

# KOREA'S NATURAL SETTING

## Korea's Natural Setting: An Overview



Detail of an early map illustrating how cartographers traditionally symbolized elements of the Korean landscape. Prominent natural features include rivers, mountains, the coastline, and the island of Ulleungdo. A distinction is made between the primary mountain ridges of Taebaeksanmaek and Sobaeksanmaek, shown as large blue peaks, and the minor ridgelines, shown in green.

Detail of *Dongguk daejeondo*, Great Map of and Eastern Country [Korea], Jeong Sang-ki, mid-18th century, color manuscript copy 272.7x147.5 cm, National Museum of Korea.

### Topography of the Korean Peninsula

The unique geography of the Korean Peninsula has produced a remarkably beautiful and varied scenery. The scenery or landscape of a particular place is made up of those visible landforms, plants, and other elements that give a place its character. Within a short distance, a traveler in Korea can see very different landscapes: rocky shorelines, rugged mountains, tranquil lakes, and meandering streams.

The natural elements of a landscape comprise both physical and biological components of Earth's four environmental spheres: the lithosphere, atmosphere, hydrosphere, and biosphere. These elements provide a framework for the

activities of humans, who affect—and are greatly affected by—the natural setting. Topography, for example, partly determines the location of agricultural fields, cities, roads, and reservoirs. In recent millennia, the ability of humans to modify the environment has expanded rapidly so that we are now significant components of many environmental processes. The anthroposphere, sometimes recognized as a fifth environmental sphere, is dominated by human construction and modification of the natural landscape.

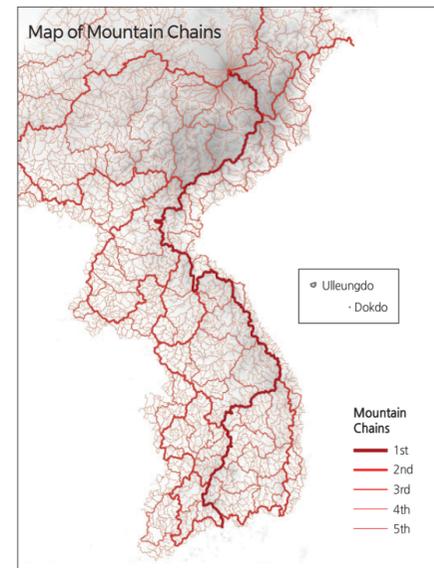
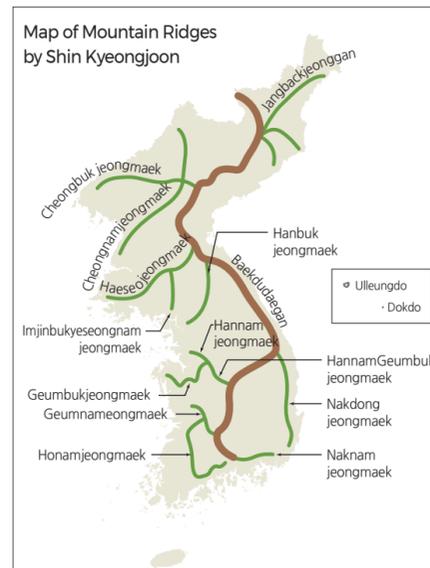
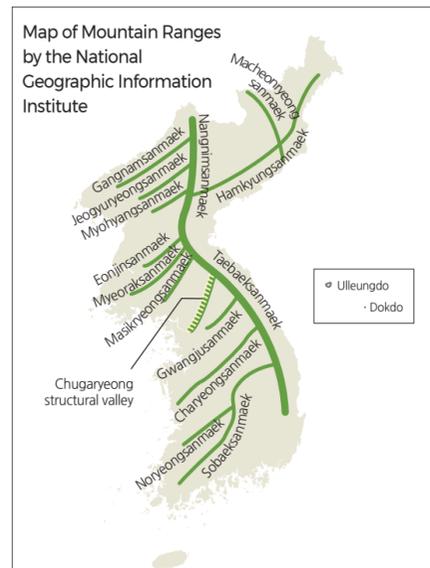
The lithosphere includes the study of landforms, geology, rocks, minerals, and soils. The atmosphere encompasses all studies relating to the composition of the air around our planet, how it moves, and how weather and climates interact with the sun's energy and the locations of elements on the surface of the earth. The hydrosphere pertains to the water systems on our planet, including seas and oceans, arctic and alpine snow and ice, as well as inland water systems in rivers, lakes, and underground aquifers. And the biosphere refers to the realm of all living things, including all classifications of plants and animals.

The Korean Peninsula is bordered by water on three sides. The Yellow Sea is relatively shallow, generally less than 100 meters deep. The East Sea, however, is quite deep even close to the shoreline and reaches depths of more than 3,000 meters. The Peninsula has relatively extensive coastlines for its size. In contrast to its smooth eastern coastline, its southern and western coastlines are irregular and complex, with many islands.

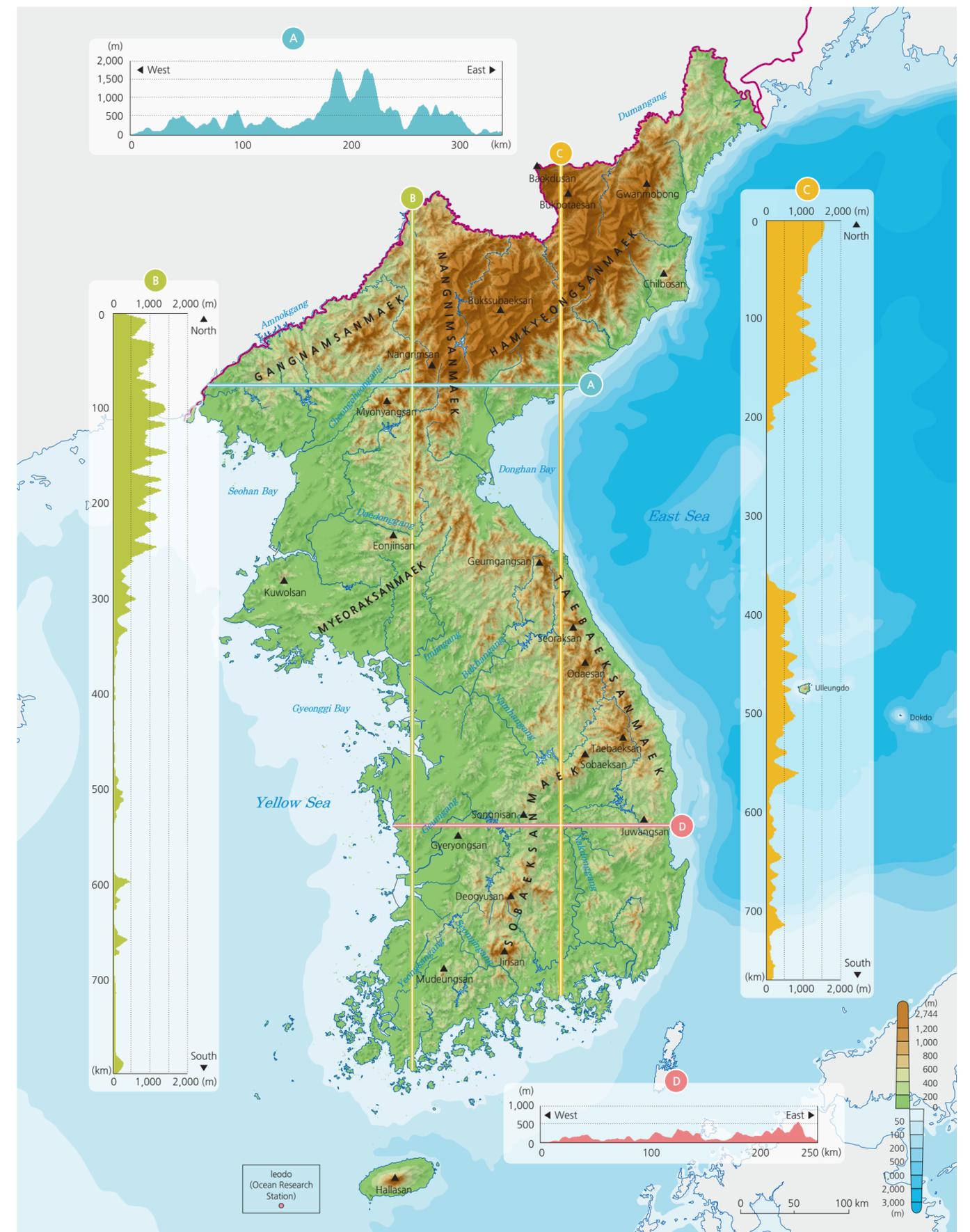
A topographic map reveals the broad asymmetry in elevation across the Korean Peninsula. Mountain ranges, with high elevations depicted in orange and yellow, mostly occur to the north and east. Lower elevations, shown in green, mostly occur in the west and south. The highest point, Baekdusan, at 2,744 meters, is a volcanic peak near the border of North Korea and China. The Hamkyeongsanmaek and Taebaeksanmaek mountain ranges run north-to-south, following the coastline. Rivers on the east side of these ranges flow a short distance to the East Sea. Rivers flowing to the west generally run much longer as they cross the lowlands toward the Yellow Sea.

The mountains of Korea have traditionally been portrayed on maps as linear ridges, which emphasizes the connectedness of areas with high elevation. These traditional linear ridges correspond roughly to stream basin boundaries, also called watershed boundaries or drainage divides. This ancient way of depicting the landscape is conceptually similar to modern ecological approaches that use watersheds as a fundamental unit of landscape analysis to study natural processes.

### Different Traditional Ways of Portraying Korea's Mountain Ranges



### Topographic Relief and Profiles of the Korean Peninsula



National Geographic Information Institute (2019)

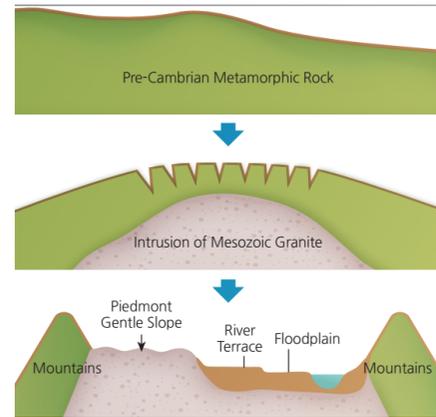
# Geomorphology: Mountainous and Volcanic Landforms

## Geomorphology of Korea : The Science of Landforms

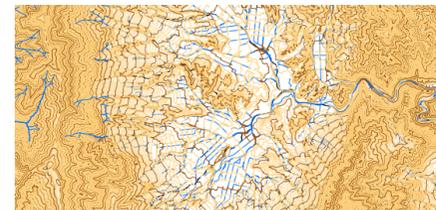
Geomorphology is the study of landforms, their origins, and their relationship to processes that operate at the earth's surface. Landforms can reflect present and past environmental conditions, erosional and depositional histories, and the influences of climate change. Geomorphic features are fundamental components of the landscape that can determine many other aspects of the natural environment: soil properties, water quality, microclimate, plant and animal habitats, and many other phenomena and processes.

Korea maintains a National Ecosystem Survey that evaluates the current status of the natural environment. It covers abiotic components (topography, geology, land, and soil) and biotic components (plants and animals). The survey enhances the understanding of geomorphic features, the distribution of plant and animal species, the degree of environmental health, and the value of ecosystem services by analyzing the characteristics of each element. Evaluation of environmental features is based on a general grading system, with Grade 1 features (mapped here) having a high preservation value.

### Formation of Erosional Basins



### Example of Erosional Basin (Haean Basin)



National Geographic Information Institute (2015)

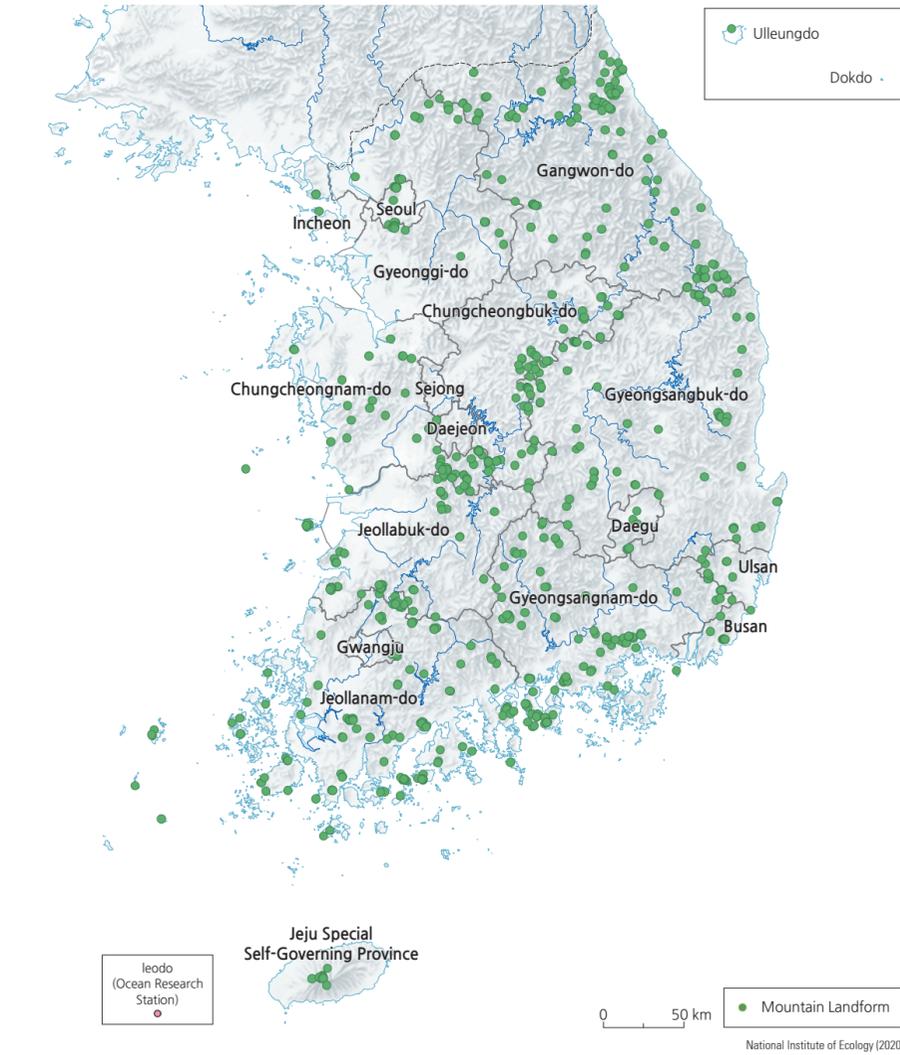


Erosional Basin (Haean Basin in Yanggu, Gangwon-do)



