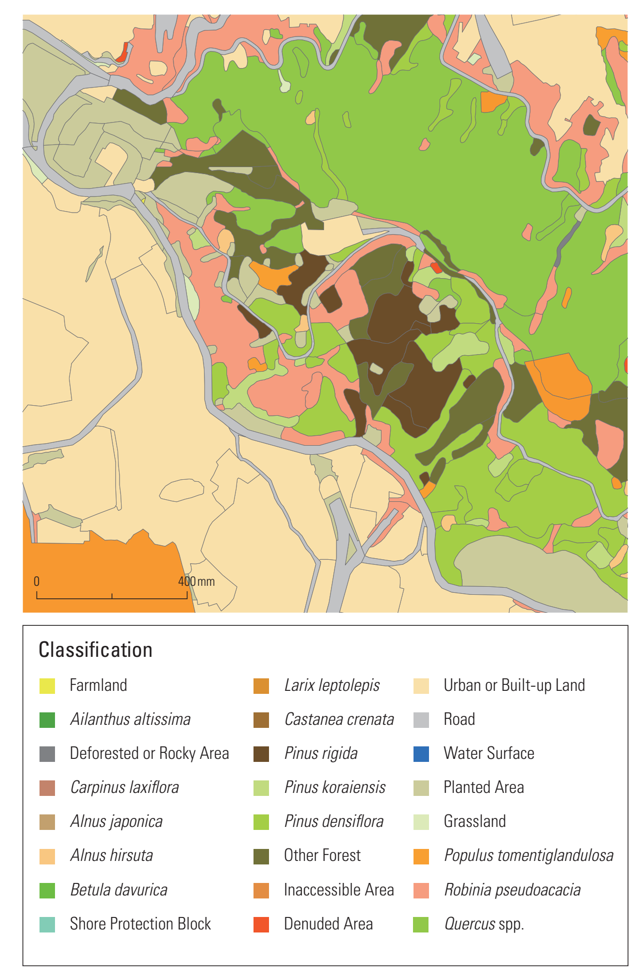
Urban Ecology Status Map (Biotope Map)

A biotope map is composed of base map, thematic map, biotope type map, and biotope evaluation map. The base map includes land use map, land cover map, topographic map, vegetation map, and flora and fauna map. Thematic maps are made according to the characteristics of a specific region. A land cover map illustrates the categorical type and percentage of each land cover type. A flora and fauna map explains the distribution of flora, wild birds, reptiles, mammals, insects, and fish. A vegetation map represents the status and type of vegetation covering the surface. A biotope type map includes the structural and ecological characteristics of biotope types. A land use map displays the purposes for which land is used. A topographic map is a set of grid maps of the shape of terrain, including elevation, slope gradient, and aspect. A biotope evaluation map represents the ecological value of each biotope.

Example of an Evaluation of Biotope Type

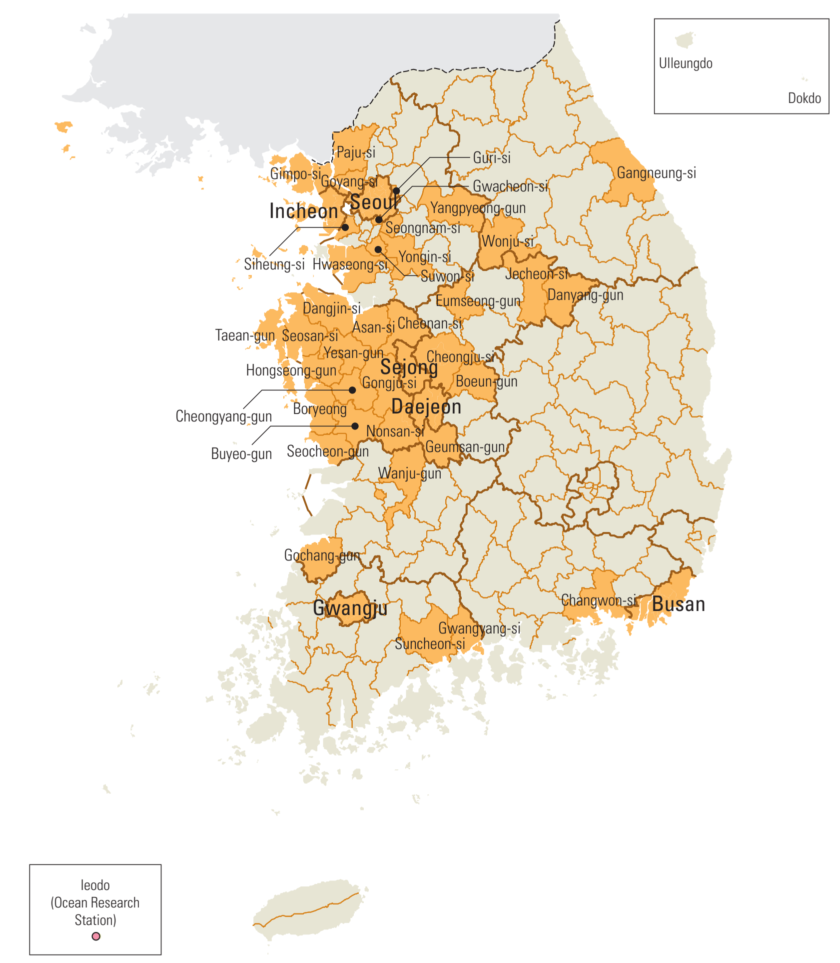
Seoul Metropolitan Government (2010)

Example of a Vegetation Map



Seoul Metropolitan Government (2010)

Cities and Counties with Biotope Mapping Conducted



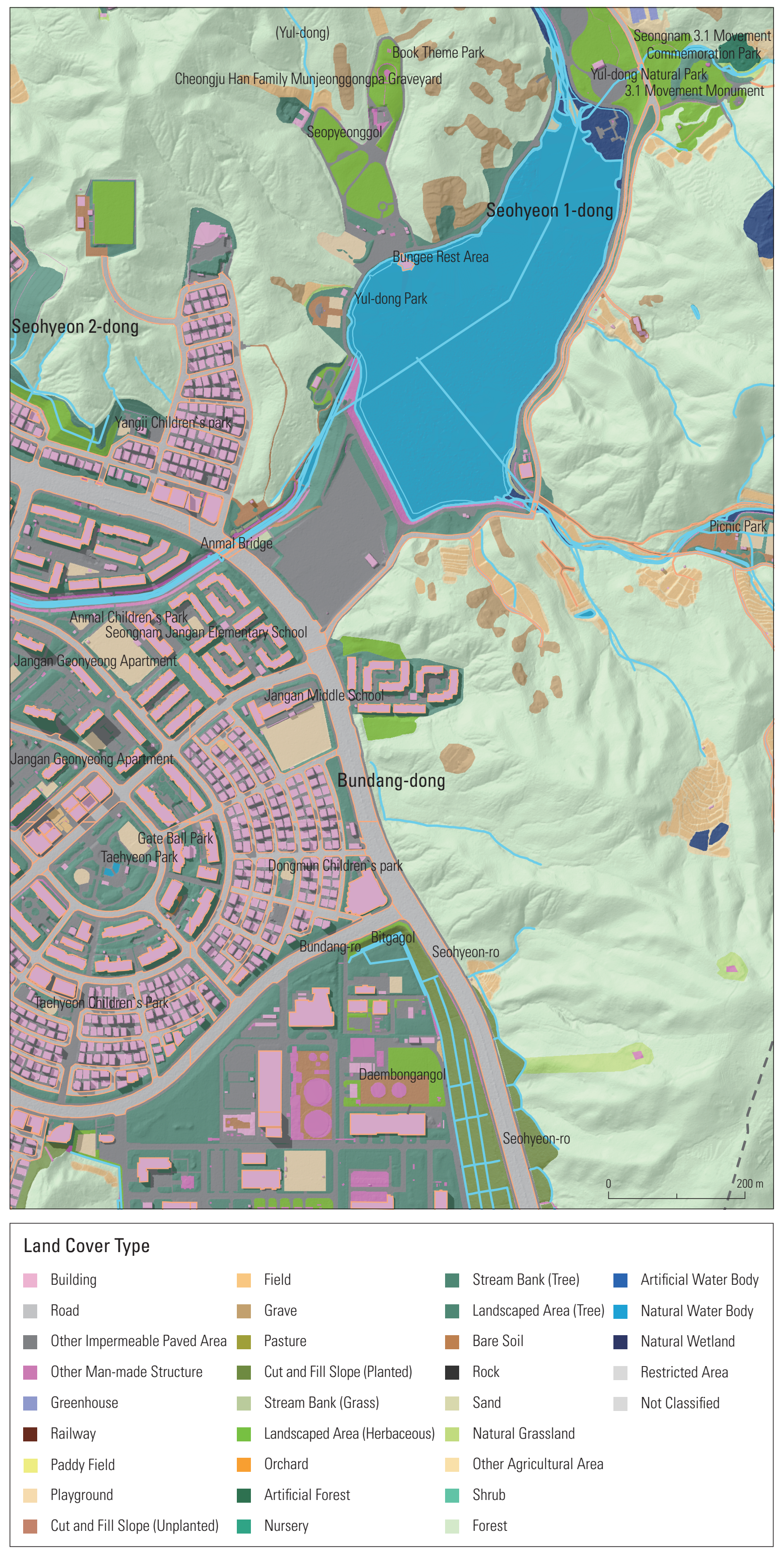
Ministry of Environment (2015)

Korea is a highly urbanized country, with as many as 9 out of 10 people living in cities, and it is increasingly important to manage the urban areas in eco-friendly and sustainable ways. A biotope map is a map that shows an area's biodiversity status based on investigations and evaluations performed by local governments to take better action against the problems within their administrative districts. It divides the map area by biotope unit and expresses the biotope type based on the ecological characteristics and the rating of each biotope's value.

The first biotope map for Korea was created in 2000 in Seoul. Seoul developed a biotope map to serve as the baseline data for eco-friendly urban management and has been updating it every 5 years. The Seoul Urban Planning Ordinance specifies the development and the usage of the biotope map for land suitability assessments and several other fields. A total of 43 local governments, including Seongnam-si, Gwangyang-si, Goyang-si, and Siheung-si, had completed or proceeded with producing biotope maps by 2015. Though biotope mapping was initiated according to the purposes of the local governments, the Ministry of Environment has been promoting biotope mapping since 2007 by creating and distributing the biotope mapping guidelines.

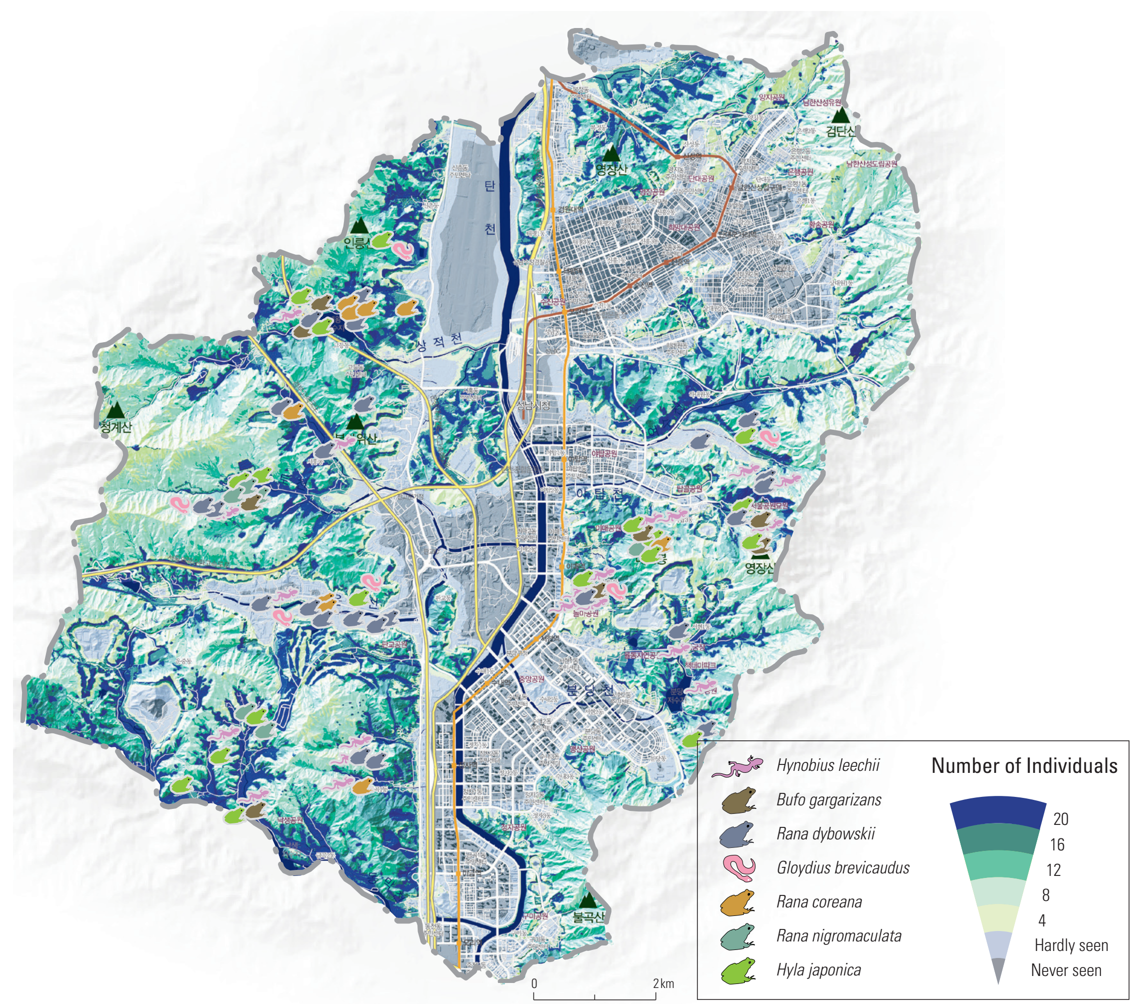
Biotope Map of Seongnam-si (2009)

Land Cover Map (Bundang-dong Area)