Tafoni (Maisan, Jinan, Jeollabuk-do)

### First Grade Mountain Landforms



National Institute of Ecology (2020)



Granite Dome (Bukhansan, Seoul)



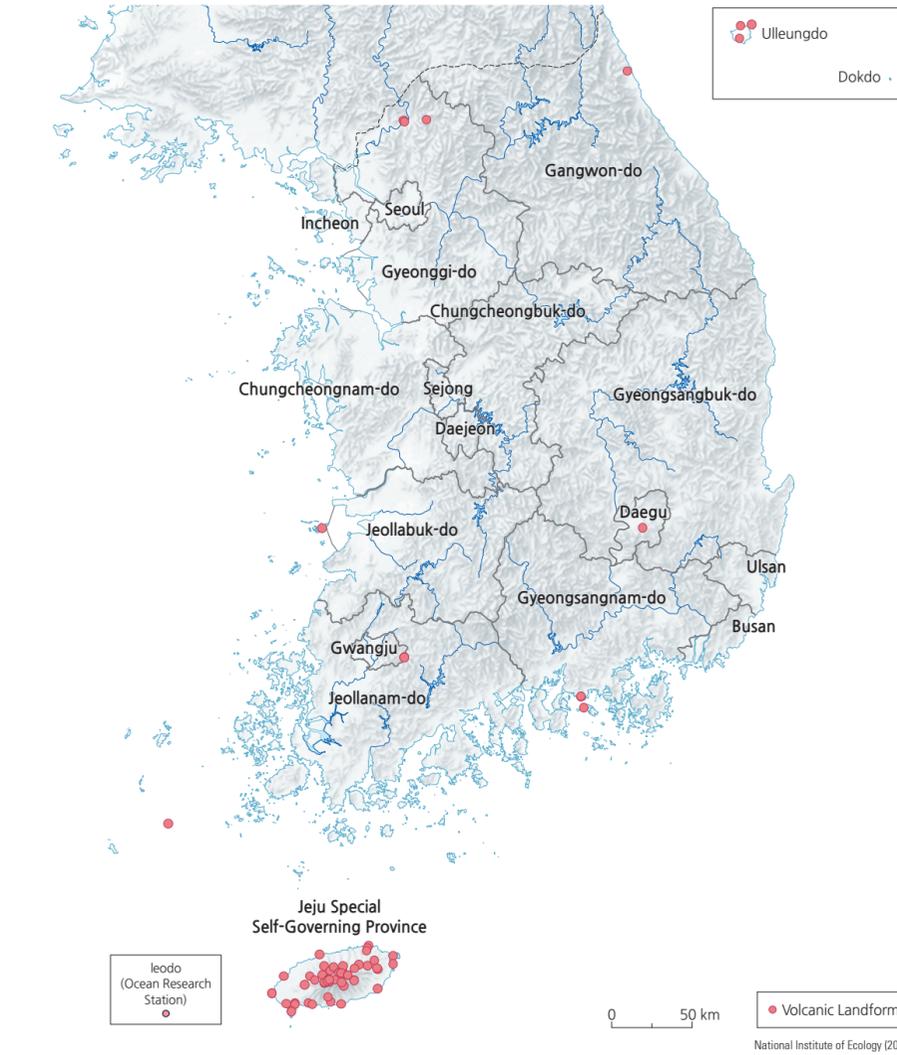
Block Field (Seoraksan, Inje, Gangwon-do)

### Landforms of Mountainous Regions

The processes of weathering and erosion are dominant in shaping many landforms in mountainous regions. Bedrock that is more resistant to erosion underlies high rugged mountains, while less resistant rocks are eroded to form lowlands, basins, and valleys. South Korea displays a complex topographic regime due to variable bedrock types formed during different geological periods. Many metamorphic rocks originate from the Pre-Cambrian, while granite and other volcanic rocks were formed during the Mesozoic. Many sedimentary rocks were deposited later, during the Tertiary and Quaternary.

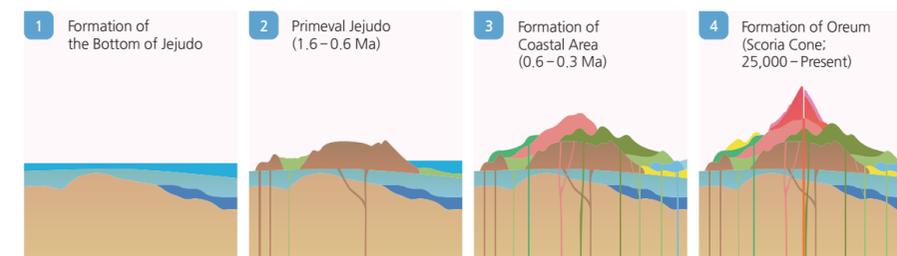
Typical eroded and weathered landforms include erosional basins, rock cliffs, rock domes, tors, tafoni, and caves, while depositional landforms include block streams, talus deposits, and upland wetlands. According to the Natural Ecosystem Survey, Grade 1 landforms occur in the high mountain ranges of Taebaeksanmaek and Sobaeksanmaek but are also widely distributed throughout inland areas.

### Volcanic Landforms



National Institute of Ecology (2020)

### Development of Volcanic Islands (Jeju)



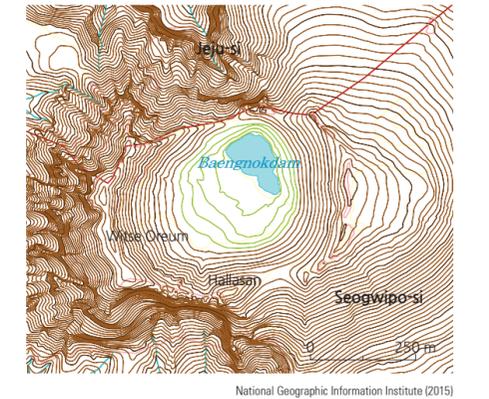
### Volcanic Landforms

Although Korea does not currently have active volcanoes, some volcanism occurred throughout the Quaternary Period. As a result, distinct volcanic landforms can be observed in Jeju, Baekdusan, Ulleungdo, Dokdo, and the Cheorwon Plateau.

Jeju is a volcanic island off the southern coast of Korea, topped by Hallasan peak. Its base was formed by multiple volcanic eruptions over long periods of time as a shield volcano, with gentle slopes and a roughly elliptical shape, extending 73 by 31 km in dimension, with an area of 1,847 km<sup>2</sup>. Hallasan itself was formed as a more steeply-sloped cone, shaped by volcanic rock known as scoria. Jeju features diverse volcanic landforms that are not generally seen on the Korean Peninsula and has recently been designated as a geopark and a UNESCO World Heritage Site.

The islands of Ulleungdo and Dokdo represent exposed peaks of a submarine stratovolcano. Unlike Jeju, these islands have undergone extensive erosion, resulting in more varied topography. Ulleungdo is a massive volcano that stands at over 3,000 m from the seafloor to its highest peak.

### Volcanic Crater and Lake (Baengnokdam, Hallasan)



National Geographic Information Institute (2015)



Crater Lake (Baengnokdam, Hallasan, Jeju)



Columnar Joint (Daepodong, Seogwipo, Jeju)



Gimyeonggul and Manjanggul Lava Tubes, Jeju, Natural Monument No. 98

# Geomorphology: Fluvial and Coastal Landforms

## Coastal Landforms

Coastlines around the Korean Peninsula can differ markedly in appearance, with each stretch of coast exhibiting its own beauty. Rocky coasts with cliffs and towering sea stacks occur where waves and longshore currents have the strongest energy: on exposed headlands and along the East Sea where tectonic



Tideland (Gomsoman, Gochang, Jeollabuk-do)



Sea Stack (Yokjido, Tongyeong, Gyeongsangnam-do)



Coastal Sand Dune (Sinduri, Taeon, Chungcheongnam-do)

Example of Coastal Landforms (Sinduri Coastal Sand Dune)

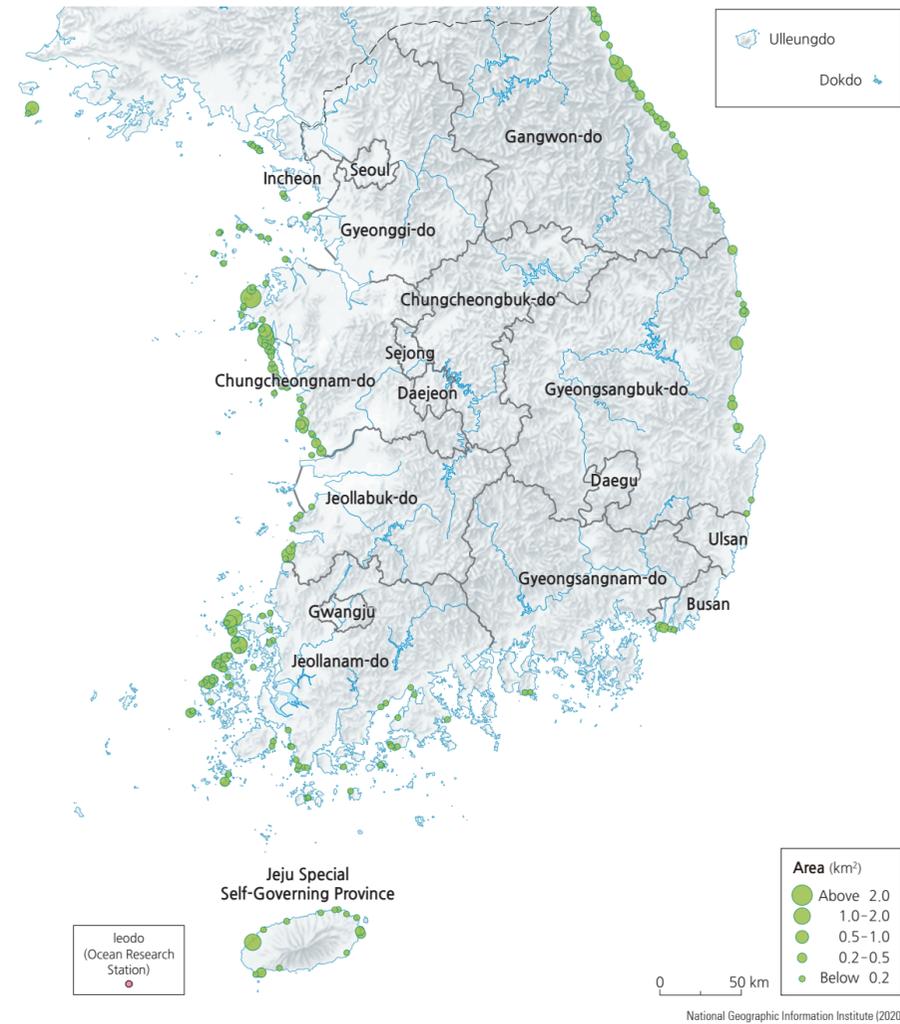


National Geographic Information Institute (2015)

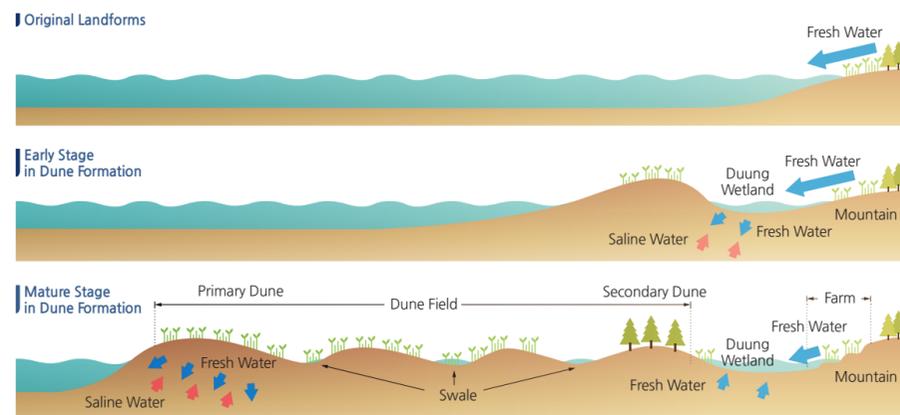
uplift has created high topographic relief. Sea cliffs, wave-cut platforms, and coastal terraces are also visible along the eastern coast of Korea.

Sandy beaches line the interior of bays and coves where lower wave energy allows currents to deposit sediment. Sandy coasts are more prevalent in the southern and western coastal areas, such as the Taean Peninsula where onshore

Distribution of Coastal Sand Dunes in Korea



Formation of Coastal Dunes (Taeon, Chungcheongnam-do)



winds have deposited a series of dunes and swales.