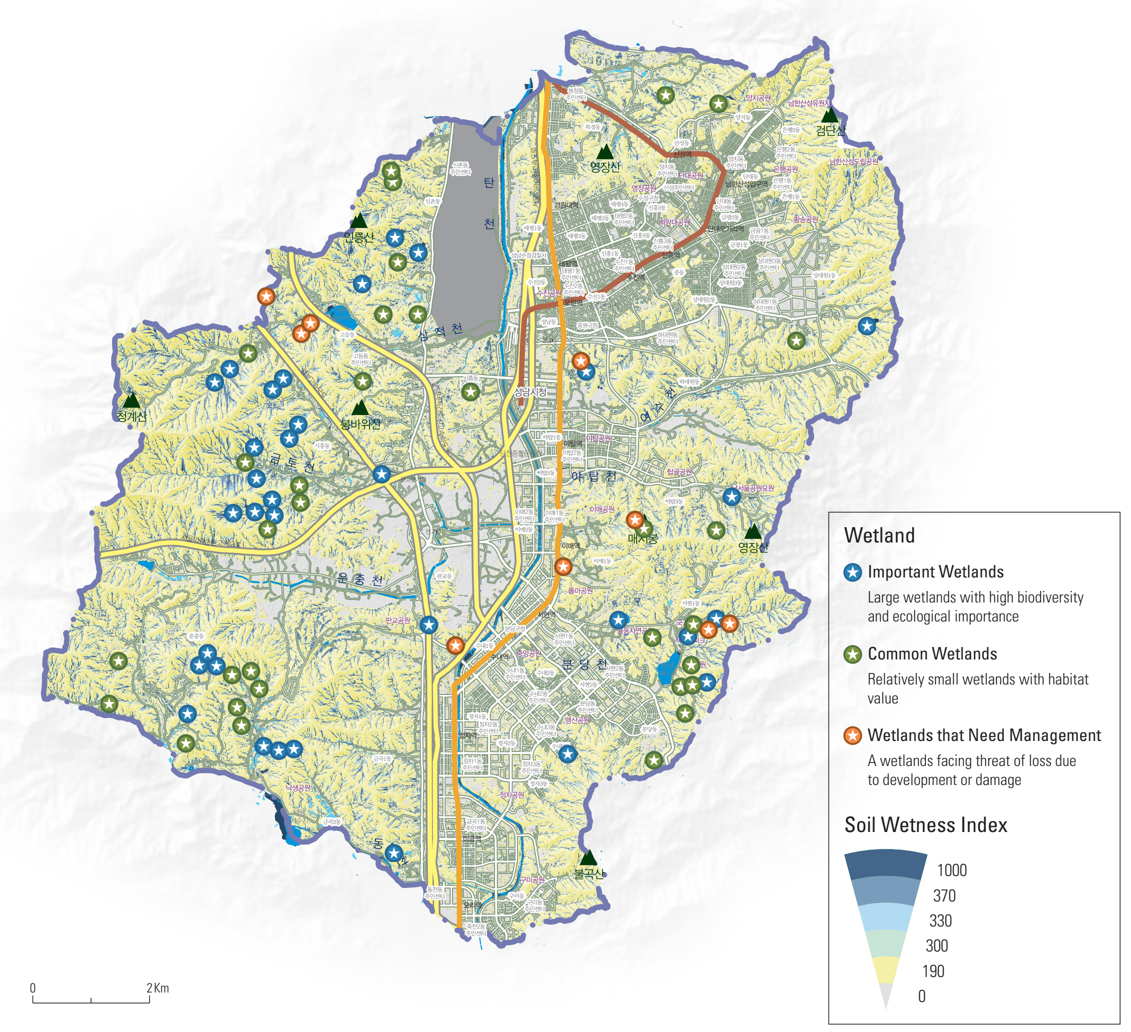
Seongnam City Government (2009)

Estimation of Amphibian and Reptile Density



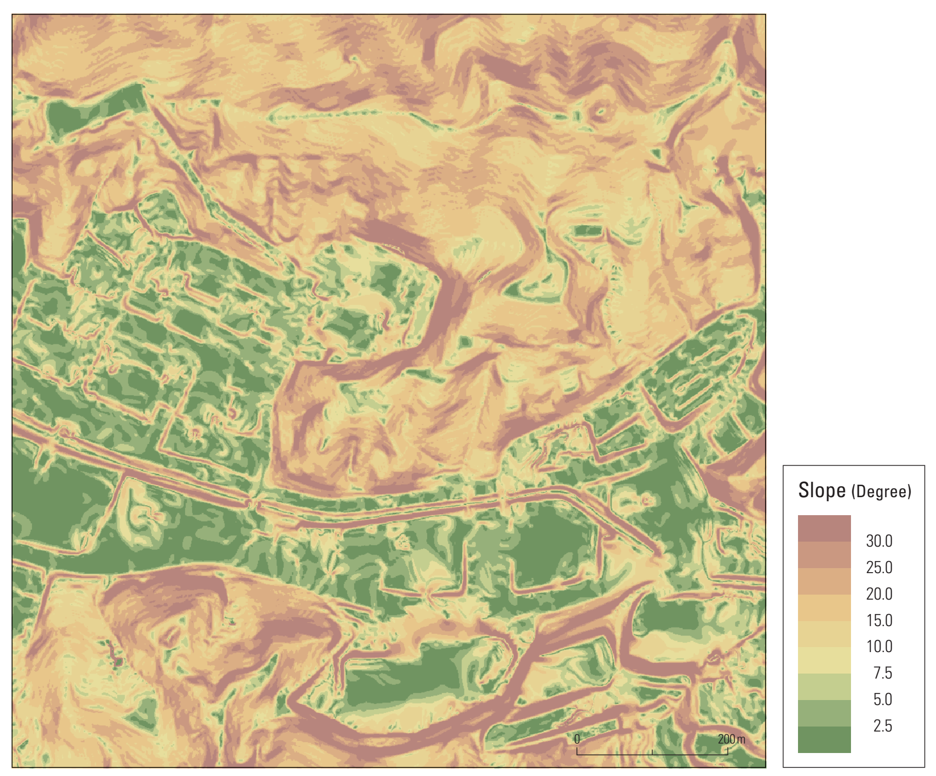
Seongnam City Government (2009)

Soil Wetness Index and Wetlands



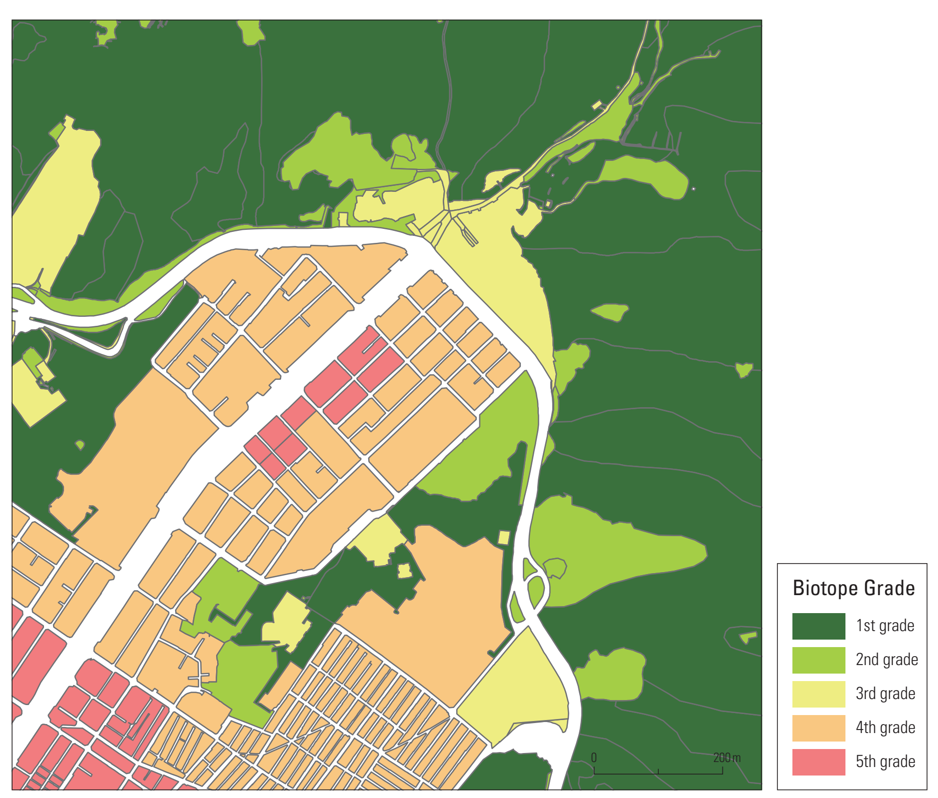
Seongnam City Government (2009)

Slope Map (Yatap-dong Area)



Seongnam City Government (2009)

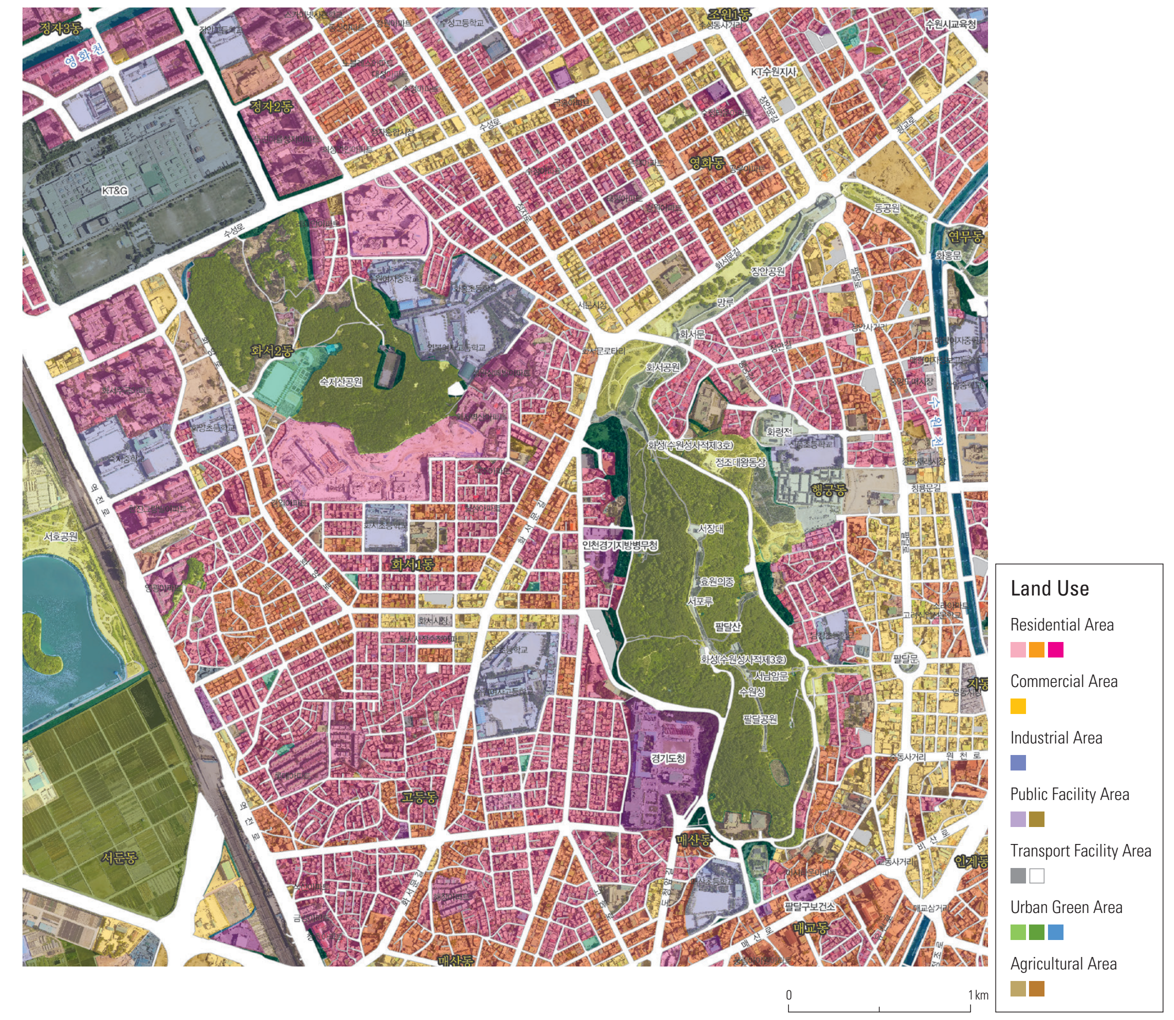
Biotope Grade Map (Eunhaeng-dong Area)



Seongnam City Government (2009)

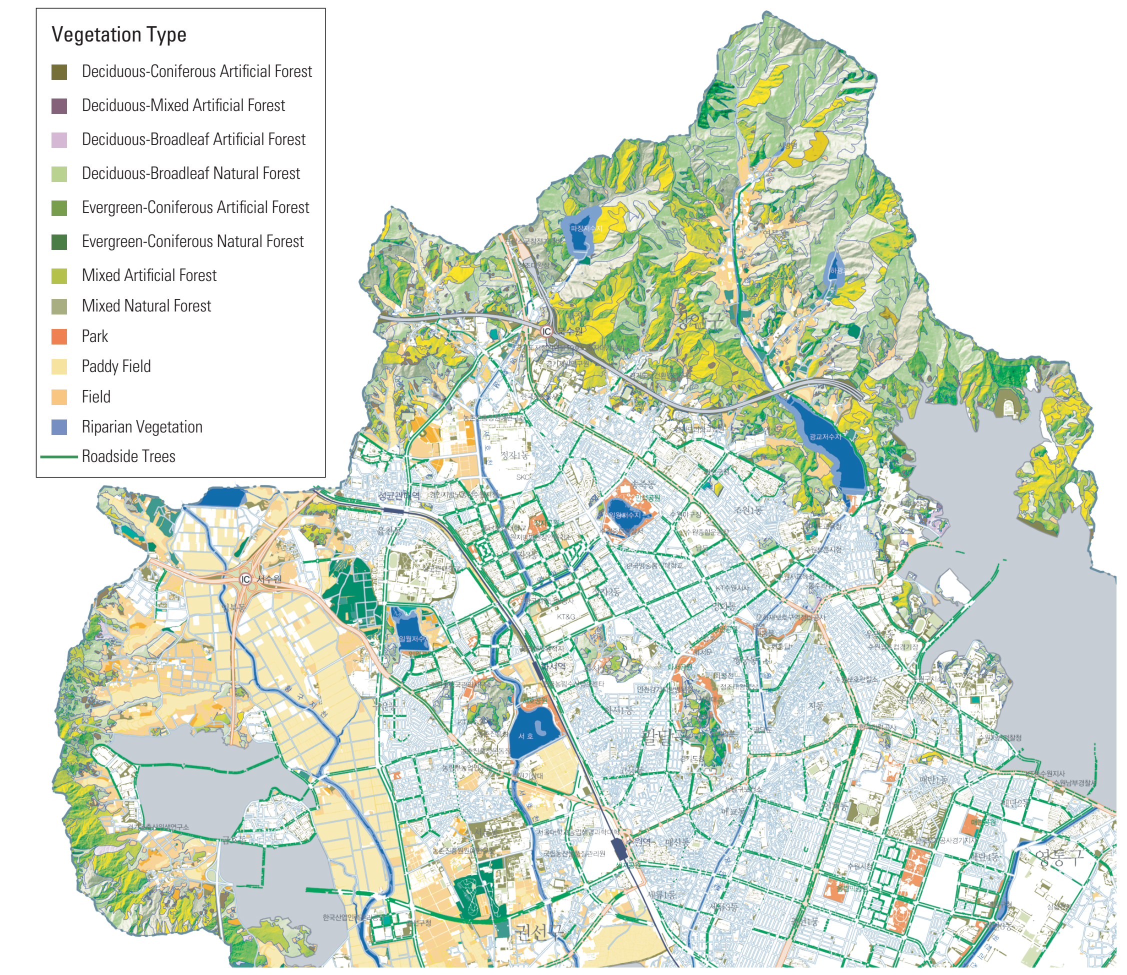
Biotope Map of Suwon-si (2010)

Land Use Map (Hwaseo-dong Area)



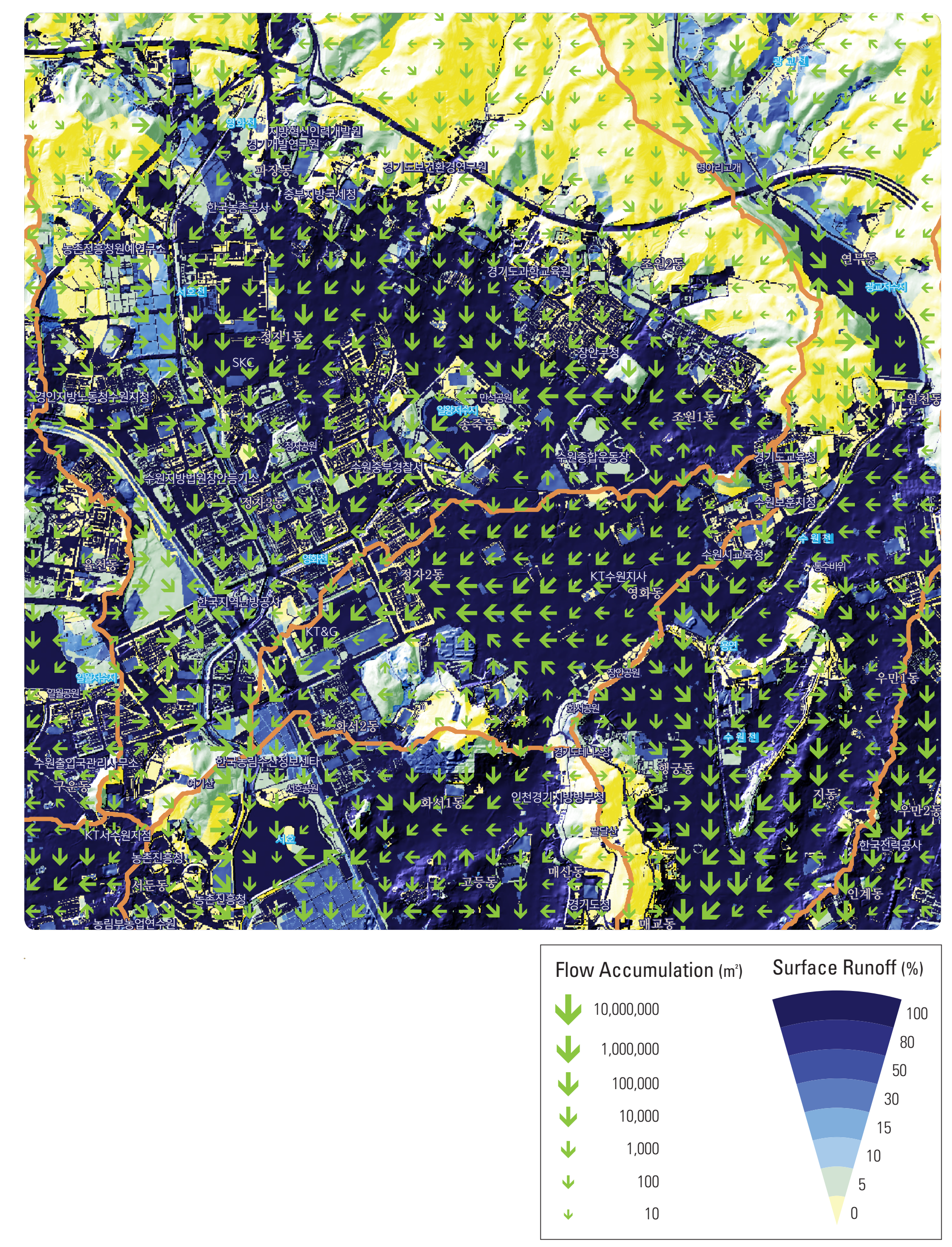
Suwon City Government (2010)

Vegetation Map



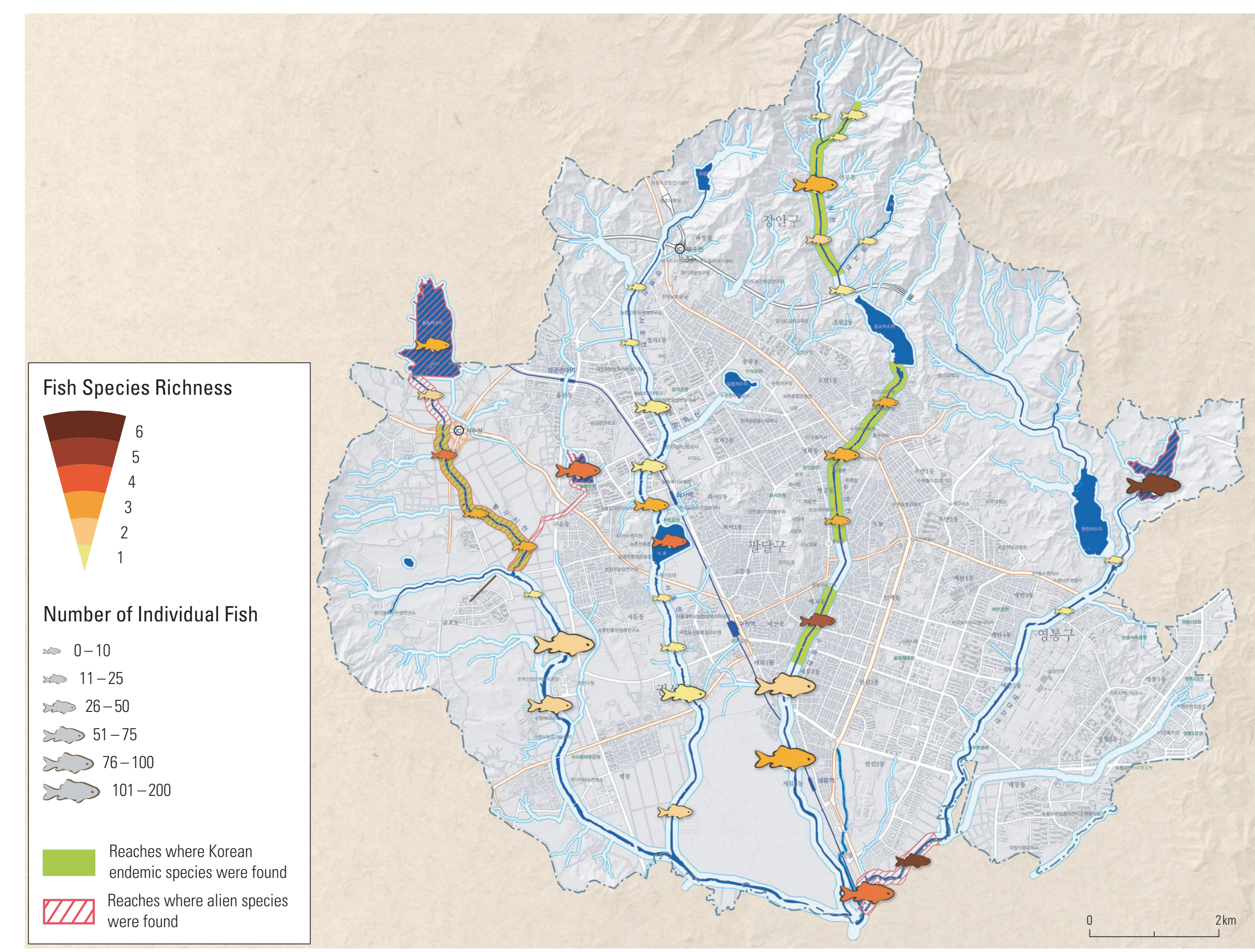
Suwon City Government (2010)

Surface Runoff and Flow Accumulation (Jangan-gu Area)



Suwon City Government (2010)

Fish Habitat Map



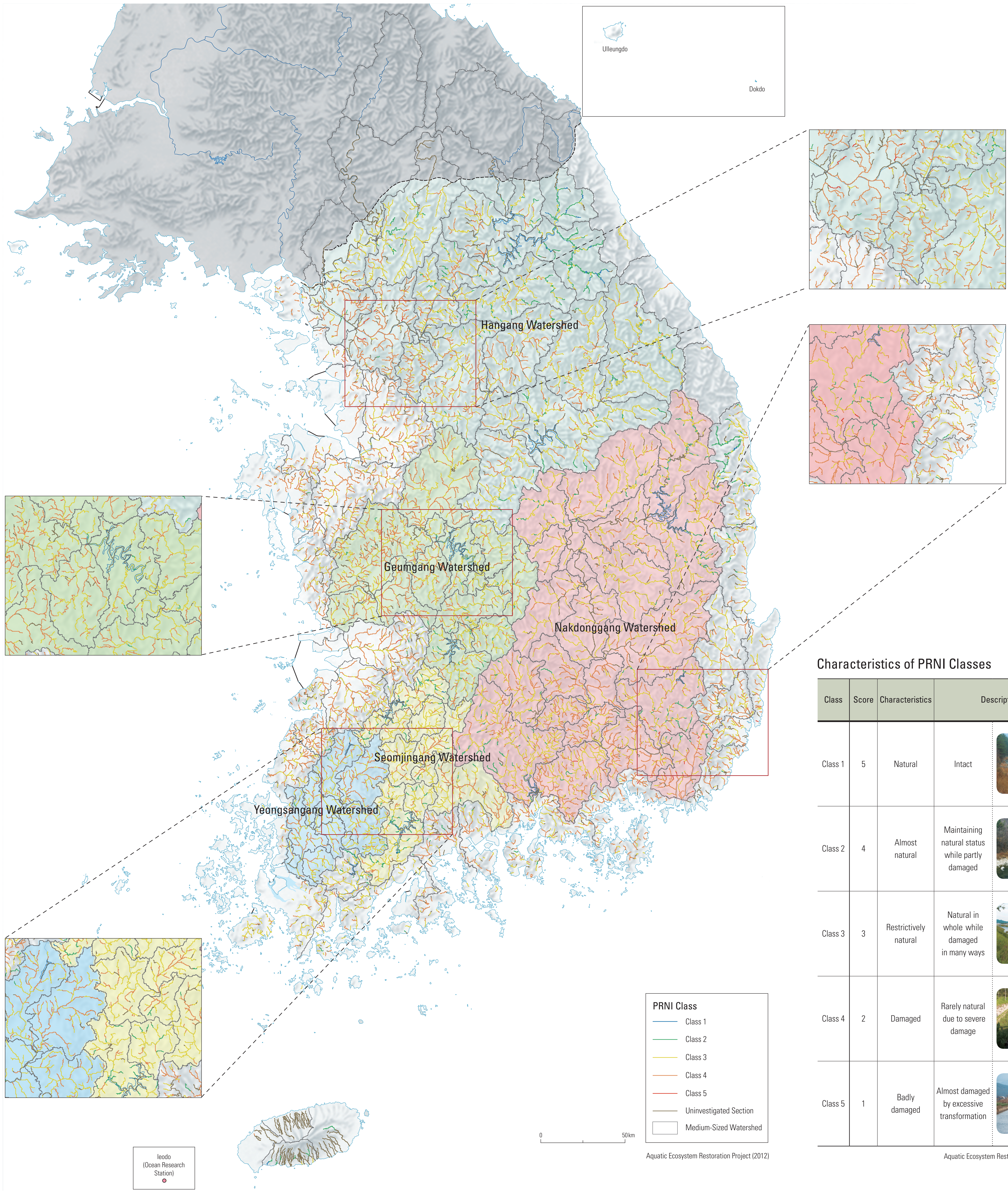
Suwon City Government (2010)

Biotope maps are used as referential data in projects such as conservation and restoration of natural environments, formation of ecological networks, and eco-friendly sustainable urban management. Currently, local governments are utilizing these maps for environmental assessment, development permission, urban planning, and ecosystem management, but the scope of the usage is yet limited. A land-environment linkage system plan is being developed to promote appropriate land development, and biotope maps are expected to play an important role in this procedure. These maps provide the most detailed data among all available data that represent ecological status. Spatially explicit environmental plans based on these maps are further applied to urban planning processes.