Muddy coasts are found along the western and southern coasts where flood and ebb tides are farther apart, wave activity is weak, and silt-sized particles are deposited. The largest tidal flats occur in Gyeonggiman (Gyeonggi Bay), where the tidal range is as large as 8-10 m. First-grade coastal landforms are evenly distributed along the coastline, mainly around relatively less-developed islands.

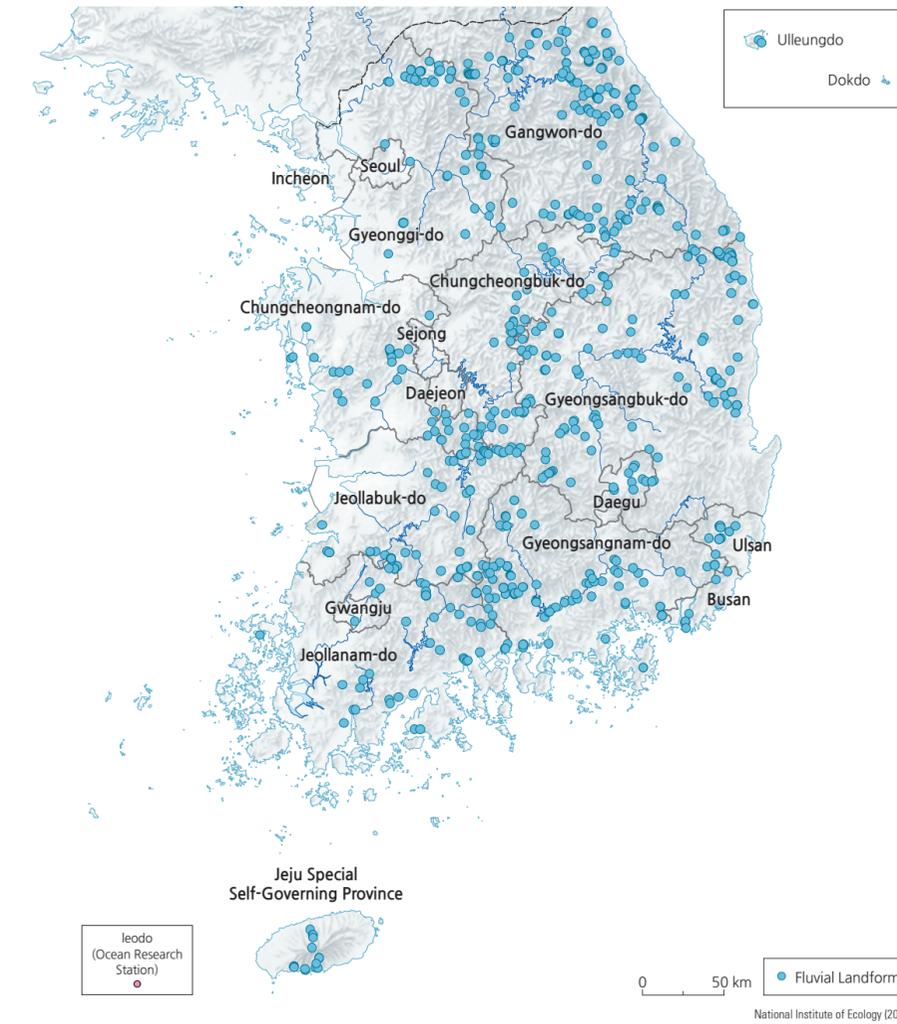
## Fluvial Landforms

Rivers in Korea are classified as straight, meandering, or braided. Straight rivers are bounded by exposed bedrock between narrow valleys and mounds, while

meandering rivers develop on wide floodplains. Typical erosional landforms include waterfalls, potholes, riverine cliffs, and riverine caves, while typical depositional landforms are deltas, alluvial fans, point bars, and riverine wetlands.

The floodplains formed by Hangang, Nakdonggang, and Geumgang constitute major agricultural plains in South Korea. The natural levees and backswamps of these floodplains developed from the last glacial period; eroded valleys were filled with sediments due to rising sea levels. Where rivers meet a low-energy coast, deltas are formed, shaped by sediment discharge, ocean tides, and waves. Nakdonggang Delta is a representative example. Further upstream, alluvial fans can be deposited, with rich soils suitable for agriculture.

First Grade Fluvial Landforms



Entrenched Meander (Yeongwol, Gangwon-do)

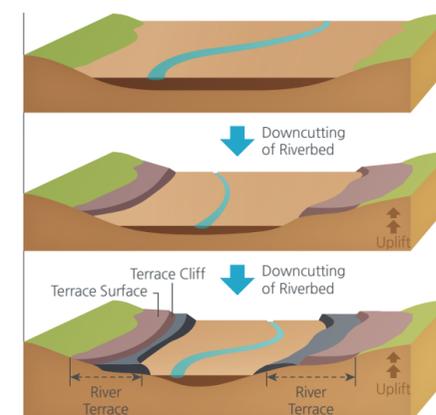


Riverside Cliff (Yeongyang, Gyeongsangbuk-do)

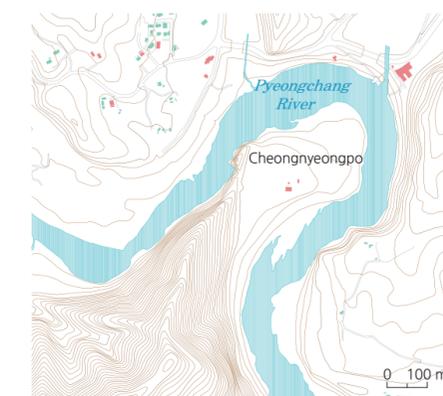


Riverine Wetland (Yeongwol, Gangwon-do)

Formation of River Terrace



Example of Fluvial Landforms



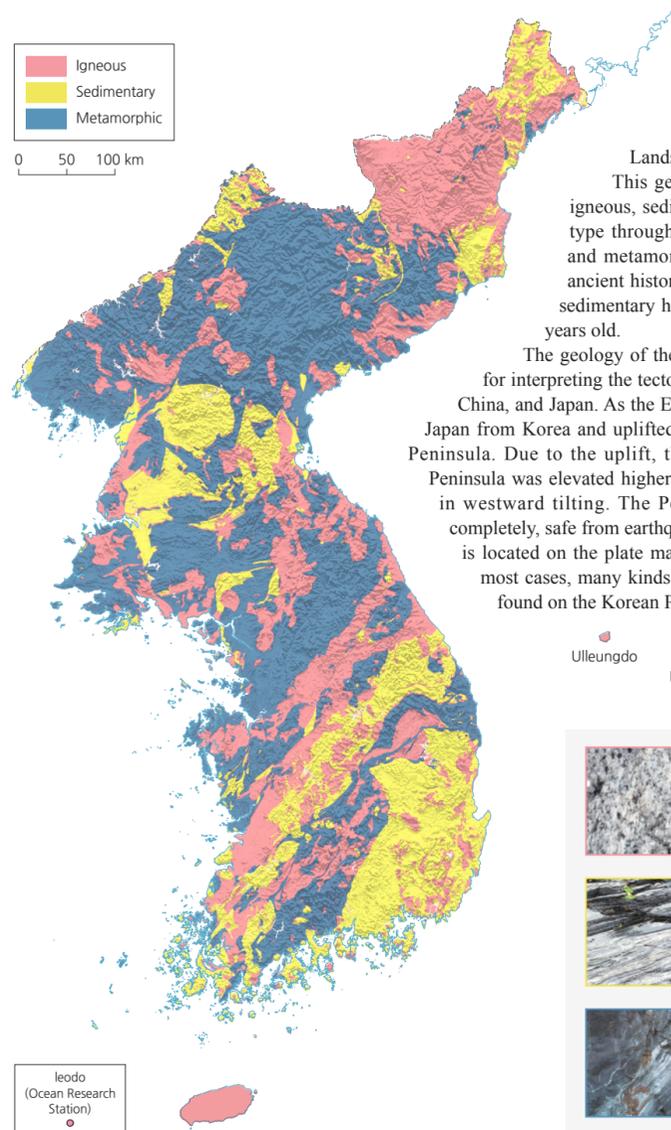
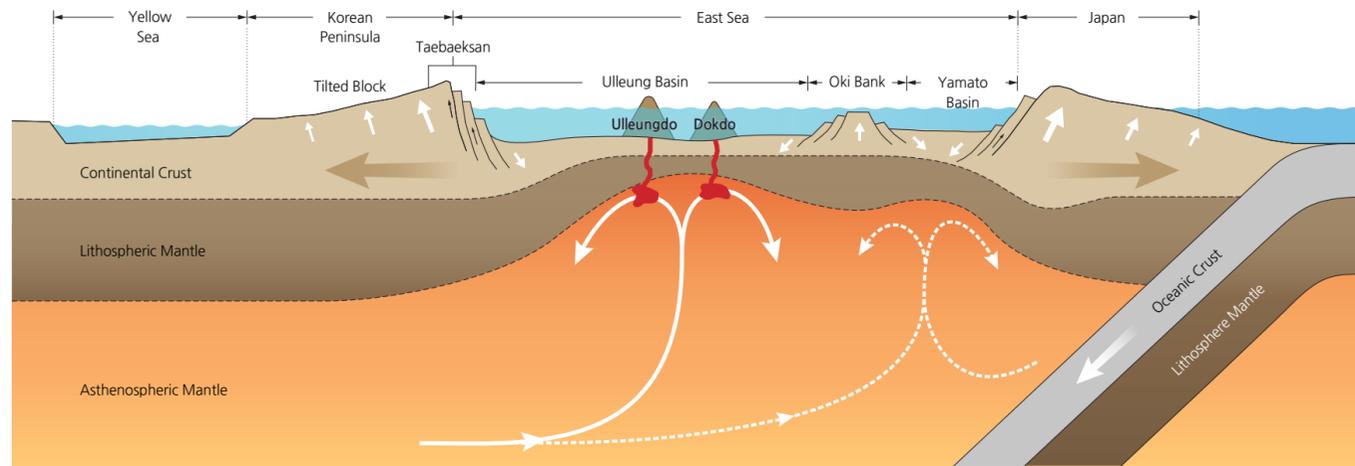
National Geographic Information Institute (2015)



Waterfall (Seoraksan, Inje, Gangwon-do)

# Geology of Korea / Fossils

## Topographic and Geotectonic Cross-Sectional View



## The Rock Cycle

Korea has a diverse and interesting geologic history and owes much of its natural beauty to the rocks underneath the landscape. Bedrock that is resistant to weathering and erosion forms high rugged mountains, while less resistant rocks characterize the lowlands, basins, and valleys. Sites of geological significance have been preserved as twenty-two National Parks, seven Geoparks, and nine Ecological Landscape Conservation Areas across the country.

This geologic map has been simplified to show the locations of the three main rock types: igneous, sedimentary, and metamorphic. Any of these rock types can be transformed to any other type through the rock cycle. More than two-thirds of the Korean Peninsula consists of igneous and metamorphic rocks. By studying rocks and their distributions, geologists can work out the ancient history of Korea as it was shaped by volcanism, tectonic plate movements, erosion, and the sedimentary history that goes back billions of years. The oldest rocks in Korea are about 2.5 billion years old.

The geology of the Korean Peninsula is important for interpreting the tectonic relationship between Korea, China, and Japan. As the East Sea was formed, it separated Japan from Korea and uplifted the eastern part of the Korean Peninsula. Due to the uplift, the eastern part of the Korean Peninsula was elevated higher than the western part, resulting in westward tilting. The Peninsula is relatively, but not completely, safe from earthquakes compared to Japan, which is located on the plate margin. Although not abundant in most cases, many kinds of mineral resources have been found on the Korean Peninsula.



Seoraksan, the tallest peak in the Taebaek range, is composed of a mix of both igneous and metamorphic rock types.

Ulleungdo  
Dokdo



**Igneous Rock** Forms by solidifying directly from a molten state. The most common igneous rock in Korea is granite, which solidifies while the body of molten magma is still underground. Many granite and volcanic rocks in Korea were formed during the Mesozoic period about 250 to 66 million years ago. Most granites are milk-white in color but alkali granites show a pinkish red color.