Systems of National Land Development and Environmental Planning

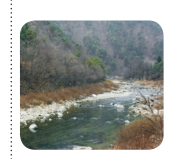
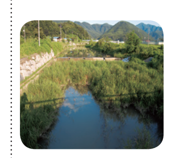
Ministry of Environment (2015)

Physical River Naturalness Index (PRNI)



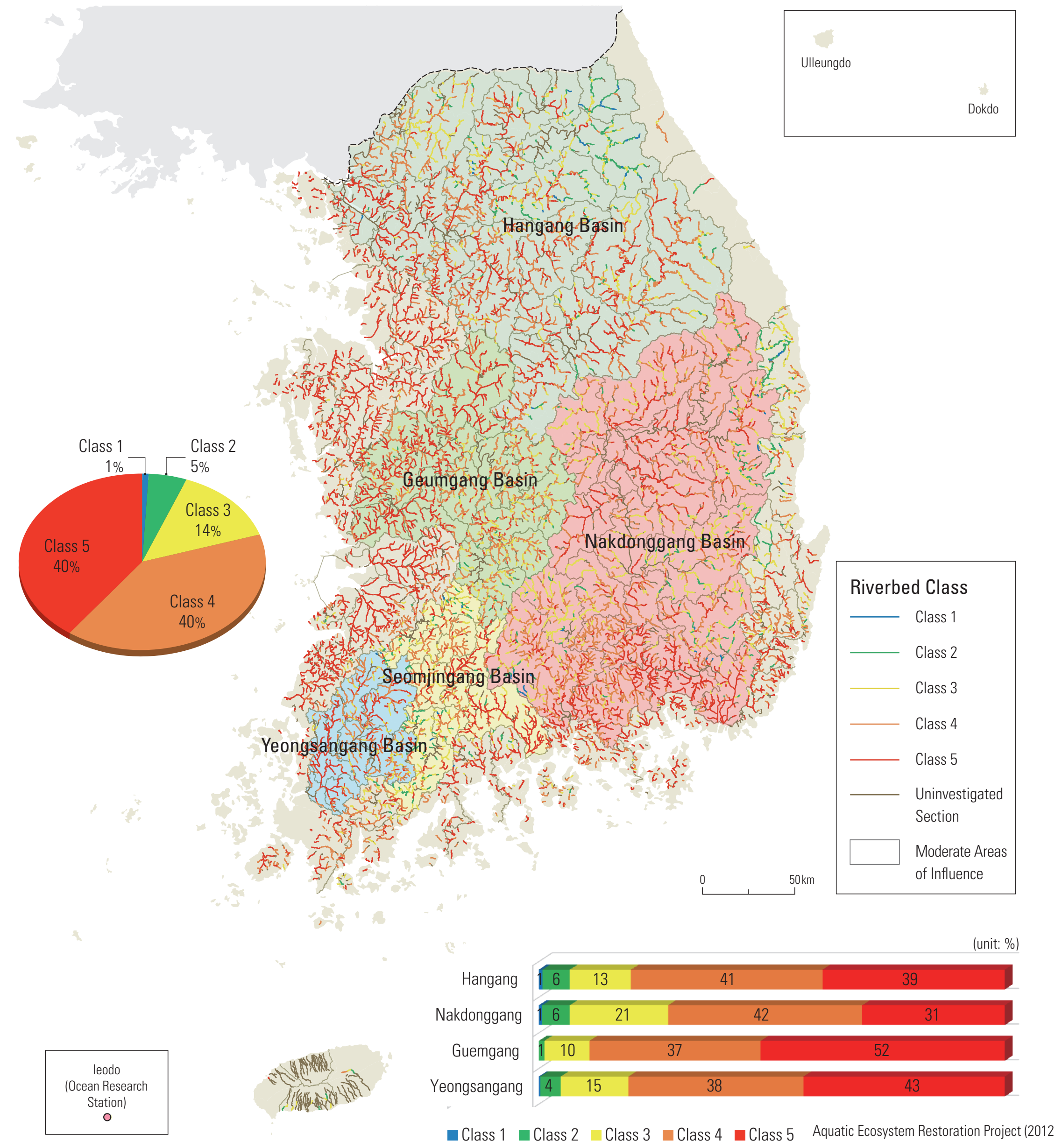
Aquatic Ecosystem Restoration Project (2012)

Characteristics of PRNI Classes

Class	Score	Characteristics	Description	
Class 1	5	Natural	Intact	
Class 2	4	Almost natural	Maintaining natural status while partly damaged	
Class 3	3	Restrictively natural	Natural in whole while damaged in many ways	
Class 4	2	Damaged	Rarely natural due to severe damage	
Class 5	1	Badly damaged	Almost damaged by excessive transformation	

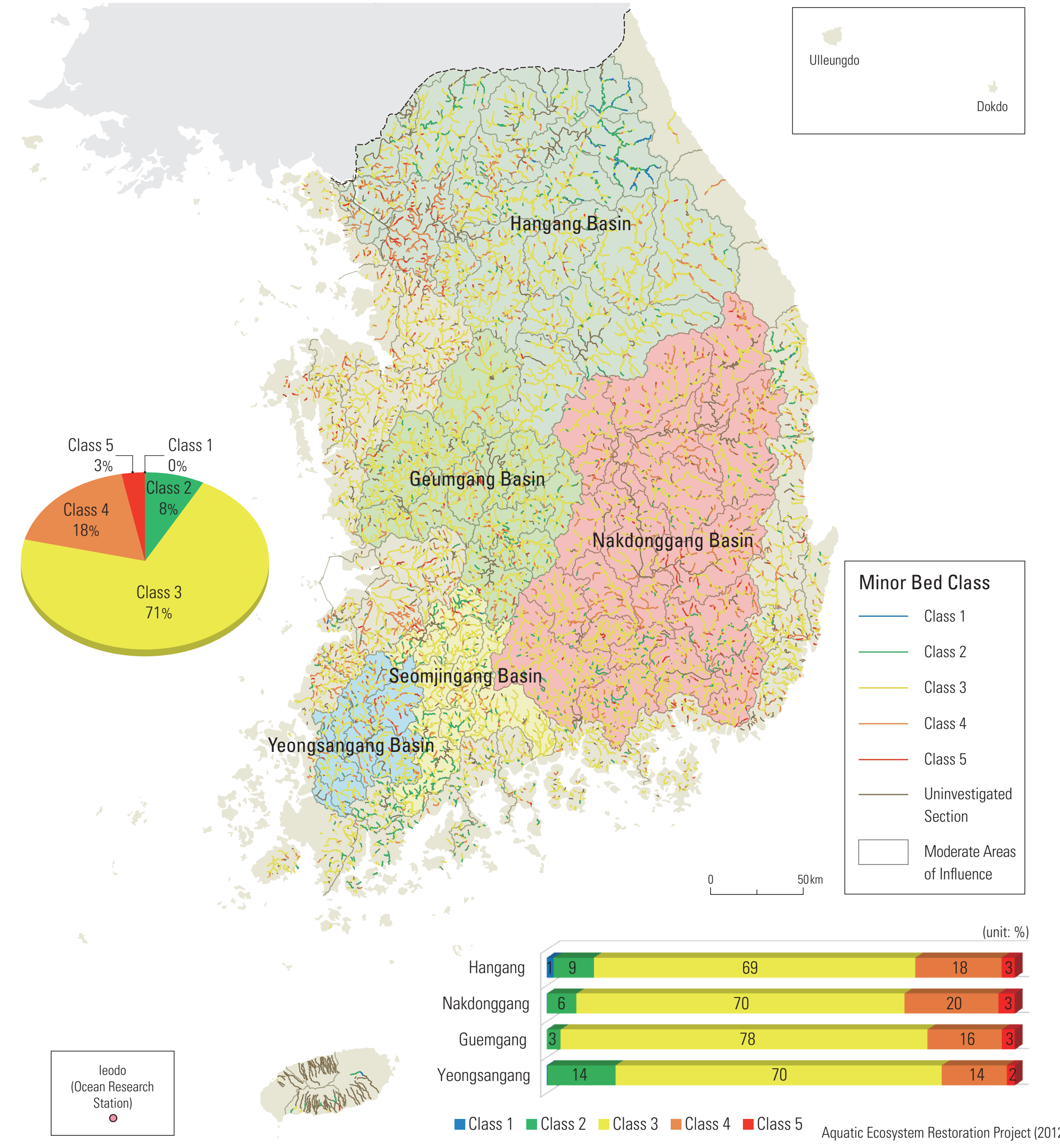
Aquatic Ecosystem Restoration Project (2012)

Naturalness of Riverbed Structure



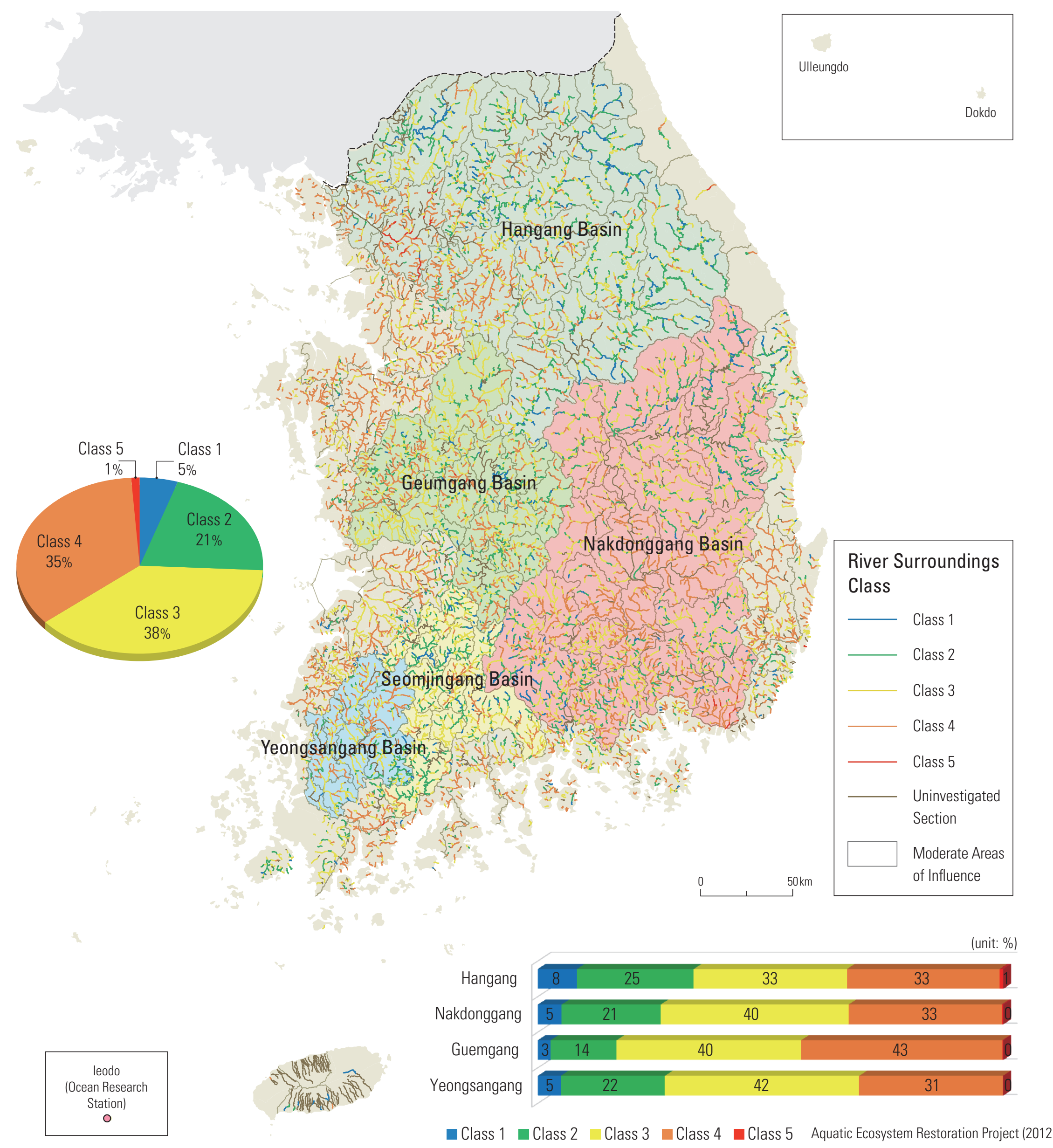
Aquatic Ecosystem Restoration Project (2012)

Naturalness of Minor Bed Structure



Aquatic Ecosystem Restoration Project (2012)

Naturalness of River Surroundings



Aquatic Ecosystem Restoration Project (2012)

River Length of Restoration Needed

River	Class 4				Class 5				Total (km)
	Left Side		Right Side		Left Side		Right Side		
	> 50%	10 – 50%	> 50%	10 – 50%	> 50%	10 – 50%	> 50%	10 – 50%	
Hangang	137.36	174.90	148.88	178.85	234.95	297.84	253.79	299.53	827.82
Anseongcheon	18.16	18.16	12.57	12.57	23.94	29.78	35.70	35.70	92.12
Hangang Tributaries to Yellow Sea	24.78	24.78	24.56	24.56	8.29	10.89	10.89	10.89	69.30
Hangang Tributaries to East Sea	2.63	2.63	2.63	5.29	8.18	8.18	8.18	5.53	21.62
Nakdonggang	224.30	266.60	263.71	301.15	715.02	790.54	775.34	860.08	2,050.37
Hyeongsangang	-	-	-	-	59.51	48.92	59.51	51.68	113.49
Taehwagang	17.08	10.07	17.08	10.07	10.54	7.91	10.54	7.91	49.46
Hweyagang · Sooyeonggang	7.62	4.91	10.25	7.54	-	-	-	-	16.24
Nakdonggang Tributaries to East Sea	22.55	36.11	25.42	35.41	185.60	272.72	130.73	189.82	415.23
Nakdonggang Tributaries to South Sea	5.58	5.69	2.78	2.78	25.10	34.84	20.14	21.01	56.82
Guemgang	107.83	117.71	91.47	86.34	102.12	143.59	127.76	133.84	444.87
Sapgyocheon	10.62	13.39	16.73	21.65	13.64	13.64	12.83	12.83	56.13
Guemgang Tributaries to Yellow Sea	29.96	32.80	29.96	32.8	5.36	5.36	2.69	2.69	69.67
Mangyeonggang · Dongjingang	48.10	48.10	53.22	53.22	63.29	63.29	67.44	67.44	232.05
Seomjingang	82.34	103.53	112.16	129.63	47.17	48.43	33.92	41.13	289.73
Seomjingang Tributaries to South Sea	11.11	16.00	8.41	13.29	8.04	13.40	16.58	22.23	50.37
Yeongsangang	279.21	283.43	278.52	282.82	123.74	149.03	145.42	163.23	842.38
Tamjingang	-	-	-	-	-	-	-	-	0
Yeongsangang Tributaries to South Sea	2.71	5.86	2.71	5.86	-	-	-	-	7.31
Yeongsangang Tributaries to Yellow Sea	63.86	63.86	52.68	52.68	72.01	72.14	72.12	74.85	261.53
Streams in Jejudo	2.79	5.34	2.79	2.79	-	2.67	-	-	7.15
Total	**1,098.59**	**1,233.87**	**1,156.53**	**1,259.30**	**1,706.50**	**2,013.17**	**1,783.58**	**2,000.39**	**5,973.66**

Aquatic Ecosystem Restoration Project (2012)

The Physical River Naturalness Index (PRNI) represents the quality of the river as the target of ecological restoration, especially in terms of the naturalness of the physical structure as a natural habitat, which is the practical objective of restoration projects.

PRNI was calculated for each map of stream orders, which were divided into approximately 2 km length, from the total of all national and regional rivers of approximately 30,000 km in length. Based on the degree of the physical naturalness of each river across a national and regional scale, the results confirmed the regions that require conservation, improvement, and restoration, and the need for physical improvement and restoration measures for water systems and river sections.

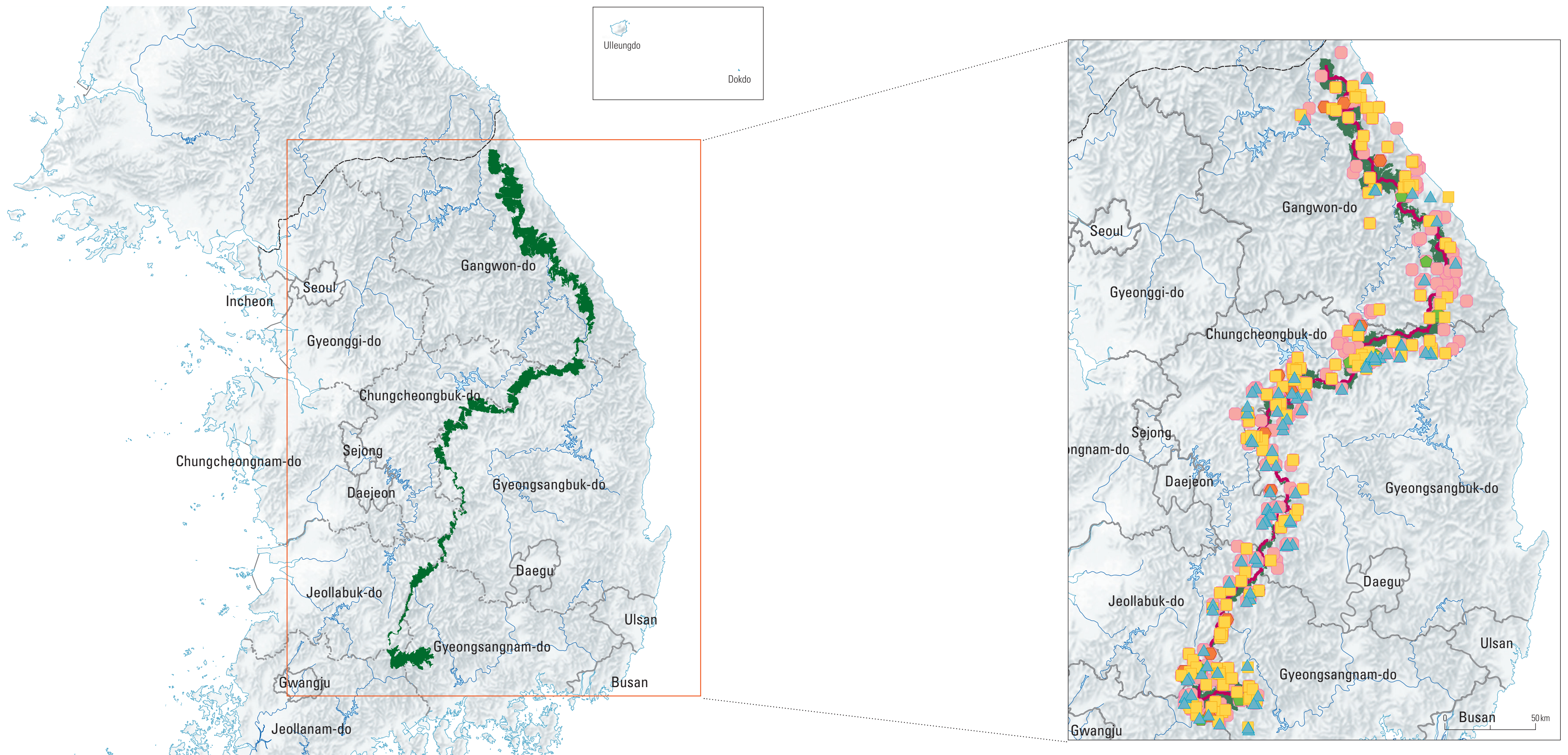
PRNI can be applied to various fields. First, it can be used for the establishment of improvement measures for the physical structure of rivers. Restoration measures have been prioritized after various examinations and assessments, and such prioritization can be applied to the evaluation of the effectiveness of the River Recovery Projects.

Moreover, a quantified database can be used to compare the evaluation results of the structural quality of the rivers in Korea with those of European rivers that were studied according to similar approaches.

The PRNI for each part of a river is broken down into sectoral and total PRNI. The sectoral PRNI is the outcome of the evaluation of the following 6 sectors: 1) development of waterways, 2) longitudinal section, 3) cross section, 4) riverbed structure, 5) minor bed, and 6) river surroundings. The total PRNI is the comprehensive result of each sectoral evaluation. The total PRNI on a nation-wide scale showed a diverse class system ranging from Class 1 to 5, with the mode of the class distribution as Class 3. The Hangang, Nakdonggang, and Seomjingang watershed had a total PRNI ranging from Class 1 to 5, with Class 3 as the mode. The total PRNI for the Geumgang watershed ranged from Class 2 to 5, with Class 4 as the mode. Classes from 2 to 4 were identified in the Yeongsangang watershed, and the mode was Class 3. In the Jejudo watershed, the total PRNI ranged from Class 1 to 4, with a mode of Class 2. For the sectoral evaluation, the mode for the development of waterways and the structure of the riverbed sector was Class 4, which was low relative to the modes for the other sectors. Also, the mean was the lowest at 2.0, making the restoration of these two sectors the most challenging task. For the longitudinal section, on the contrary, the mean was 3.1, which appeared to be the highest value, and the surroundings sector showed a higher rate of Class 1 than the others.

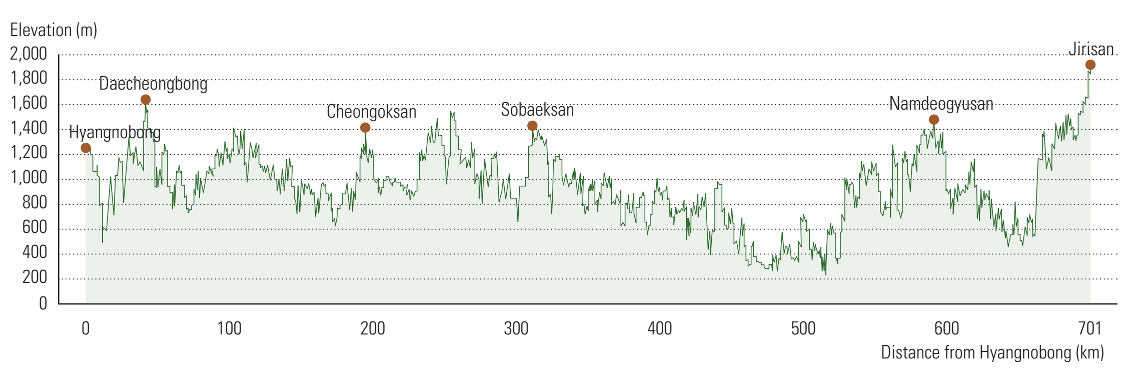
Traditional Ecology of Korea

Baekdudaegan Conservation Areas and Distribution of Major Cultural Assets



Korea Forest Service (2015)

Elevation Along Baekdudaegan



Korea Forest Service (2016)

Dryocopus martius

Nucifraga caryocatactes

Leucosticte arctoa (Jirisan)

Tetrastes bonasia (Gajisan)

Baekdudaegan is a traditional system of geographical perceptions in Korea. In the late 18th century, Shin Kyeong Jun wrote *Sangyeongpyo* to describe the Korean mountain ranges as a connected mountain system running from Baekdusan to Jirisan with hierarchical branches which consist of one Jeonggan and 13 Jeongmaeks. The mountain range and riverine system of Baekdudaegan served as a fundamental base for understanding the people, philosophy, literature, ecology, and culture of the Korean Peninsula.

The land of South Korea is covered with 64% forest in 2015, and most forests are connected to the Baekdudaegan. The Baekdudaegan, like the human backbone, has long been a central axis where interactions between humans and nature led to the formation of an eco-cultural space and spirit. Therefore, the designation of the Baekdudaegan as a protected area supports the identity of the Korean people and their willingness to maintain mutual dependency with the oceanic and continental ecosystems by strengthening the linkage between the cultures of the Pacific region and the Eurasian continent.

The protection area of Baekdudaegan is extremely valuable in terms of Korea's cultural history. Each major mountain boasts temples that entwine Buddhist culture with impressive landscapes. The area houses both tangible and intangible cultural heritage; there are 543 state-designated cultural assets, including 31 national treasures, 273 treasures, and 49 historic sites. There are also 965 province-designated heritage, 523 cultural and historical documents, 53 registered cultural heritage, and so forth. In particular, temple forests play a central role in enhancing the value of the protection area. Out of the 935 traditional temples in Korea, 173 (19%) are located in Baekdudaegan. Baekdamsa (Seoraksan), Woljeongsa and Sangwonsa (Odaesan), Hwaeomsa (Jirisan) are main temples well known to the public. They contain approximately 16,571 ha of temple forests which accounts for 6% of the total protection area in Korea.

The Korea Forest Service developed four criteria for designating the Baekdudaegan Conservation Areas as follows: first, the Baekdudaegan Conservation Areas as the core of the mountain range, should not be disconnected; second, the ecosystems of Baekdudaegan must be secured to ensure their continuity and connectedness; third, the boundaries of core and buffer areas must be defined by ecological factors such as riverine systems, mountain systems, and vegetation; and fourth, any negative impact to local residents must be minimized and the opinions of diverse stakeholders must be considered.

Three principles were also applied to designation of the Protection Areas of Baekdudaegan: first, management regions, defined as areas within the third tributary of a watershed at the center of mountain ridges, and outer areas with consideration for their physical, biological, and managed status; second, core areas, defined as areas belonging to the 1st tributary of a watershed and areas with distinguishable ecological factors; and third, buffer areas, defined as protected zones excluding core areas.

Based on these criteria and principles, a total of 263,000 ha of the Baekdudaegan Conservation Areas had been designated as of September, 2005. In terms of ownership, Conservation Areas were composed of national forests (208,000 ha, 79%), public forests (20,000 ha, 8%), and private forests (35,000 ha, 13%).

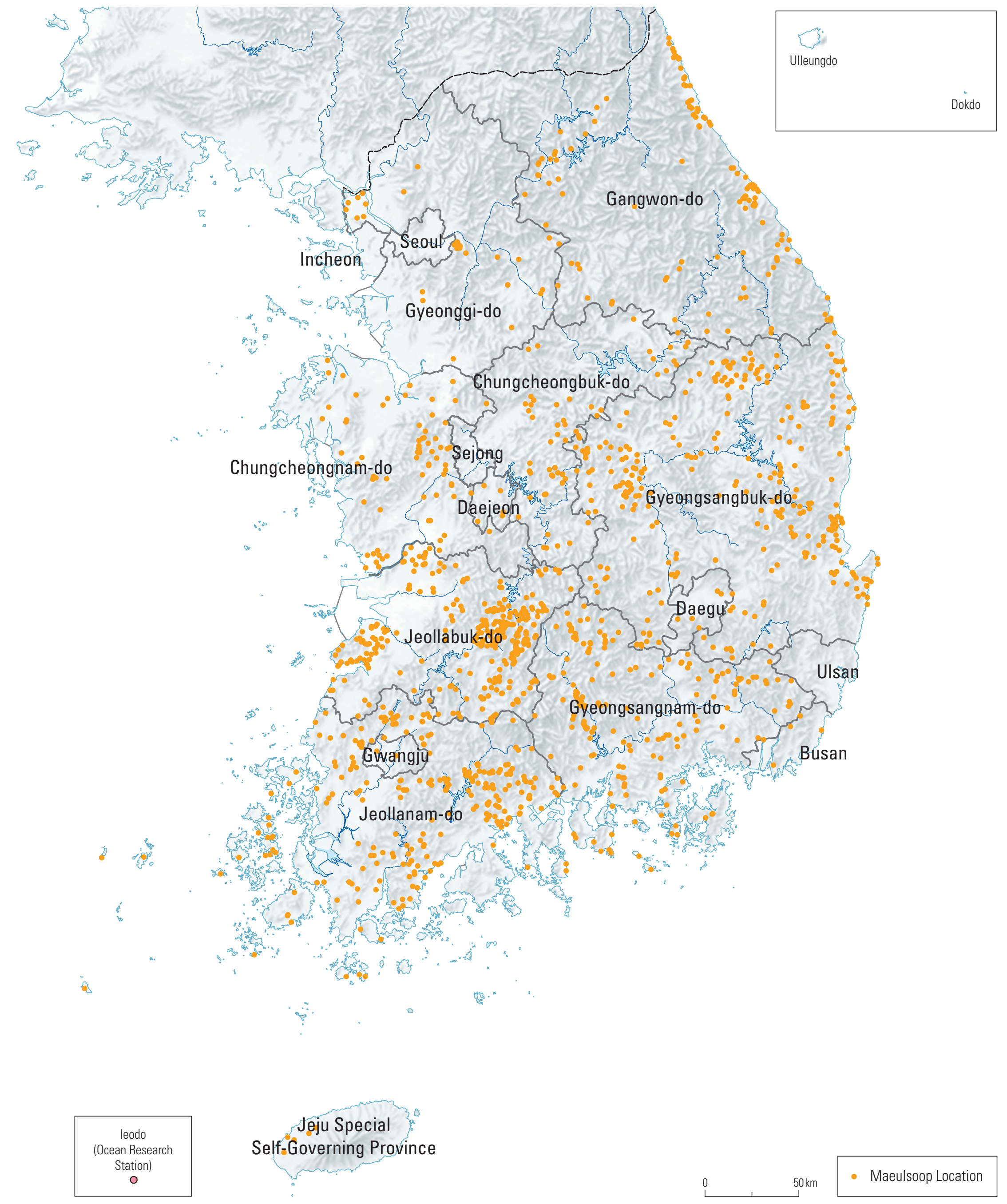
Diverse wildlife live in the Baekdudaegan region, although the Baekdudaegan contains only 4.2% of the total forests of Korea. Studies indicate that Korea's flora consists of 126 families, 541 genus, and 1,248 species (3 subspecies, 204 varieties, 22 forms), and its fauna includes 23 species of mammals (such as otters, martens, leopards, and flying squirrels), 91 species of birds (including 12 legally protected birds), 11 amphibians, and 6 reptiles.

BIOSPHERE

Ecology

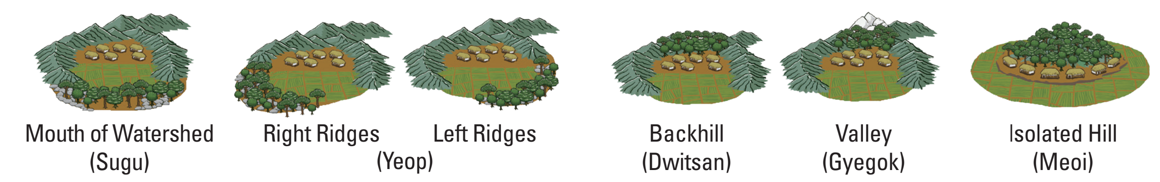
Traditional Ecology of Korea

Distribution of *Maeulsoop* (Village Groves)



National Institute of Forest Science (2014)

Typical Locations of Traditional Maeulsoop



National Institute of Forest Science (2014)

Based on their location, village groves can be classified into the following five types: *sugu* (a grove covering the mouth of a watershed in which the village is nested), *yeop* (a grove covering low areas either on the left or right side of the village), *dwitsan* (a grove covering the ridge of low hills behind the village), *gyegok* (a grove covering an unsightly object in the valley behind the village), and *meoi* (a grove covering an isolated hill).

The oldest village grove in Korea is Daegwallim which is thought to have been created with levees by Choi Chiwon in order to prevent floods during his term of office as governor of Cheollyeong-gun during the reign of Queen Jinseong (A.D. 887 – 897). The grove is protected as Natural Monument No. 154.