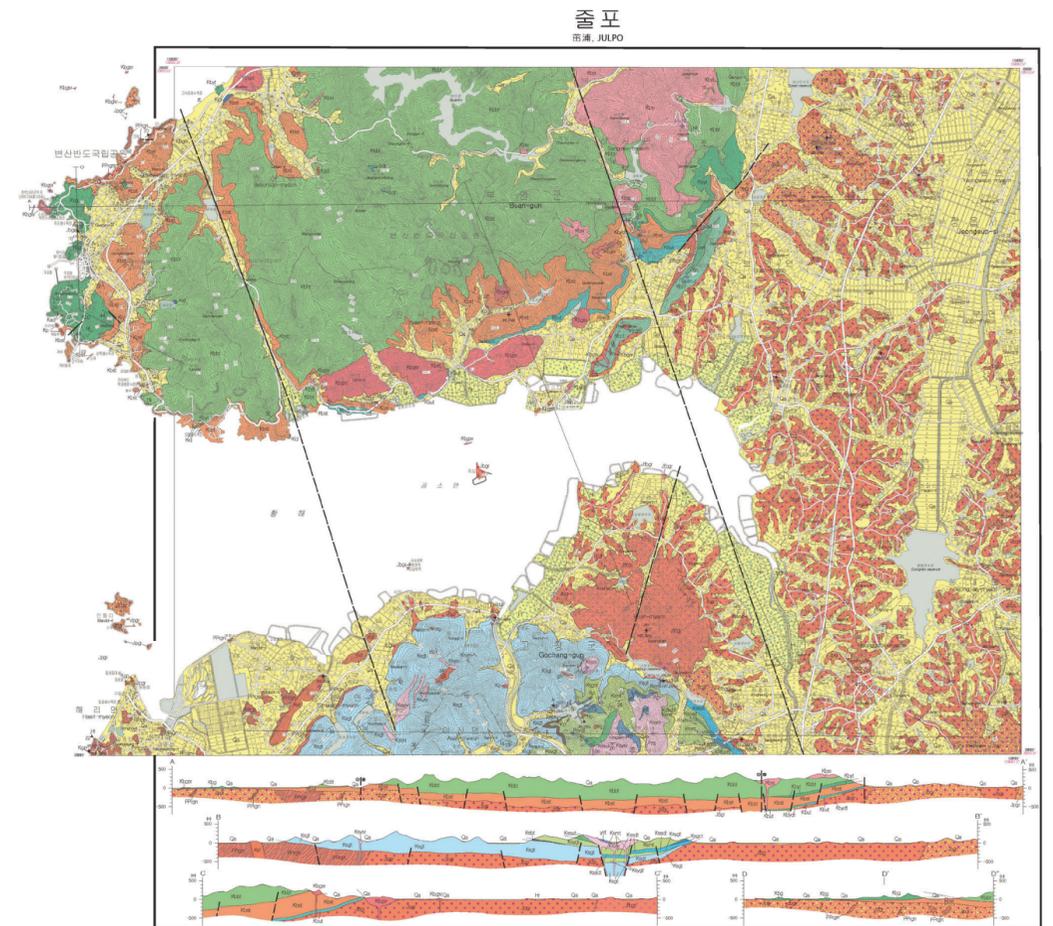
**Sedimentary Rock** is formed by the consolidation of sediments that have accumulated in an area. Many sedimentary rocks in Korea were deposited during the Tertiary period (66 to 2.5 million years ago) and the Quaternary period (2.5 million year ago until the present). The main sedimentary rocks are shale, sandstone, conglomerate, and limestone.



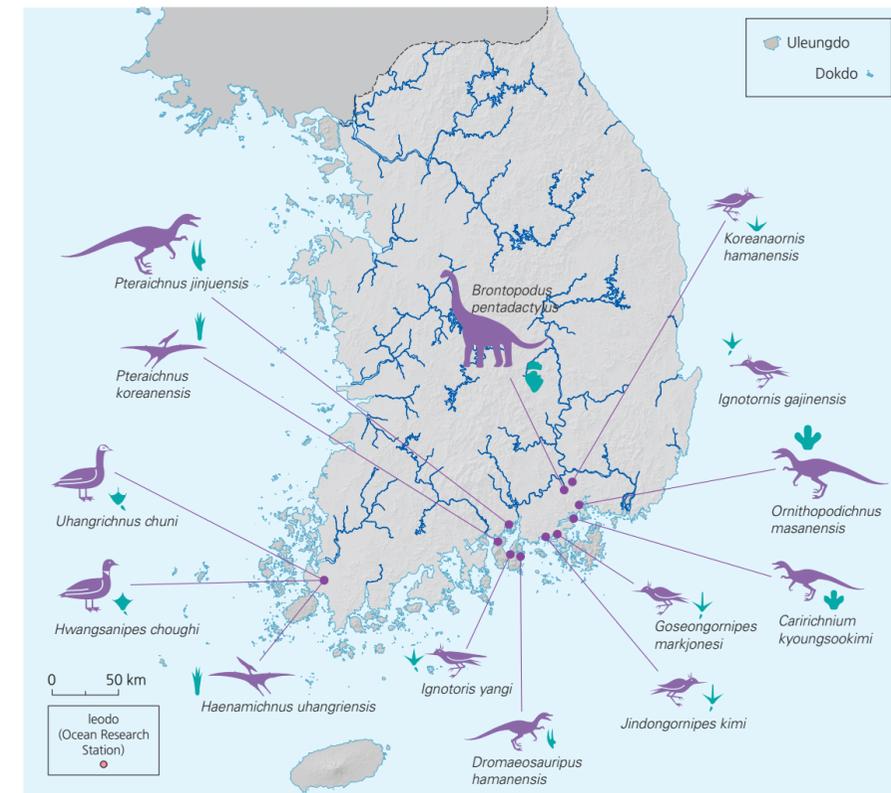
**Metamorphic Rock** is formed by applying heat and pressure to a rock to physically or chemically change it. Most metamorphic rock in Korea formed in the Pre-Cambrian period (more than 540 million years ago). In Korea, metamorphic rocks consist of mainly gneiss and include schist, phyllite, quartzite, marble, and amphibolite, which formed by the metamorphism of shale, sandstone, limestone and basic igneous rocks.

## Geologic Mapping

The Korea Institute of Geoscience and Mineral Resources produces geologic maps at a variety of scales. The Geologic Map of Korea (1: 1,000,000) has been revised several times, with the final version published in 2019. Maps at a scale of 1: 50,000, such as the one shown here, have been made to cover the entire Korean Peninsula. These maps also feature geologic cross-sections, or vertical profiles, which show stratigraphy and faults. Geologic maps of 1: 250,000 and 1: 25,000 scales have also been published, along with other maps for special purposes. In addition to their utility for practical purposes, these geologic maps in themselves represent beautiful works of art.



## Distribution and Types of Fossil Footprints of Major Vertebrates in the Cretaceous Period



## Traces of Dinosaurs

Dinosaurs roamed the Korean Peninsula during the Cretaceous period, 145 to 66 million years ago. Terrestrial (i.e., non-marine) sedimentary rocks from this time period occur on the southern end of the Korean Peninsula and contain abundant dinosaur fossils, including footprints and egg and bone fossils. Dinosaur footprint fossil sites are found in the southern region of the Korean Peninsula. The variety of size, shape, and trackway patterns of footprints indicate that diverse sauropods, ornithopods, and theropods lived on the Korean Peninsula. The pterosaur found in Uhangri, Haenam-gun, was recently approved as a new species, named *Haenamichnus uhangriensis*. The largest number (443) and the widest trackway (7.3 m) of pterosaur footprints are found in the Uhangri area. In this area, the footprints of pterosaurs, dinosaurs, and birds occur together in the same sedimentary layer, a rare occurrence.



Dinosaur Tracks Exposed in Layers of Sedimentary Rocks along the Coast

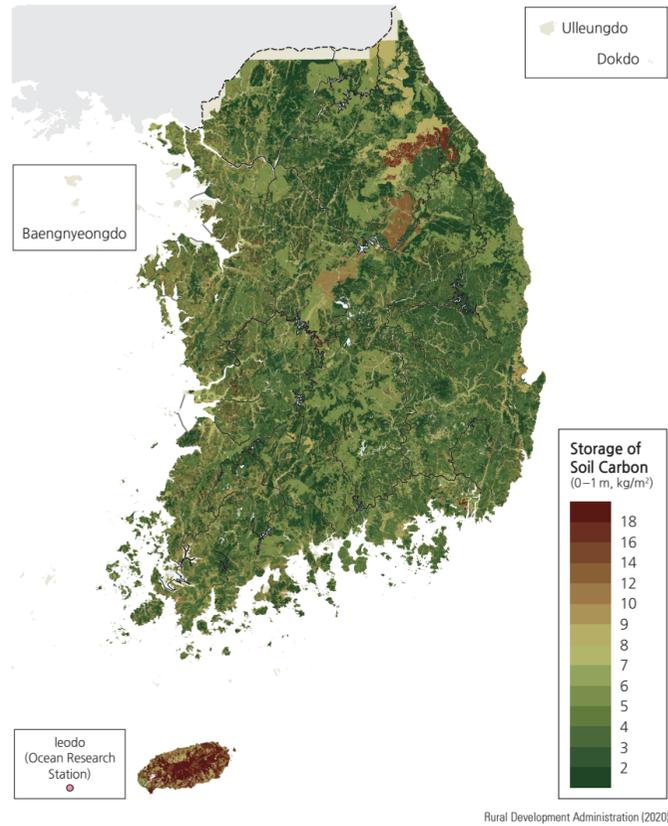
# Soils of Korea

## Soils Developed from Granite

LANDFORM	Mountainous Area	Foot Slope	Upper Valley	Lower Valley	Valley	Valley	Flood Plain
Soil Series	Samgag Series, Typic Dystrudepts	Sangju Series, Dystric Fluventic Eutrudepts	Noegog Series, Fluvaquentic Dystrudepts	Eungog Series, Fluvaquentic Eutrudepts	Sachon Series, Aeric Endoaquepts	Yecheon Series, Fluvaquentic Endoaquepts	
Soil Profile							
Drainage Class	Excessively Drained (EX)	Well Drained (W)	Moderately Well Drained (MW)	Moderately Well Drained (MW)	Somewhat Poorly Drained (SP)	Poorly Drained (P)	
Land Use	Forest Land	Farm and Grove	Farm and Grove	Paddy Field	Paddy Field	Paddy Field	

Rural Development Administration (2015)

## Soil Carbon Stocks



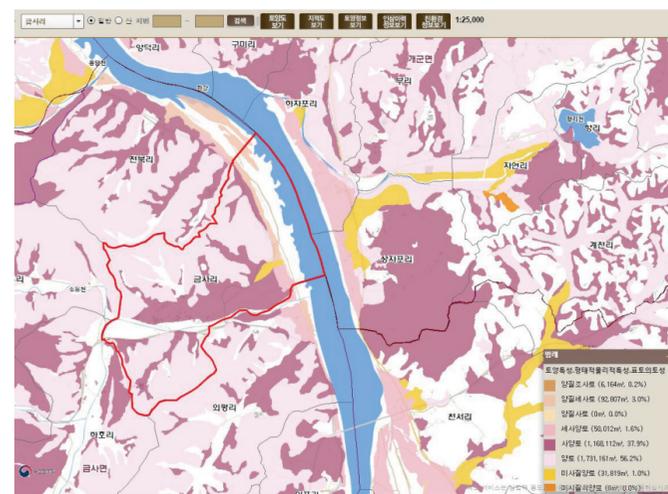
Rural Development Administration (2020)

Soil-forming factors such as microclimate, vegetation, topography, hydrology, geologic substrate, or weathering exposure times determine the spatial distribution of soil types in an area. These factors can affect the land's surface in a particular pattern for a given landscape, resulting in a somewhat predictable pattern in the spatial arrangement of soil types. The pattern of soils developed across a slope due to differences in substrate and hydrologic properties is called a soil catena. The illustration above depicts a sequence of soil types typically found across the Korean landscapes from granitic drainage divides downslope to floodplains.

The soil, though an often-overlooked component of the natural environment, yields many valuable benefits, helping to support biodiversity, acting as a reservoir for water, recycling nutrients, purifying groundwater, filtering out pollutants, and mitigating and adapting to climate change. The various benefits provided by soil are called soil ecosystem services, which in Korea are worth about 1,190 trillion won. Soil is also an important natural medium for supporting plant growth and crop production. Organic matter content is a key property associated with soil health, fertility, and water holding capacity. Soil carbon stock is an important indicator for evaluating the carbon balance of agricultural land and the global carbon balance.

Korea's soil distribution pattern is quite complex, due in part to the long history of intensive land use, diversified geological features, and rough terrain. Current classifications are generally made according to Soil Taxonomy, established by the United States Department of Agriculture (USDA), and based on soil physical and chemical properties. According to the Soil Taxonomy, out of the 14 orders of soil recognized globally, Korea has seven orders, 14 suborders, and 32 great groups of soils. In addition, approximately 400 soil series (the most detailed level of soil classification) have been identified to date. Inceptisols, soils lacking clear horizon development, cover 76.7% (7.21 million ha) of Korean territory. The predominance of Inceptisols indicates that the land surface has undergone dynamic changes. For instance, rapid soil erosion constantly removes topsoil from slope surfaces, with deposition in areas such as alluvial fans, valleys, and floodplains.