The Korea Forest Service investigated and organized information for the village groves in 1,335 regions as of September, 2014, and found that major plant species of the village groves on the list were *Pinus densiflora* and *Zelkova serrata*. Sugumagi was the most common type of village grove.

Size of Maeulsoop

Area	0 – 1 ha	1 – 2 ha	2 – 3 ha	3 – 4 ha	4 – 5 ha	> 5 ha	Sum
Number	1,003	138	43	17	16	56	**1,273**
Ratio (%)	78.8	10.8	3.4	1.3	1.3	4.4	**100**

* Analyzed with 1,237 Maeulsoops suveryed out of a total of 1,335

Management Authority of Maeulsoop

Authority	Village	Local Government	Indiv-idual	State	Clan	Other	Sum
Number	358	124	72	48	38	8	**648**
Ratio (%)	55.2	19.1	11.2	7.4	5.9	1.2	**100**

*Analyzed with 648 Maeulsoops suveryed out of a total of 1,335

Plant Species of Maeulsoop

Species	Pine tree	Zelko-va Tree	Hack-berry	Oak Tree	Black Pine	Ginkgo Tree	Other	Sum
Number	43	295	51	39	38	17	111	**954**
Ratio (%)	42.2	30.9	5.4	4.1	1.0	1.8	11.6	**100**

*Analyzed with 954 Maeulsoops suveryed out of a total of 1,335

Type of Maeulsoop

Type	Blocking the River Mouth	Backhill	Biboye-apsung	Moe (Hills in Plain)	Other	Sum
Number	449	30	3	24	421	**927**
Ratio (%)	48.4	3.2	0.3	2.6	45.4	**100**

*Analyzed with 954 Maeulsoops suveryed out of a total of 1,335

National Institute of Forest Science (2014)

Beobseong Forest, Yeonggwang-gun, Jeollanam-do

Mulgeon-ri Forest, Namhae-gun, Gyeongsangnam-do

Wongarim Forest, Jinan-gun, Jeollabuk-do

Geumdangsil Forest, Yecheon-gun, Gyeongsangbuk-do

Songmal Forest. Icheon-si, Gyeonggi-do

Sangnim, Hamyang-gun, Gyeongsangnam-do

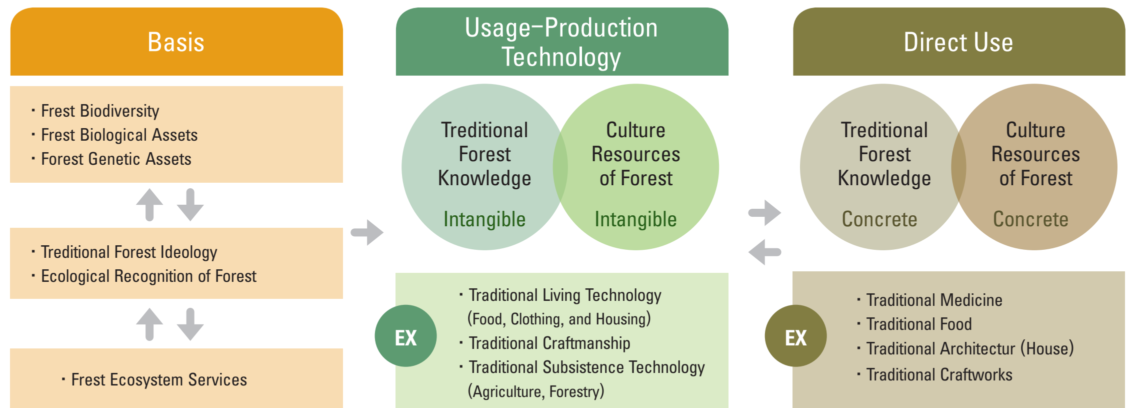
Modern society's industrialization and urbanization have caused various environmental problems and accelerated changes of the climate and natural ecosystems. The ecological knowledge and resource management practices handed down from traditional cultures have gained attention as means for solving environmental problems as well as managing and distributing resources.

Korean traditional villages took the concept of the *Baesanimsu* (with back to the mountain and face to the water) as the basic principle to guide settlement location and land use. Also, this principle greatly benefited villagers who, as a result, lived within well-secured watersheds with access to water, protection against the wind, and accessibility to resources. The traditional villages were adapted to the local natural conditions and existed in a harmonious relationship with the surrounding natural ecosystems, resulting in their ability to maintain that spatial arrangement for a long period of time. One good example is maeulsoop (Korean village grove).

A village grove is a forested area that helps the people adapt to the monsoon climate and helps the village to harmonize with the surrounding environment. The grove is a part of the village landscape, or is a property co-owned with and protected and managed by villagers. A village grove is a common gathering place for villagers and provides shelter for people during the hot summer. Further, it is a sacred site and holy place that the villagers protect and where they perform ancestral rites periodically.

Big trees such as pine and zelkova grow in the groves. Also, many species of birds like mandarin duck, scops owl, owl, woodpecker, great tit, and starling, which normally live deep in the mountain forests and build nests in the hollows of tree trunks and branches, inhabit the area, frequently being observed near the village.

Developments in Traditional Forest Knowledge

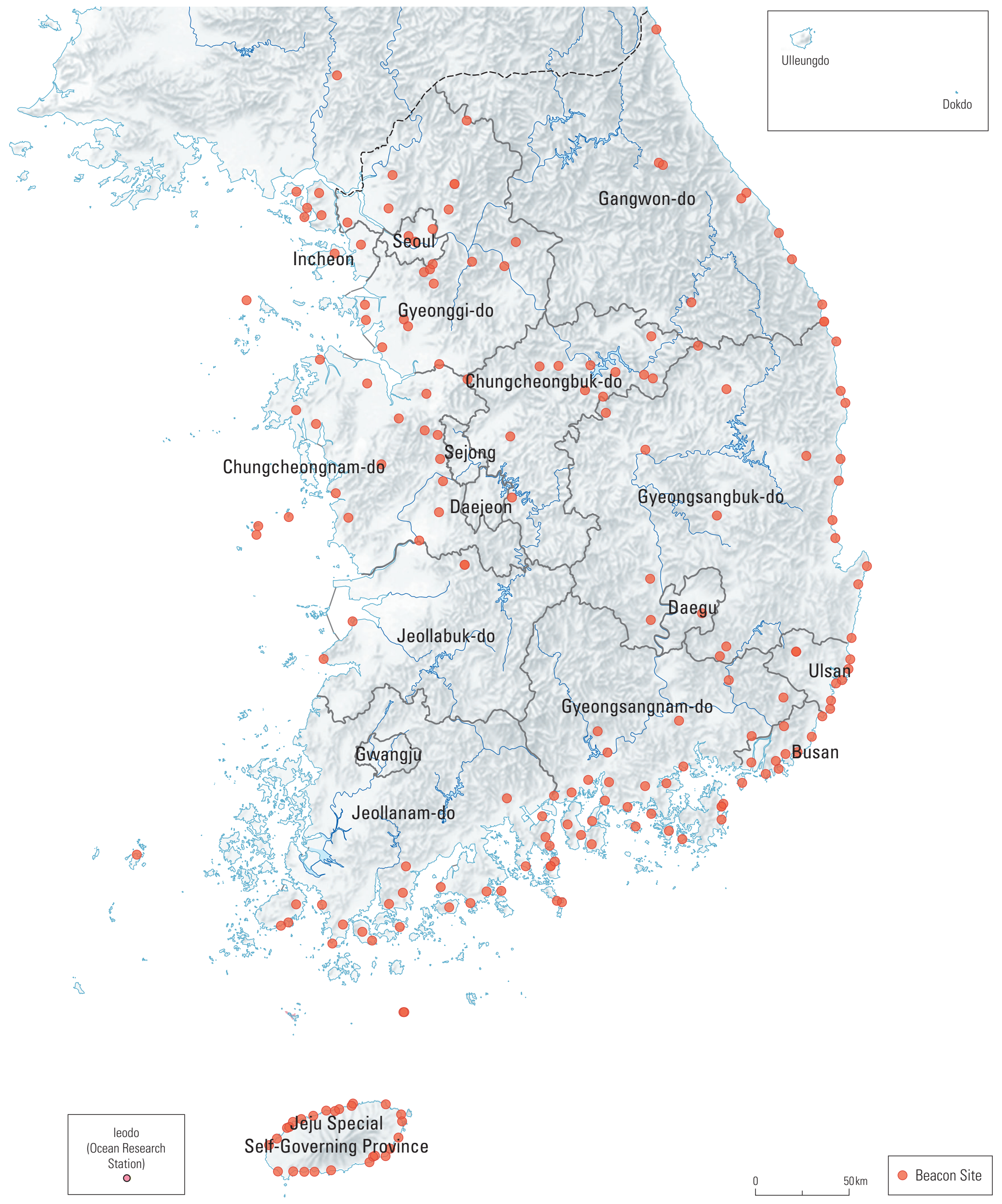


Korea Forest Research Institute (2014)

Traditional forest knowledge is defined as an integral aspect of the cultural heritage, ecological (genetic) resources, and traditional wisdom that a particular region or a group of people (tribe or ethnic group) has passed down over the generations. Based on this, Korea has developed the usage, production, and related technology for traditional knowledge. Recently, efforts have been made to classify traditional forest knowledge into 5 categories (humanities, forest philosophy, natural environment, production technique, and social-economic policy) to fit the international trend toward the traditional knowledge-related International Patent Classification.

Beacon, which signaled urgent matters via smoke and fire, is a representative example of tangible resources and an important communication tool used in the traditional Korean society. Especially beacons on mountains and travel beacons were used as effective means of communication. Currently, locations of 194 beacon mounds have been identified.

Distribution of Beacons



Korea Forest Research Institute (2014)

Traditional Ecological Practices

Types of Acorn Trees

Sawtooth Oak (*Quercus acutissima*)
Chinese Cork Oak (*Quercus variabilis*)
Mongolian Oak (*Quercus mongolica*)
Korean Oak (*Quercus dentata*)
Oriental White Oak (*Quercus aliena*)
Bao Li (*Quercus serrata*)

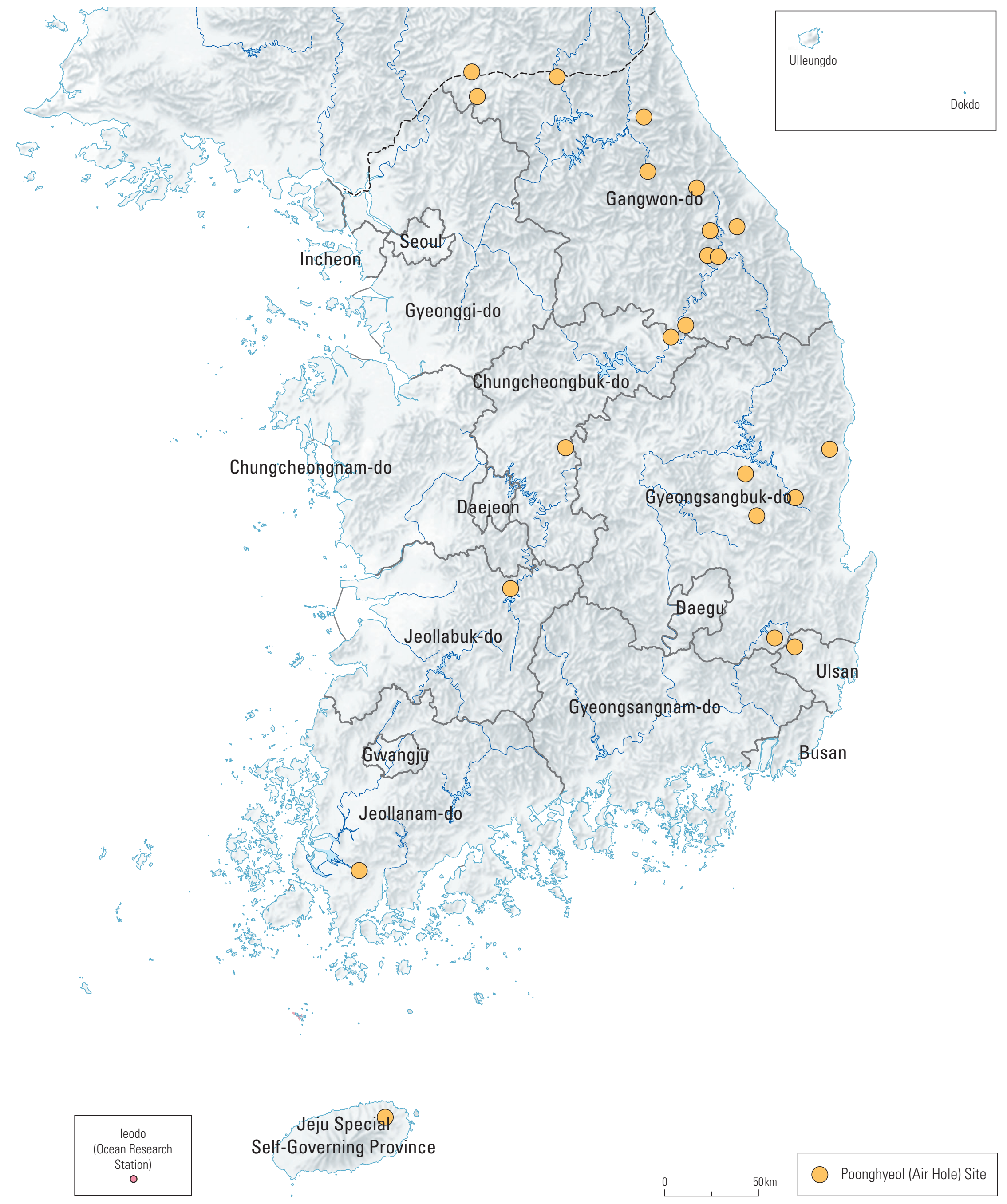
National Institute of Forest Science (2014)

Food Made with Acorns

The Korean word *dotori* for acorn is a compound word derived from "dot" (boar) and "tol" (nut), meaning a kind of nut that wild boars like to eat. Korean people use acorns for food today. The Korean history of using acorns as food dates back farther than one would expect. Twenty-five pits that were discovered on Sejuk beach in Ulsan contained evidence that people dug holes regularly to get rid of acorn tannins with sea water and made food with acorns as far back as 6,000 BC. Records related to acorns can also be found in the *Annals of the Joseon Dynasty*. On the 20th of August, 1424, King Sejong ordered that people "keep a good number of acorns in reserve for famine years." He also commanded people to plant oak trees as a hardy plant when crop production was not sufficient. The *Injeji* of *Imwon gyeongjeji* (the largest practical encyclopedia of the Joseon Dynasty), explains how people could plant oak trees and take care of them. *Boncho gangmok* (the book of Chinese medicinal herbs) describes acorns as "neither crop nor fruit, but having merits of both, a good diet without any supplementary tonic." Thus, sawtooth oak (*Q. acutissima*), having bigger acorns and being more productive than all the other oak tree species, are generally found near villages, rather than in high mountains. Sawtooth oak inhabits temperate forest regions with annual mean temperatures ranging from 5 to 14 ˚C below an elevation of 800 m.

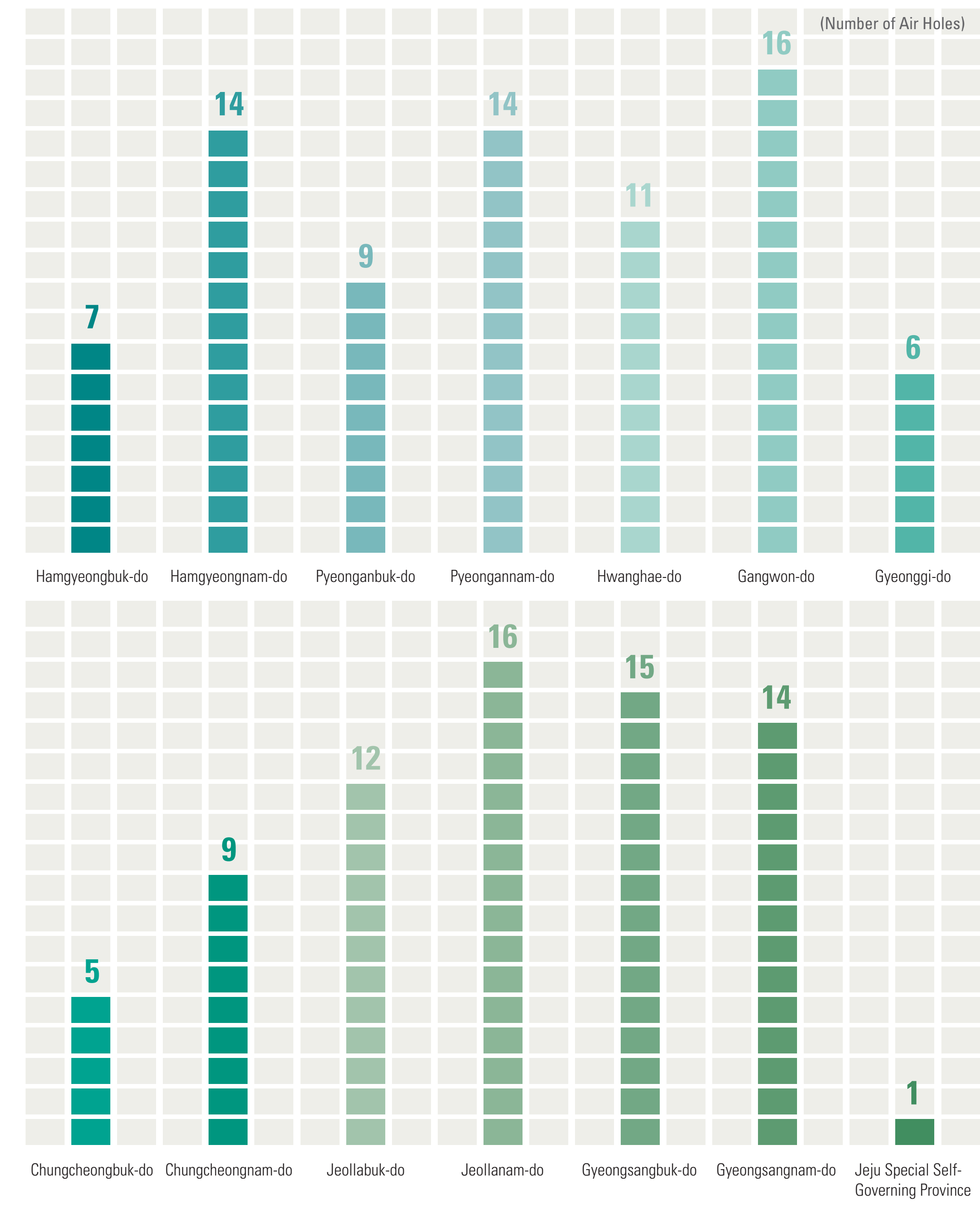
Air Holes and Ecosystem

Distribution of Major Air Holes (Poonghyeols)



Korean Society of Environmental Impact Assessment (2011)

Number of Air Holes (Poonghyeols) by Province



Korean Society of Environmental Impact Assessment (2011)

Landscape of Hongcheon Air Hole

Hongcheon Air Hole (Talus Type)

Mountain Cranberry (*Vaccinium vitis-idaea*)

Climate Data Loggers at Hongcheon Air Hole

Characteristics of Major Air Holes

Administrative District	Longitude/Latitude	Elevation (m)	Topography	Road Access	Land Use
Dongmak-ri, Yeoncheon-gun, Gyeonggi-do	127° 06′ E, 38° 04′ N	70 – 350	terminal of slope, stream-side	near to road	arable land, near to village
Bangnae-ri, Hongcheon-gun, Gangwon-do	128° 16′ E, 37° 48′ N	about 350 m a.s.l.	terminal of slope	near to road	arable land, near to village
Deogu-ri, Jeongseon-gun, Gangwon-do	128° 43′ E, 37° 21′ N	350 – 430	terminal of slope, stream-side	near to road	arable land, near to stream
Wunchi-ri, Jeongseon-gun, Gangwon-do	128° 37′ E, 37° 15′ N	320 – 400	terminal of slope	connected to road	forest
Nuenggang-ri, Jecheon-si, Chungcheongbuk-do	128° 14′ E, 36° 59′ N	about 689 m a.s.l.	middle of slope	access by climbing	forest, cold spring
Naeryong-ri, Cheongsong-gun, Gyeongsangbuk-do	129° 13′ E, 36° 18′ N	240 – 330	terminal of slope, stream-side	connected to road	near to tourist spot, cold spring, stream-side
Binggae-ri, Euiseong-gun, Gyeongsangbuk-do	128° 45′ E, 36° 13′ N	140 – 180	terminal of slope, stream-side	connected to road	near to tourist spot, cold spring, near to stream
Jwapo-ri, Jinan-gun, Jeollabuk-do	127° 17′ E, 35° 43′ N	260 – 380	terminal of slope, stream-side	connected to road	arable land, tourist spot, cold spring, near to stream
Nammyeong-ri, Miryang-si, Gyeongsangnam-do	128° 59′ E, 35° 34′ N	400 – 700	middle of slope	access by climbing	forest, near to tourist spot, near to stream

Korean Society of Environmental Impact Assessment (2011)

A poonghyeol (air hole) can be described as a wind hole or an air hole in which the air blowing out of the hole is cooler in summer but warmer in winter than the surrounding air, exhibiting a unique micro-meteorological condition. Poonghyeols are normally found on the foothills of mountain, in which periglacial landforms, such as talus, block fields, and block streams on steep slopes of mountains prevail. Poonghyeols without ice formation in the summer are often called wind holes or wind caves by local people. Poonghyeols that carry ice or frost until summer time have different names, such as ice valley, ice cave, ice hole, and summer frozen ground, but they are also types of air holes. Few poonghyeols, which come with cool air as well as cold ground spring water with year round temperatures between 20 to 25℃ are called cold springs.

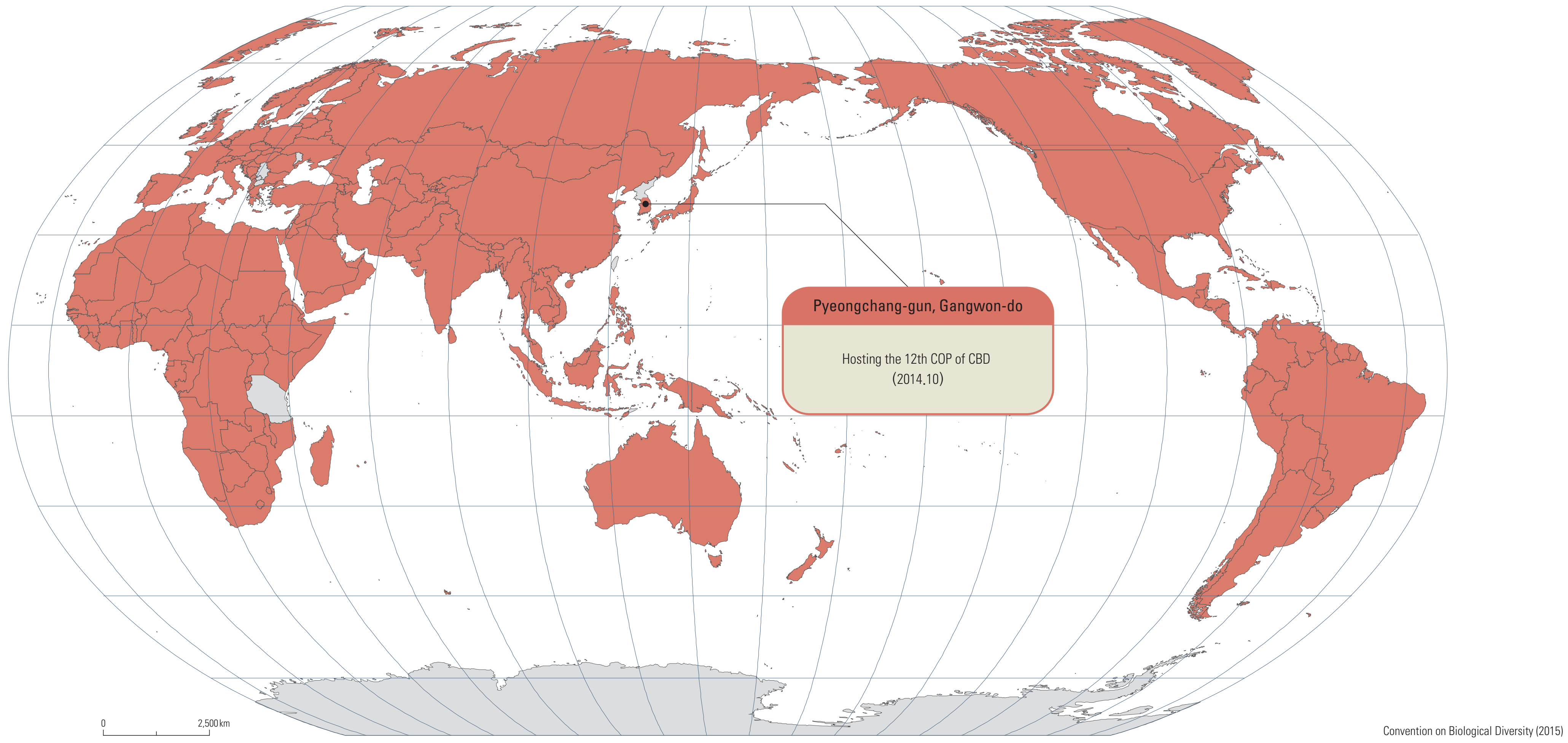
The Korea National Arboretum investigated the environmental characteristics of nine poonghyeols and analyzed them on the basis of their geology, landforms, climate, soil, hydrology, vegetation, roads, footpaths, land-use, and management systems. Poonghyeols in Korea are normally found on old geological substratum, such as a Cretaceous layer, and on northwest- and north-facing slopes at the terminal point of steep talus, block fields, and block streams, and can be categorized into three types (talus, cave, and sink).

Poonghyeols were mainly formed in the periglacial environment of the Pleistocene Epoch, Quaternary Period of the Cenozoic Era, when the climate was much colder relative to today. A large number of boreal floristic species, which are sensitive to global warming, inhabits the poonghyeols. These arctic-alpine plants migrated from the north in search of warm, suitable habitats during the glacial periods, especially during the Last Glacial Maximum, and later, cold-loving plants grew in the poonghyeol areas, where cool summer micro climates exist. Poonghyeols have served as both glacial and inter-glacial refuges for arctic-alpine plants.

The poonghyeol at Hongcheon-gun of Gangwon-do, for example, in which the arctic-alpine evergreen shrub mountain cranberry (*Vaccinium vitis-idaea*) isolatedly grows at the southernmost and lowest location on the Korean Peninsula, has biogeographical value as a potential future gene pool site for cold-tolerant or cryophilous flora. Under global warming conditions in the future, this poonghyeol site could function as an excellent conservation area for northern floristic elements such as the mountain cranberry.

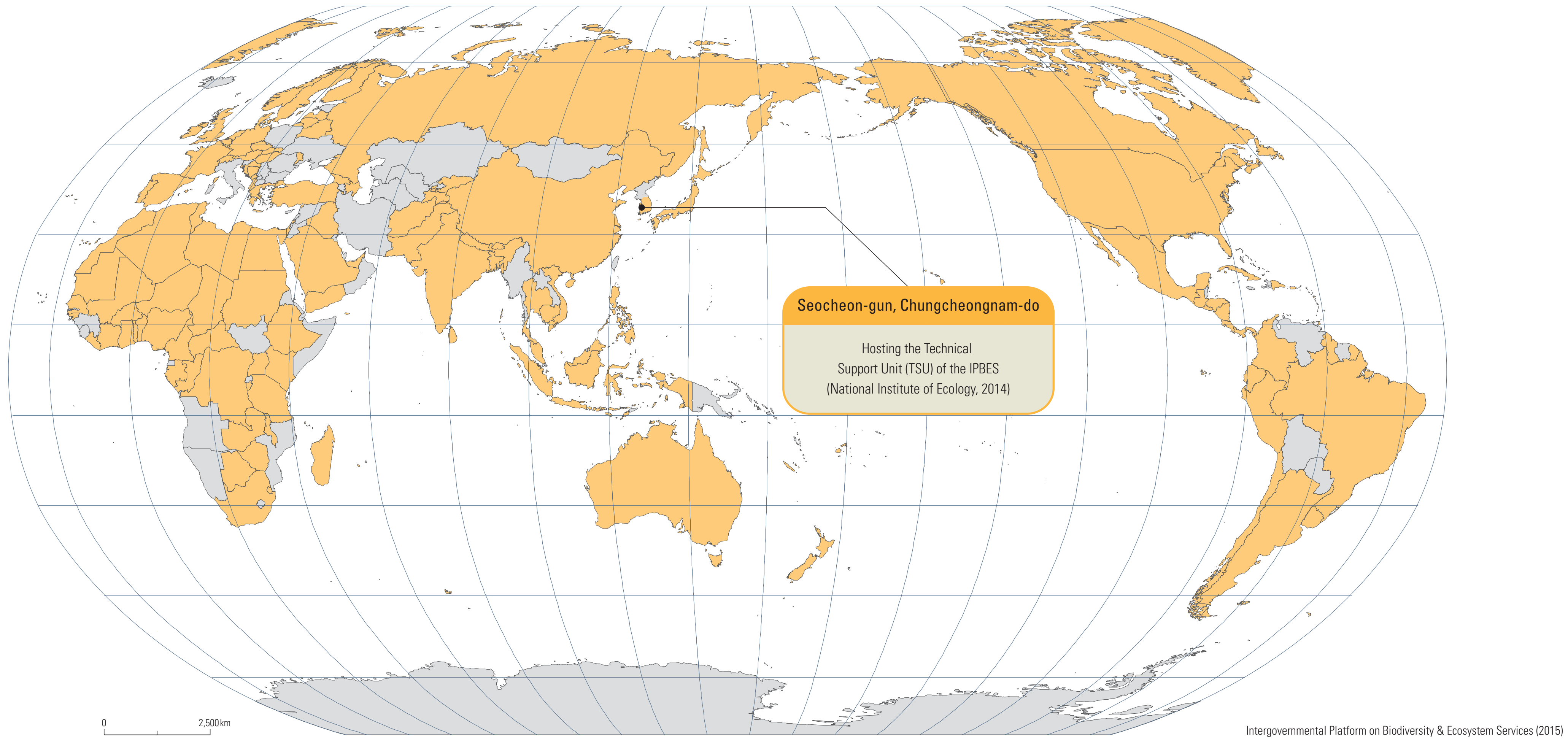
Ecological Value, Korea in the World

Participating Countries of the Convention on Biological Diversity (CBD)