## Korean Soil Information System



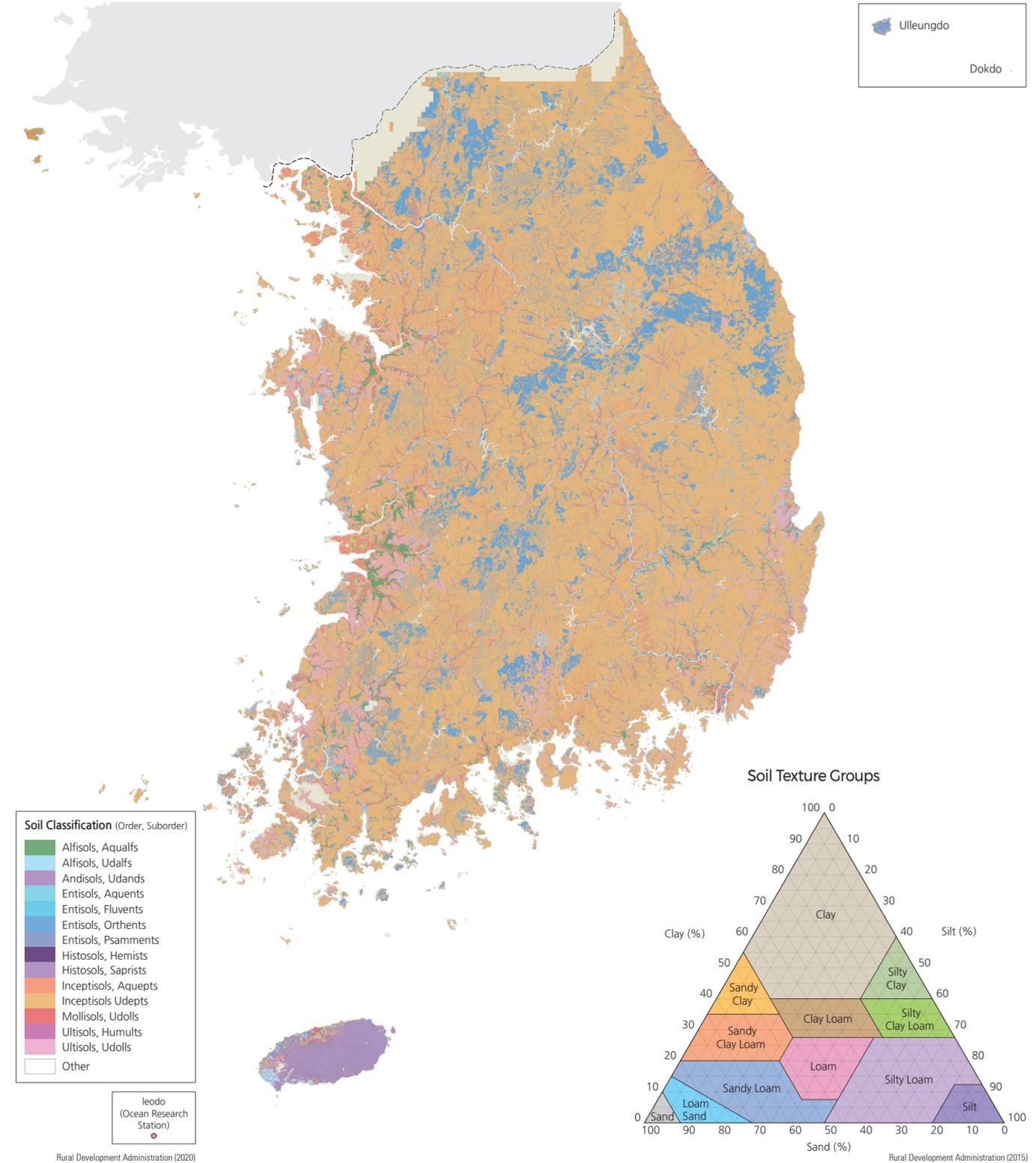
Rural Development Administration (2016)

Texture is perhaps the most important attribute of soils and controls many other physical and chemical characteristics of soil. Soil texture categories are determined by the relative proportion of three kinds of soil mineral particles: sand (0.05–2 mm), silt (0.002–0.05 mm), and clay (particles smaller than 0.002 mm). Soil textures are often plotted and visualized using the soil textural triangle, a ternary plot with three axes.

Recent environmental and climatic changes are bringing a greater awareness of the connection between soil and other elements of the environment, such

as water quality and vegetation. To respond to increasing societal demands for detailed knowledge regarding soils, there is a need to better understand the spatial distribution and temporal changes of soil properties. In order to evaluate and manage soil quality and to sustain ecosystem services, it is necessary to understand the various properties of soils and how these relate to soil functions. In response to this, Korea conducts an extremely detailed and sophisticated soil survey, the results of which are made available to the public through a digitalized soil information system.

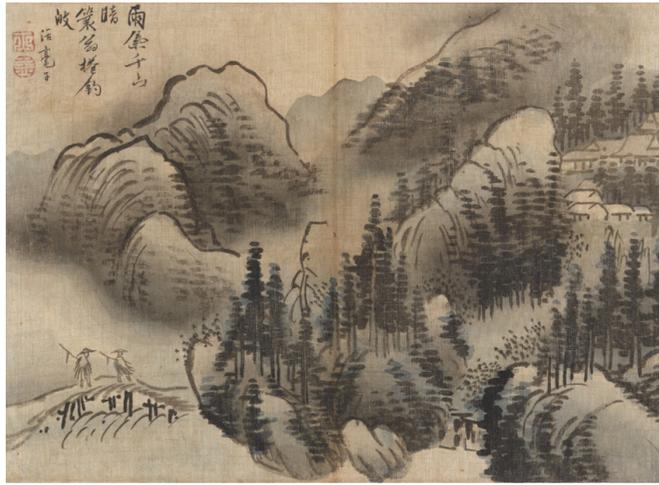
## Soil Map of Korea



Rural Development Administration (2020)

Rural Development Administration (2015)

# Weather and Climate



A Rainy Landscape in Korea. Kim Su-gyu, late 18th century. The verse at top left reads, "Rain clears and brightens a thousand mountains, Men in straw coats return with fishing rods." Metropolitan Museum of Art.

The weather of a region exerts a strong influence on many other earth-surface processes. Humans are acutely aware of the effects of daily weather variations. Often the most striking difference noticed while traveling far from home is the difference in climate. Climatic variations affect almost all other parts of the natural and human-built environment, partly determining everything from soil types to clothing styles, and from plant communities to architectural designs.

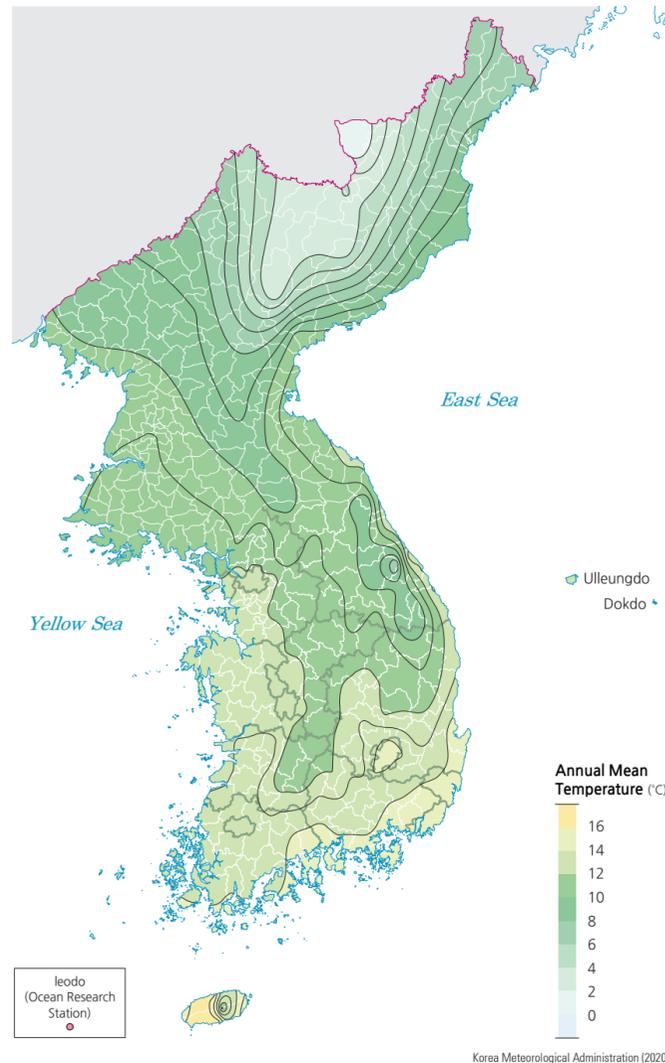
The 'climate' of a region refers to the long-term average of weather conditions and the expected variation and extremes of weather throughout the year. Climate is typically classified based on yearly and monthly average temperature and precipitation. The spatial pattern of climate across Korea is determined by factors such as latitude, elevation, proximity to water, and the direction of ocean currents. Most of Korea is characterized as a continental climate with hot summers and dry winters due to the proximity to the Eurasian continent and the influence of the East Asian Monsoon system. The climate of the coasts, especially around the southern end of the Peninsula, is greatly influenced by the ocean and is classified as a humid subtropical climate.



The Rainfall Gauge of the Joseon Dynasty

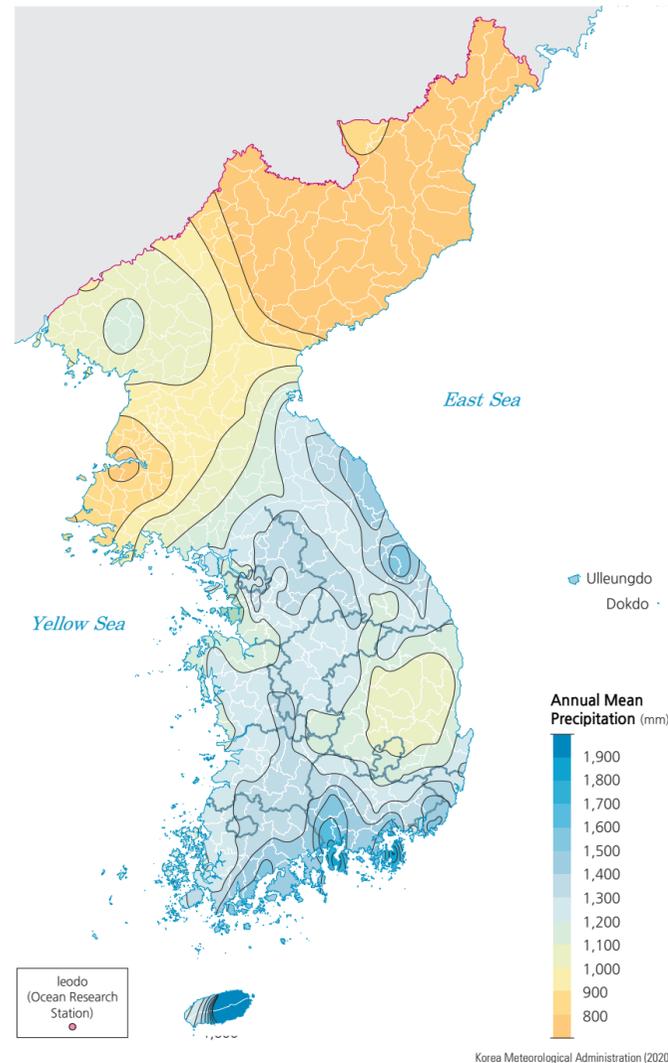
This rainfall gauge was invented around 1440. It was the official device used to measure precipitation during the Joseon dynasty. The Joseon dynasty created a standard rainfall observation system that was adopted nationally.

## Annual Mean Temperature

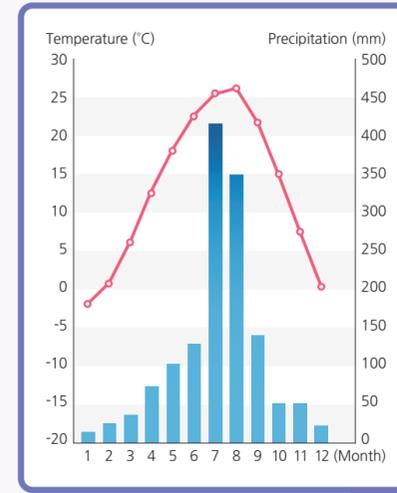


Korea Meteorological Administration (2020)

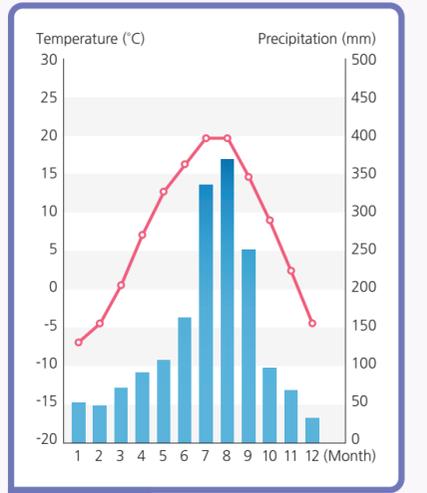
## Annual Mean Precipitation



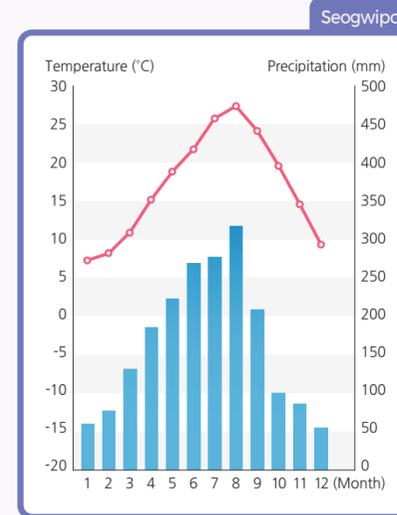
Korea Meteorological Administration (2020)



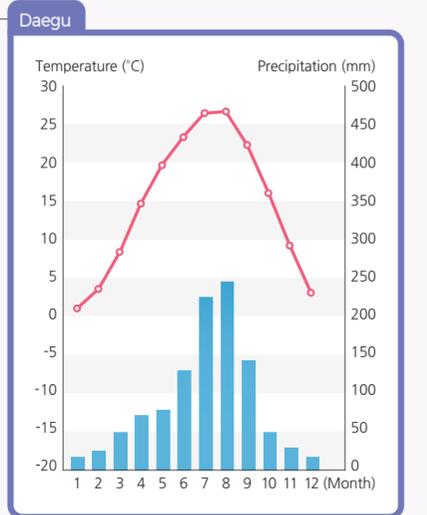
Climate of South Korea



Daegwallyeong



Seogwipo



Daegu

The difference in temperature between the north and south is a result of areas closer to the equator receiving more intense solar energy. The annual mean air temperature at Seogwipo (16.6°C) on the southernmost tip of South Korea is much higher than that at Cheorwon (10.2°C) on the northernmost tip of South Korea, showing the wide range of air temperature at different latitudes. Climate also depends strongly on elevation. The annual mean air temperature at Daegwallyeong (773 m above sea level), the highest weather station in South Korea, is 6.6°C. Hongcheon occupies a similar latitude but at a much lower elevation (141 m above sea level), and thus has a higher mean temperature of 10.3°C.

The Asian monsoon system over East Asia (including Korea, China, and Japan) is formed from seasonal shifts in global circulation patterns and the differential heating of land and sea. In winter, cold, dry wind blows from inland Asia across the Korean Peninsula due to high pressure over the continent. During summer, hot and humid wind blows into Korea from the ocean, bringing heavy rains. The climate of Korea is affected by various air masses such as the Siberian, the North Pacific, the Okhotsk Sea, and equatorial air masses.

A useful way to compare climates is to plot temperature and precipitation throughout the year. The resulting graph, a climograph, can show major differences at a glance. The horizontal axis below each plot represents the month of the year from January (1) to December (12). The lines on the graph represent monthly average temperatures throughout the year. Temperature values are read on the left vertical axis and are shown in degrees Celsius. The top-most (purple) line represents average high temperatures, the bottom (yellow) line shows average low temperatures, and the middle (red) line shows the average temperatures. Precipitation, which includes rainfall as well as snow or sleet, is shown as blue bars, read along the axis on the right in millimeters.

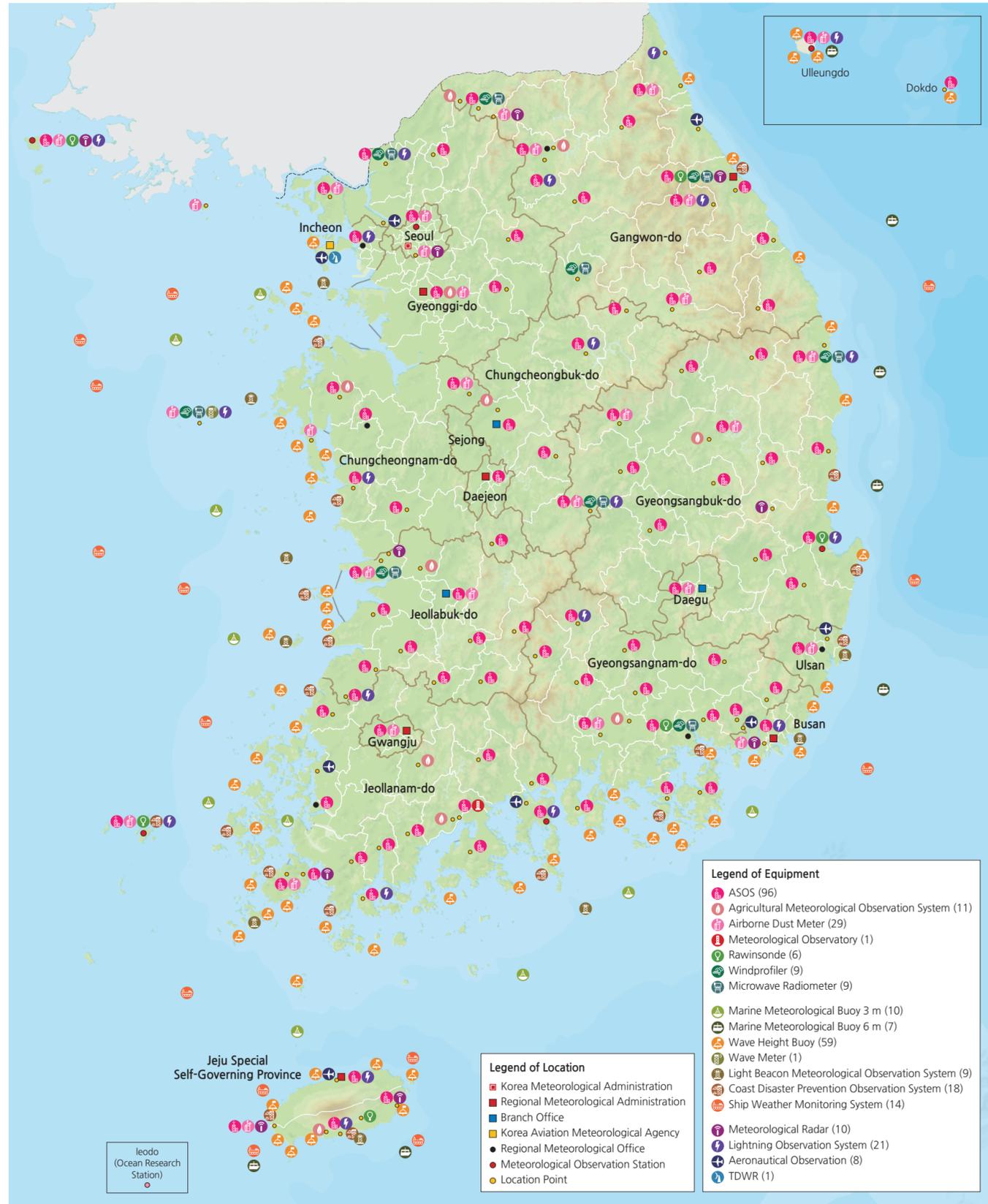
As demonstrated by these climographs, summer in South Korea tends to be hot and wet, while winter is cold and dry. In Seogwipo, on Jeju Island, temperature never drops below zero Celsius. Although not shown here, parts of North Korea, and especially the mountainous areas of the far north, have milder summer temperatures and colder winters.



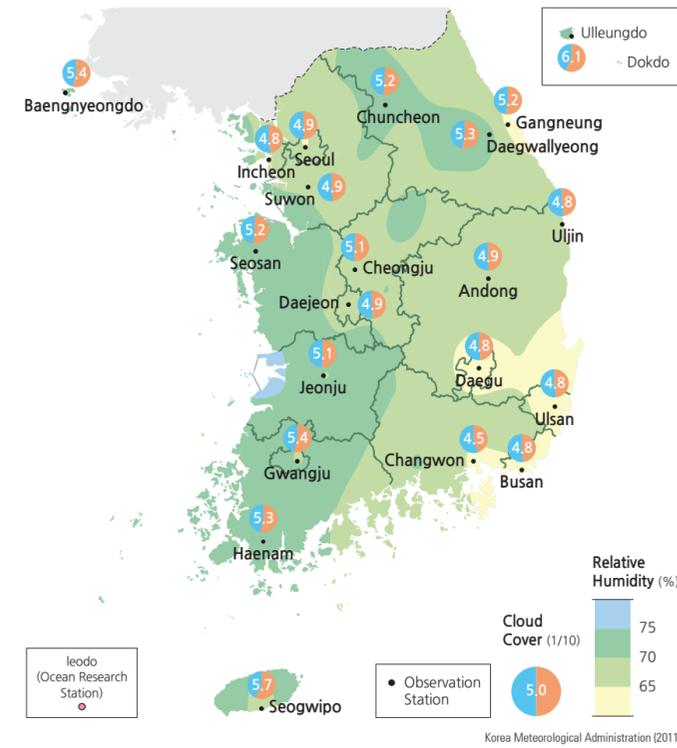
A Beautiful Day in Seoul, Sunny with High Cirrus Clouds

# Korea's Meteorological Observation Network

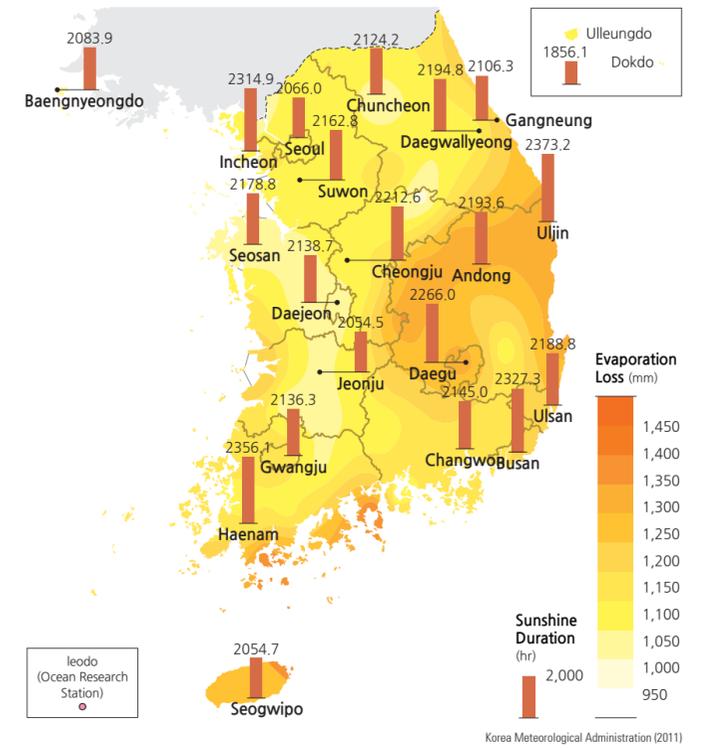
Spatial Distribution of Weather Stations



Annual Mean Cloud Cover and Relative Humidity (1981-2010)



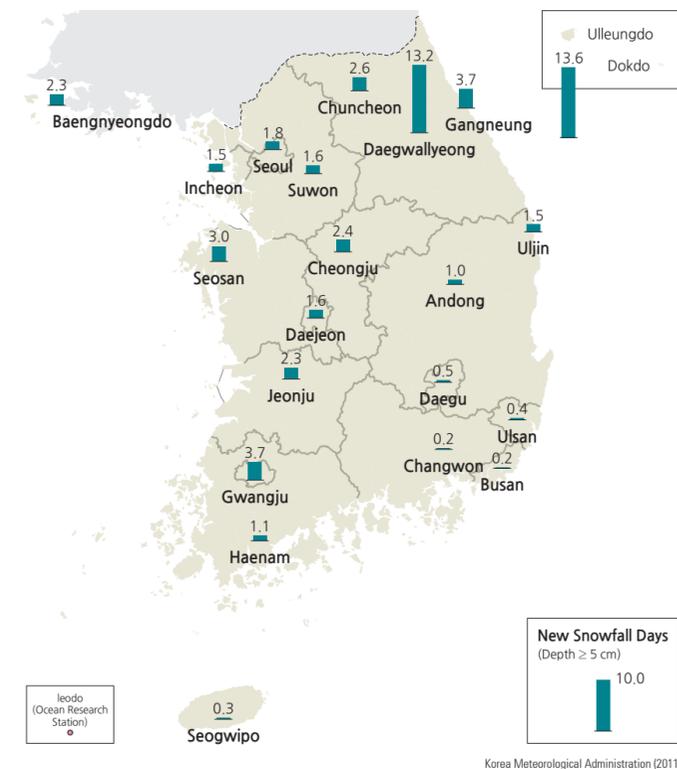
Annual Sunshine Duration and Annual Mean Amount of Evaporation (1981-2010)



The Korean Meteorological Administration (KMA) conducts surface and other weather-related observations, including upper-air, marine, radar, aviation, and earthquake observations. The surface weather observation network consists of 96 automated surface observing systems (ASOS) and 494 automatic weather stations (AWS). Six rawinsonde units and nine wind profilers and microwave radiometers are operating for upper-air observation. Marine weather observations consist of

17 ocean data buoys, 59 coastal wave buoys, 9 light house automatic weather stations, 14 ship weather monitoring systems, 18 coastal long-wave monitoring systems, 1 wave radar, and 1 marine weather observation vessel. In addition, KMA operates 10 weather radars, 21 lightning network (LINET) sensors, 8 aerodrome meteorological observation systems (AMOS), and 156 seismometer units.

Annual Mean Number of Days with New Snowfall (1981-2010)