Convention on Biological Diversity (2015)

Participating Countries in Intergovernmental Platform on Biodiversity & Ecosystem Services (IPBES)



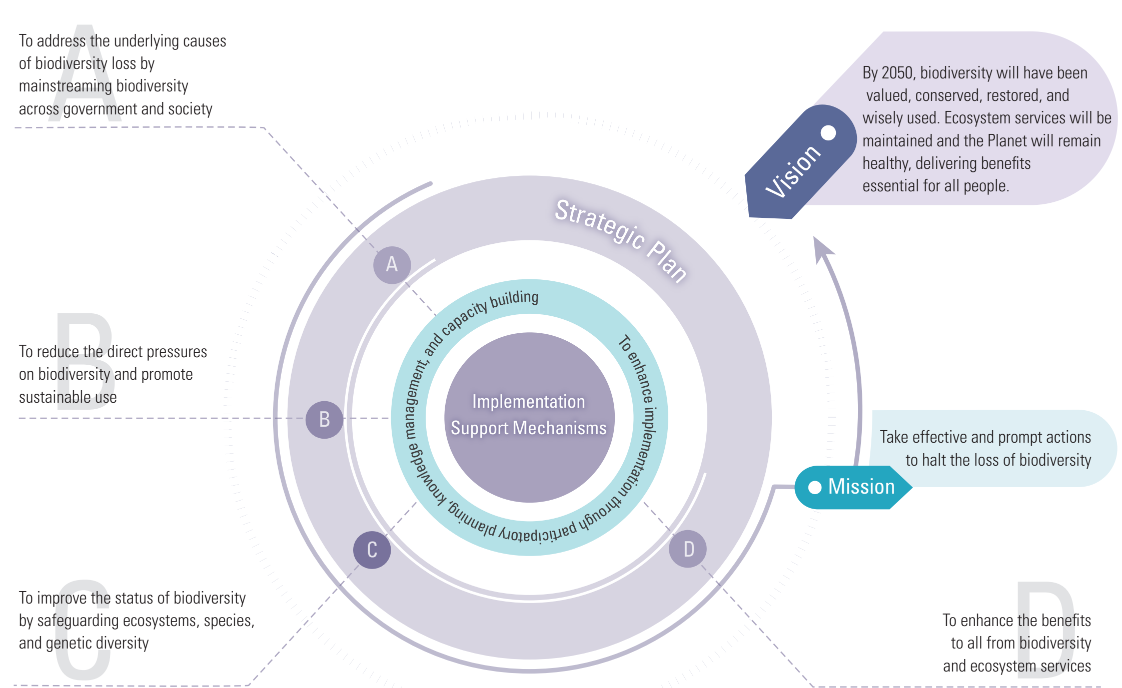
Intergovernmental Platform on Biodiversity & Ecosystem Services (2015)

Some environmental and ecological issues can be managed at a local scale, but most current issues require regional and national cooperation over a long term. To effectively take action against these urgent environmental and ecological issues, international society has organized more than 170 international conventions on environment. Considering the increasing global role of Korea, several ministries joined the international conventions related to environmental issues, supporting international cooperation.

The Convention on Biological Diversity (CBD) is one of the most important environmental conventions, along with the United Nations Framework Convention on Climate Change (UNFCCC) and the United Nations Convention to Combat Desertification (UNCCD). Korea has been a party to the CBD since 1994. The Twelfth Meeting of the Conference of the Parties to the Convention on Biological Diversity (COP 12) was held in Pyeongchang-gun of Gangwon-do, Korea, from September 29 to October 17, 2014. The Korean government suggested the Bio-Bridge Initiative to develop a streamlined mechanism for Technical and Scientific Cooperation between developed and developing countries.

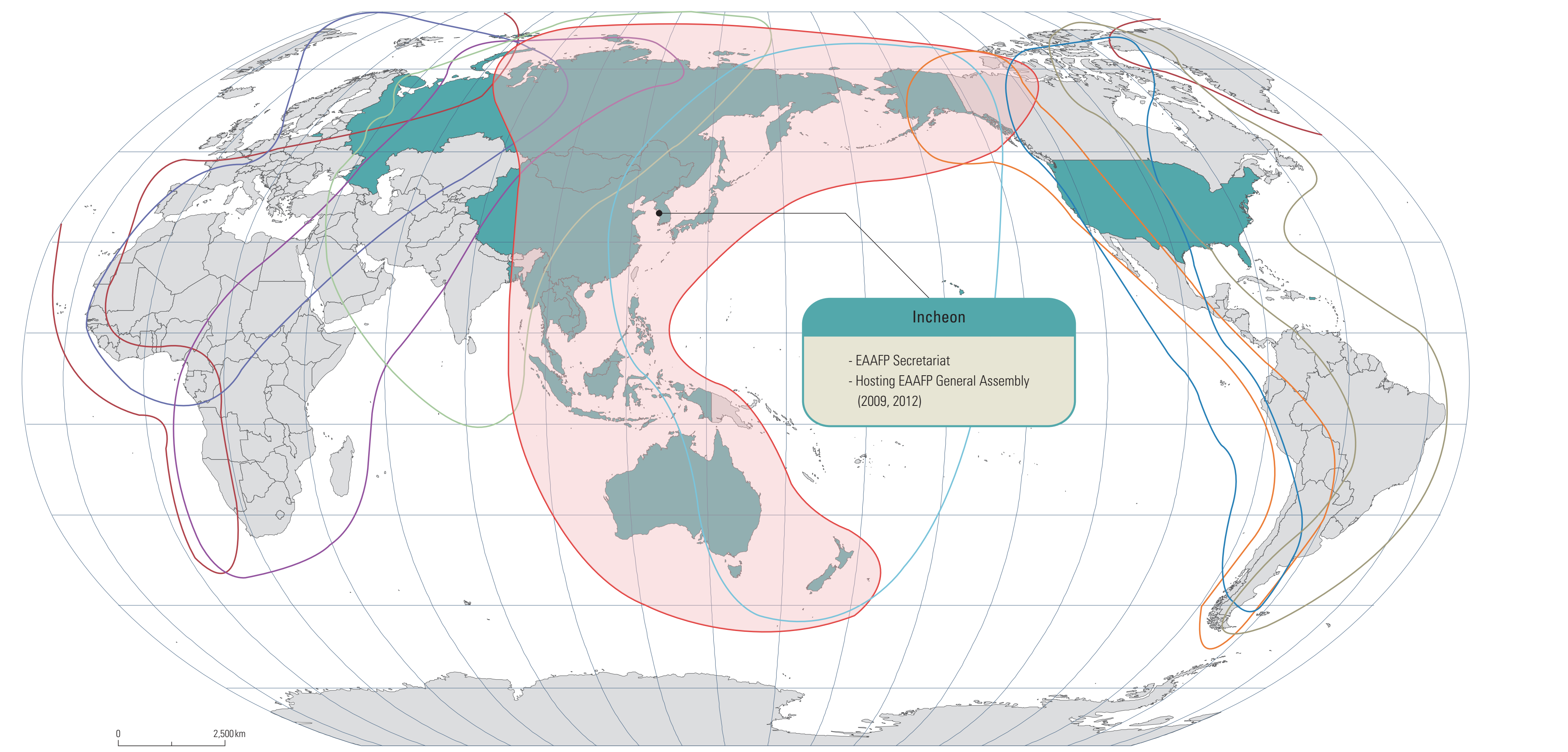
The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) is the intergovernmental body that assesses the state of biodiversity and the ecosystem services to provide scientific and political consultation. At the 2nd General Assembly of the IPBES in 2013, Korea proposed to host the Technical Support Unit for the Task Force on Knowledge and Data of the IPBES. According to the decision of the third full Multidisciplinary Expert Panel and Bureau Meeting held in Germany in 2014, the Ministry of Environment of Korea officially launched the unit at the National Institute of Ecology.

Strategic Plan for Biodiversity (2011 – 2020)



Convention on Biological Diversity (2015)

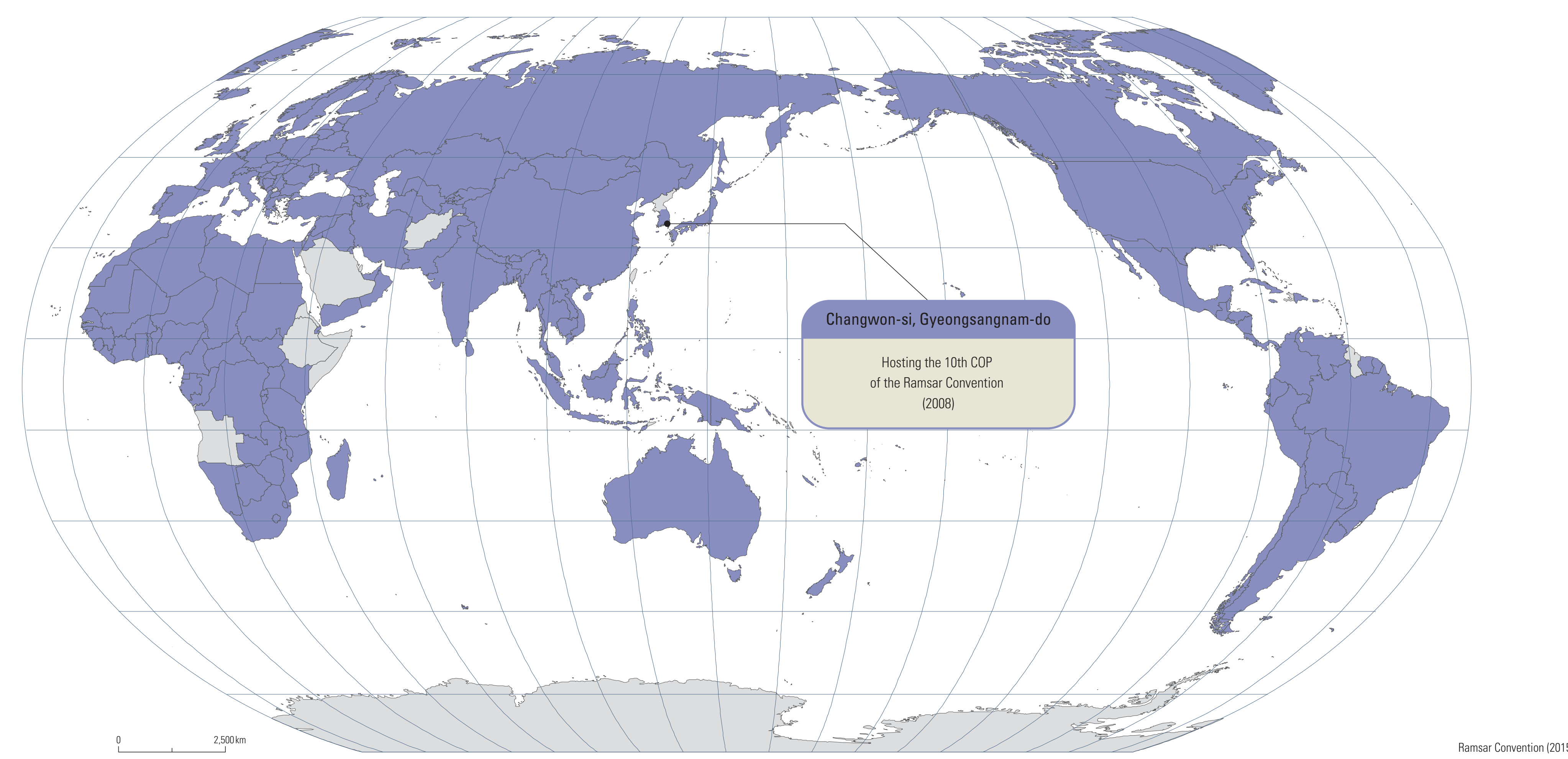
East Asian-Australasian Flyway Partnership (EAAFP)



Flyway refers to the migratory route of waterfowls migrating to breed and prepare for winter. This map was created based on the geographical migratory route of shorebirds.

East Asian-Australasian Flyway Partnership (2015)

Member Countries of the Ramsar Convention



Ramsar Convention (2015)

The Convention on Wetlands of International Importance, especially as Waterfowl Habitat (informally, the Ramsar Convention) is an international treaty for the conservation and sustainable utilization of wetlands. The treaty was adopted in the Iranian city of Ramsar in 1971 and came into force in 1975. As of 2015, 169 countries had ratified the treaty. Korea has been a party to the Ramsar Convention since 1997. Korea has 21 Ramsar sites, including Yongneup of Daeamsan (Gangwon-do), Uponeup (Changnyeong-gun), Jangdo High Moor (Jeollanam-do), Suncheon bay (Jeollanam-do), Mullyeongari-oreum (Jejudo), Du-ung Wetland (Chungcheongnam-do), Mujechineup (Ulsan), Muan tidal flat (Jeollanam-do), Ganghwa Maehwamareum Habitat (Incheon), Odaesan National Park wetlands (Gangwon-do), Muljangori-oreum wetland (Jejudo), Hanbando wetland (Gangwon-do), Sumeunmulbaengdui wetland (Jejudo).

The East Asian-Australasian Flyway Partnership (EAAFP) was launched on 6 November 2006, and aims to protect migratory waterbirds, their habitat, and the livelihoods of people dependent upon them. The EAAF Partnership is made up of partners including governments, international Non-Government Organizations (NGOs), and inter-governmental organizations. Korea had proposed to host the Secretariat in Korea, and officially launched the Secretariat in Incheon, in 2007.