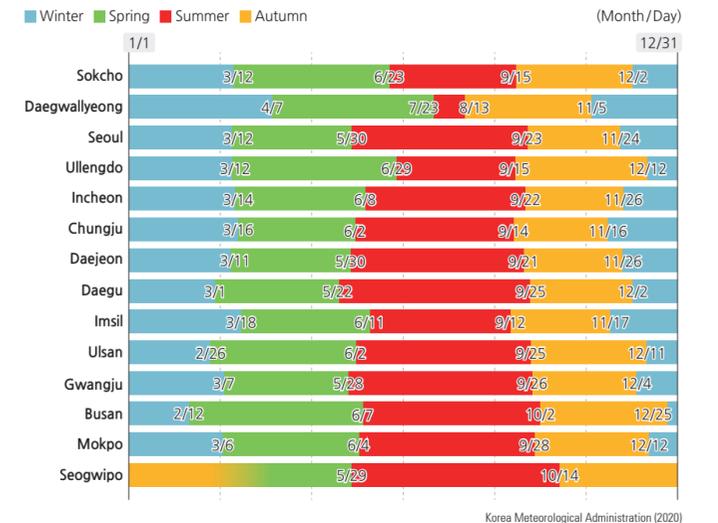


Criteria for Classification of Natural Seasons

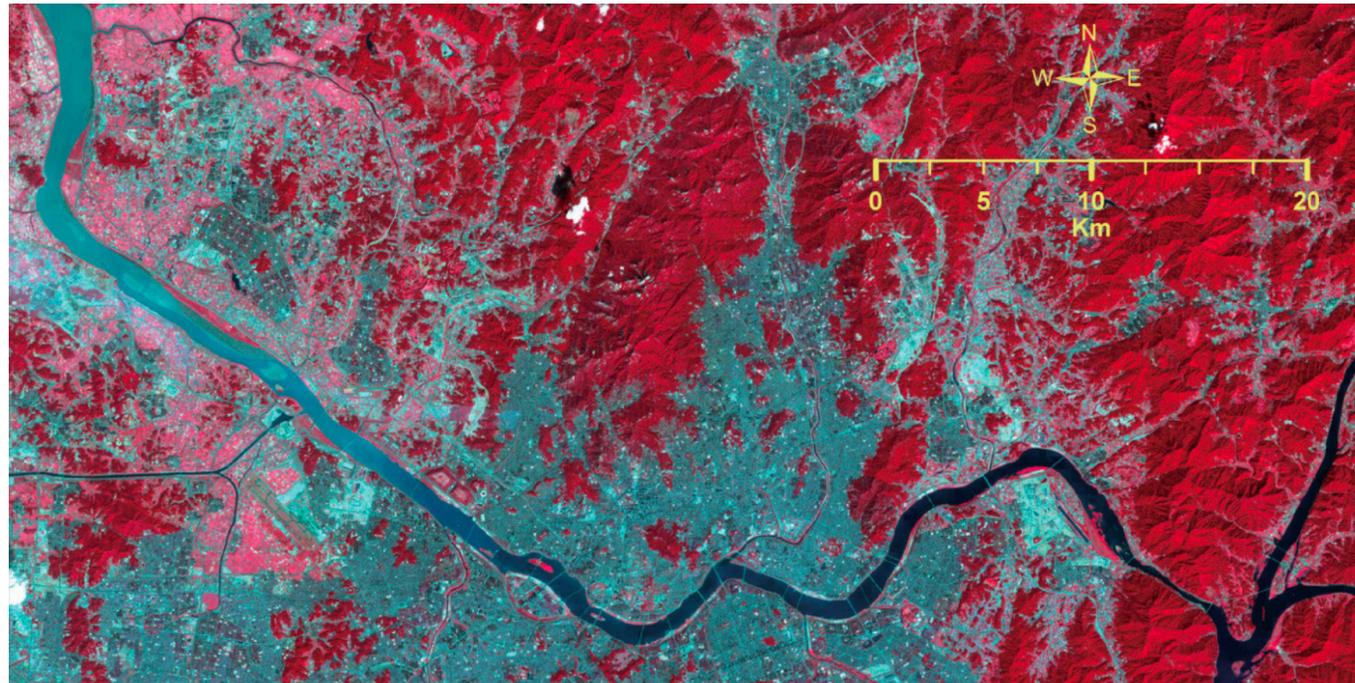
Season	Standard
Spring	The First Date with Daily Mean Temperature above 5°C
Summer	The First Date with Daily Mean Temperature above 20°C
Autumn	The First Date with Daily Mean Temperature below 20°C
Winter	The First Date with Daily Mean Temperature below 5°C

\* The daily average temperature is a 9-day moving average of the daily average temperature for 30 years (1981-2010).

Classification of Natural Seasons by Region



# Rivers and Watersheds of Korea



Seoul and the Han River, also called Hangang, because in Korean the suffix 'gang' means river. The gray colors indicate urban areas, forest is in red; clouds in white; cloud shadows in black; water in blue. The city of Seoul is seen as the gray area along the Hangang that flows from east to west.



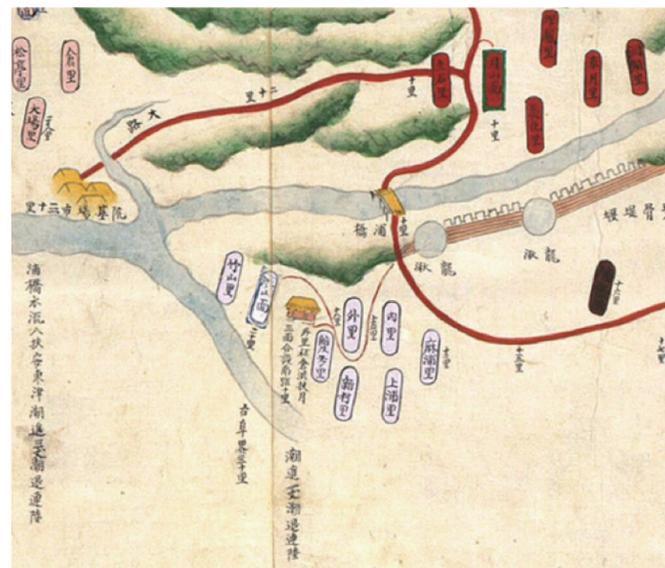
A Large River Meandering through Agricultural Fields

Given the long history of agriculture in Korea, some stream systems reflect efforts by humans to manage and control water for irrigation, flood mitigation, and other purposes. Rice was first introduced to Korea's alluvial soils in the Neolithic Age and became widespread throughout the south during the Bronze Age. *Samguk sagi*, the first historic record to mention rice farming in Korea, documents that King Daru established rice paddies across the countryside in 33 A.D. As rice farming grew, nationwide projects were conducted to build structures such as embankments, waterways, and reservoirs that would facilitate the access and storage of water.

From 2005 to 2014, the average annual precipitation in Korea was 1,323 mm, which is equivalent to 1.6 times the world average. This is enough to classify Korea as a high rainfall region, although seasonal variability is extremely high. Due to monsoonal rain and typhoons, 736 mm of rainfall (56% of the annual rainfall) is concentrated during the summer and often causes floods. Furthermore, rainfall has the tendency to quickly collect in rivers, as over 70% of the land is mountainous with an average slope of about 20%. These geomorphological and climatic characteristics cause high fluctuations in the flow rate of rivers throughout the year, which can cause both floods and droughts.

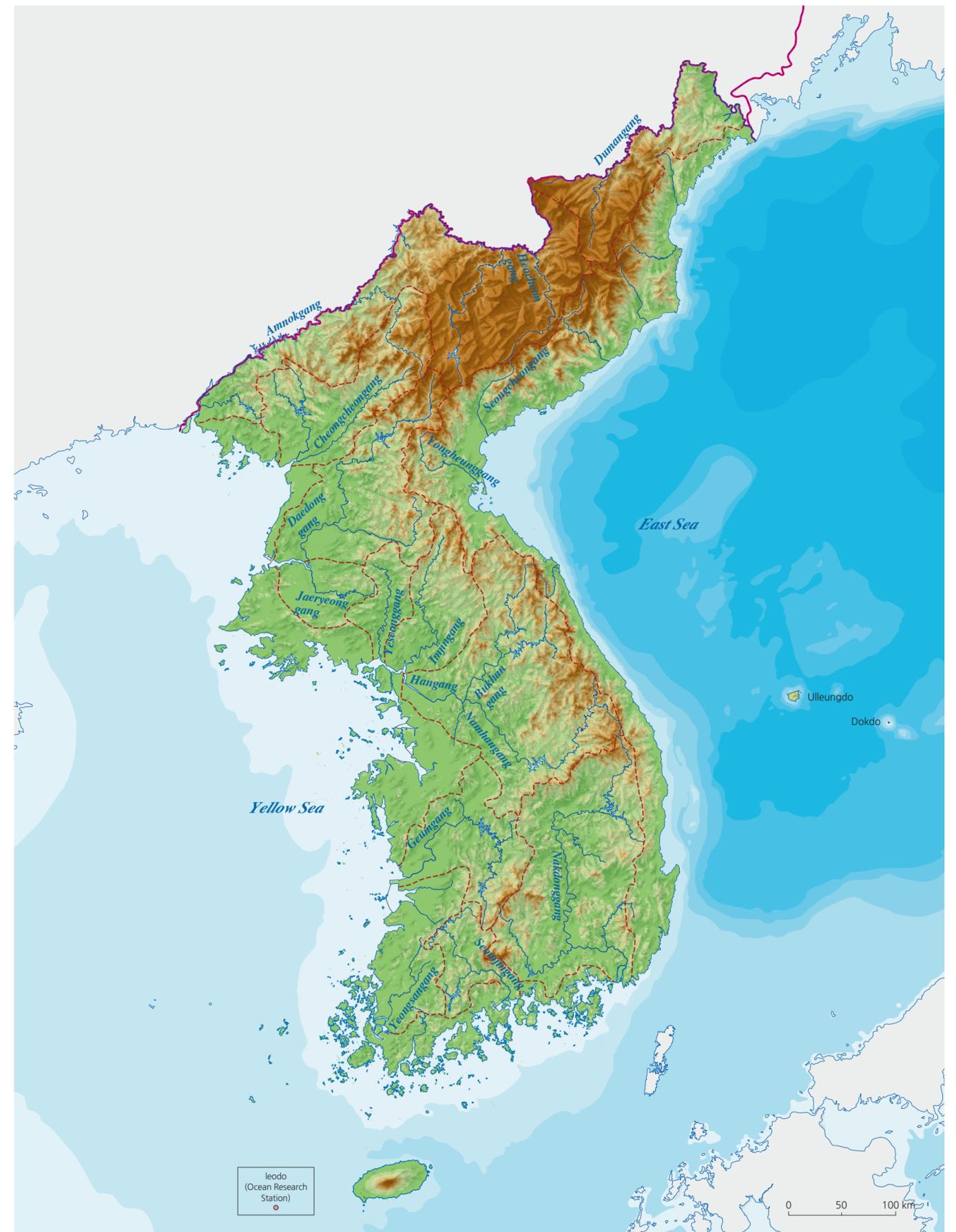
The topography of Korea is generally high and mountainous along the east coast, and low with more subdued relief along the west coast. Consequently, the longest rivers flow into the Yellow Sea and the Korea Strait. The shoreline of the east coast is relatively smooth, and rivers flowing into the East Sea are short with steep gradients. Rivers flowing to the more complex, irregular western and southern coasts tend to be long, with gentle gradients, meandering channels, and higher flow volumes. These rivers have deposited extensive and fertile alluvial plains.

In Korea, there are five major rivers: Hangang, Nakdonggang, Geumgang, Seomjingang, and Yeongsangang. The Han River (Hangang) has the largest drainage area of 35,770 km<sup>2</sup> (including the portion in North Korea), and an annual discharge of 16 billion m<sup>3</sup>, constituting 35% of the nation's total runoff volume. The longest river in Korea is Nakdonggang, with a length of 510 km.



An 1872 Map Showing a Reservoir Embankment along the Dongjin River

## Primary Rivers and Their Watershed Boundaries



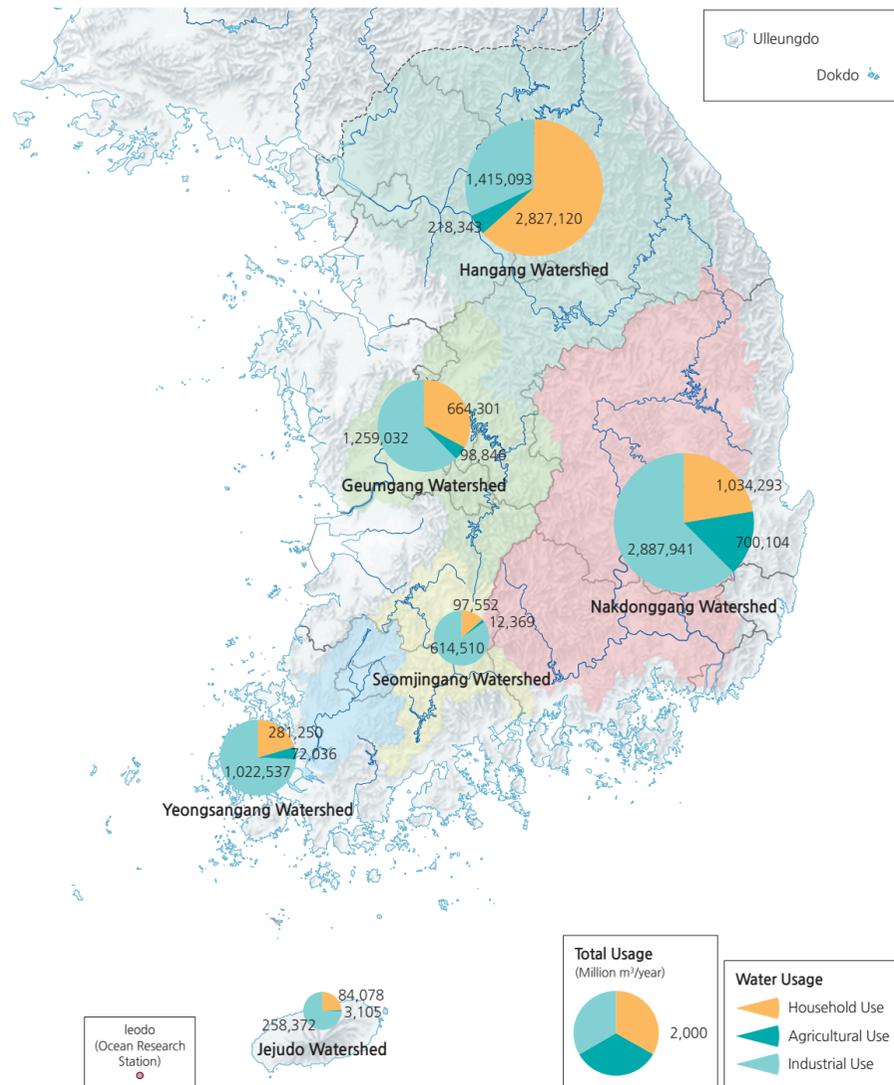
# Management of Water Resources



Daechong Dam on the Geum River

Detail "Daechong Dam" by Yoo Chul Chung (2007), licensed under CC-BY-SA 2.5 via Wikimedia Commons.

## Water Usage by Watershed

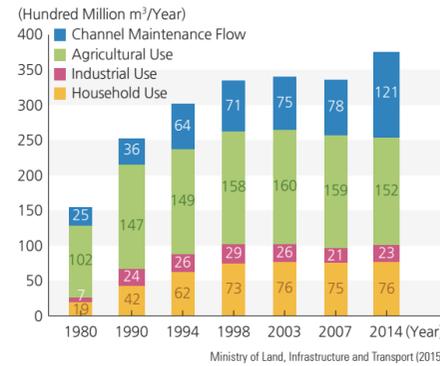


Ministry of Land, Infrastructure and Transport (2015)



The Ancient Reservoir Euirimji in Mosan-dong, Jecheon-si, Chungcheongbuk-do

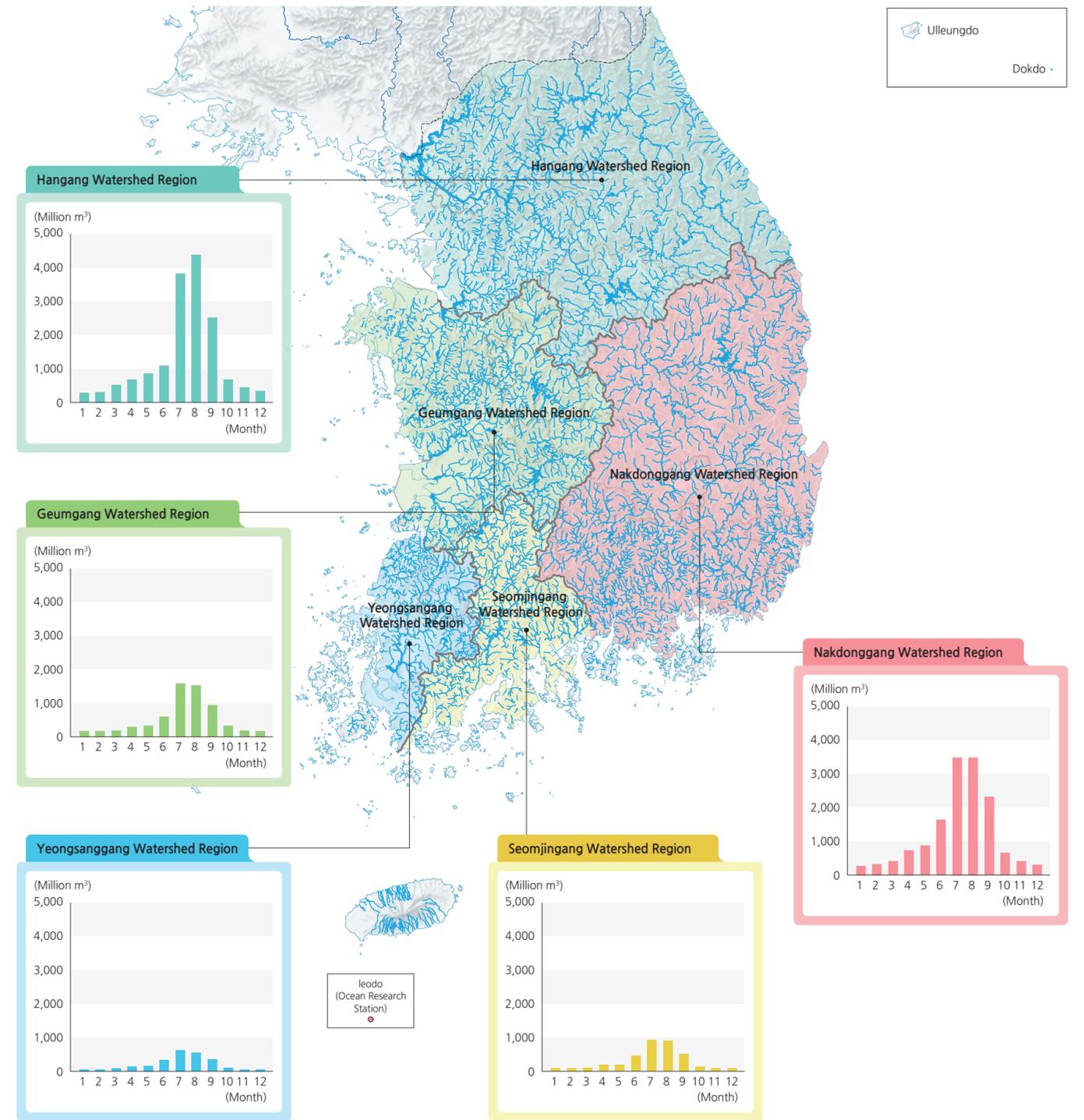
## Water Usage by Year



Ministry of Land, Infrastructure and Transport (2015)

Up until the 1950s and 1960s, most rivers in Korea were in their natural form. However, with the rapid urbanization in the 1970s, many tributaries were covered and meandering channels straightened. As environmental issues gained attention in the 1990s, various improvement projects—such as the construction of waterfront parks and promenades—were initiated along rivers. In the 2000s, the concept of improvement evolved beyond the simple construction of parks to recognize the ecological and scenic conservation value of rivers for ecosystems and humans.

## River Networks and Monthly Discharge of Major Watershed Regions



K-water (2015)

The total water use of Korea increased more than six times from 5.12 billion m<sup>3</sup> in the 1960s to 33 billion m<sup>3</sup> in the 1990s. This steep rise can be attributed to population growth, economic advancement, increased industrial development, and an increasing number of irrigation facilities. Accordingly, channel flow maintenance also increased to protect water quality, ecosystems, and landscapes. Since the 2000s, however, the rate of increase of water usage has slowed.

In 2014, agricultural use accounted for the largest proportion of total water use at 40.9%, followed by channel maintenance flow (32.5%), domestic use (20.4%), and industrial use (6.2%). Domestic and industrial water usage has remained about the same since 1998, while agricultural use has experienced a decrease over the same time. As of 2011, the Hangang watershed was the largest consumer of water at 5.23 billion m<sup>3</sup>, followed by the Nakdonggang watershed (5.1 billion m<sup>3</sup>),

Geumgang watershed (2.61 billion m<sup>3</sup>), Yeongsangang watershed (1.5 billion m<sup>3</sup>), and Seomjingang watershed (0.9 billion m<sup>3</sup>).

The proportion of domestic water consumption is highest in the populous Hangang watershed, which includes Seoul. Domestic water consumption in the Hangang basin was the highest at 63.4%, while agricultural and industrial use accounted for 31.7% and 4.9%, respectively. For all other watersheds, agricultural use accounted for the highest consumption, followed by domestic and industrial water use. Large industrial complexes contribute to high industrial water use in the Nakdonggang watershed (15.1%), while a smaller population and fewer industrial facilities mean agricultural consumption dominates in the Seomjingang watershed (84.8%).



# Plant Communities



Detail from *Wild Geese Descending to Sandbar*, Late 15th-Early 16th Century, Unidentified Artist. Metropolitan Museum of Art

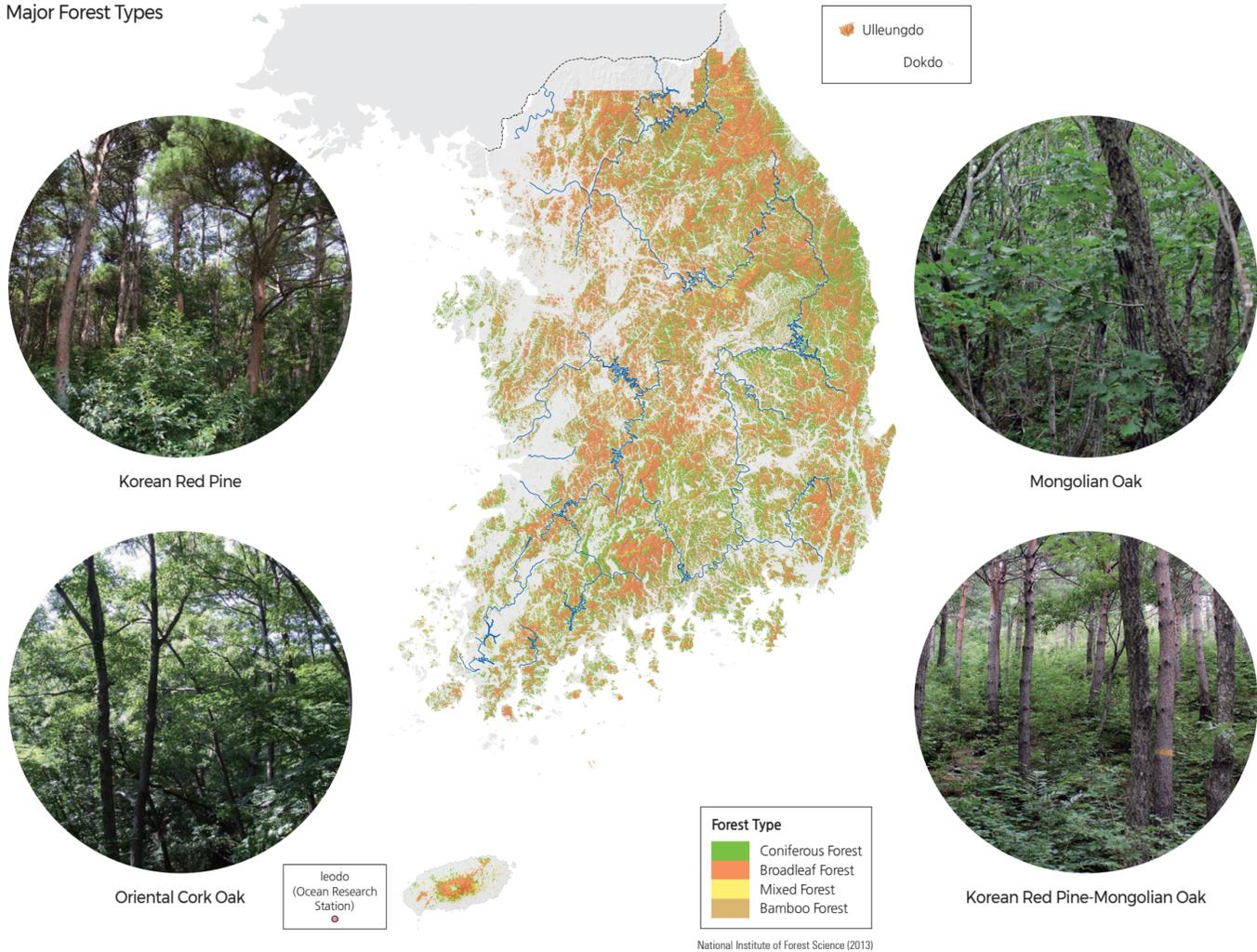
Korea's forests exhibit a high biodiversity, with many different plant species living together in rich ecosystems. Moreover, many of these plants are found only in Korea. Such plants or animals, found only in a specific geographic area, are said to be endemic. There are many reasons for the high diversity and endemism of Korea's forests. The large north-south extent of the peninsula and the variety of landscapes and soils mean there is a diverse set of habitats that allow many different species to thrive. Another reason is historical. During the ice ages, glaciers sent many species into the peninsula for refuge from the cold and ice. Thus, in Korea, older Tertiary plants were able to survive and to be joined later by species from the north.

Major forest types mapped here include coniferous forests composed mainly of evergreen trees with needles for leaves, such as pine and fir. Broadleaf forests are composed of deciduous trees that lose their leaves in winter. Examples include oaks, maples, and birches. Bamboo is an evergreen plant in the grass family. Bamboo grows very quickly and can become as tall as other trees.

Korea is known for its success in combating land deforestation. Long years of slash-and-burn farming and firewood logging left many areas denuded of trees at the end of the 19th century. Without trees, there were many problems with erosion, loss of habitat for animals, and scarcity of trees as a resource for humans. To remedy the situation, afforestation (re-planting trees) and erosion control projects were initiated throughout the 20th century and continue today.

The protection of biological species includes recovering the ecosystem equilibrium and provides abundant and diverse benefits to humans. Around 13 million species are estimated to inhabit the earth, with 70 species becoming extinct every day. Also, an estimated 25% of all species are predicted to disappear by 2050. The current extinction rate is reported to be 1,000 times faster than the natural extinction rate.

## Major Forest Types



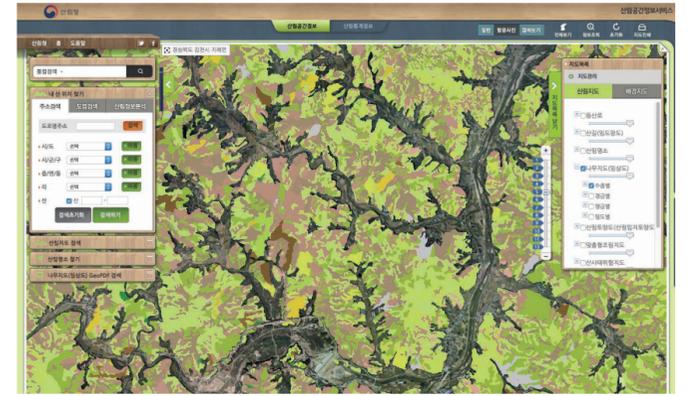
An estimated 100,000 species inhabit South Korea. As of 2020, a total of 45,292 species, including 5,349 plant species, have been identified. According to the criteria of the IUCN Red List, 4,058 species have been designated on the Korean Red List. Currently, 12 species have been reported to be extinct, and 533 species are categorized as endangered. Of the 533 endangered species, 214 are plant species, accounting for 40% of the total.



**Korean Lady's Slipper (*Cypripedium japonicum*)**  
A small population of *Cypripedium japonicum* remains in the regions of Gyeonggi-do, Gangwon-do, Jeollanam-do, Jeollabuk-do, and Chungcheongbuk-do. Affected by illegal collection and characterized by a low seed setting rate, the species displays high fluctuation in population numbers.

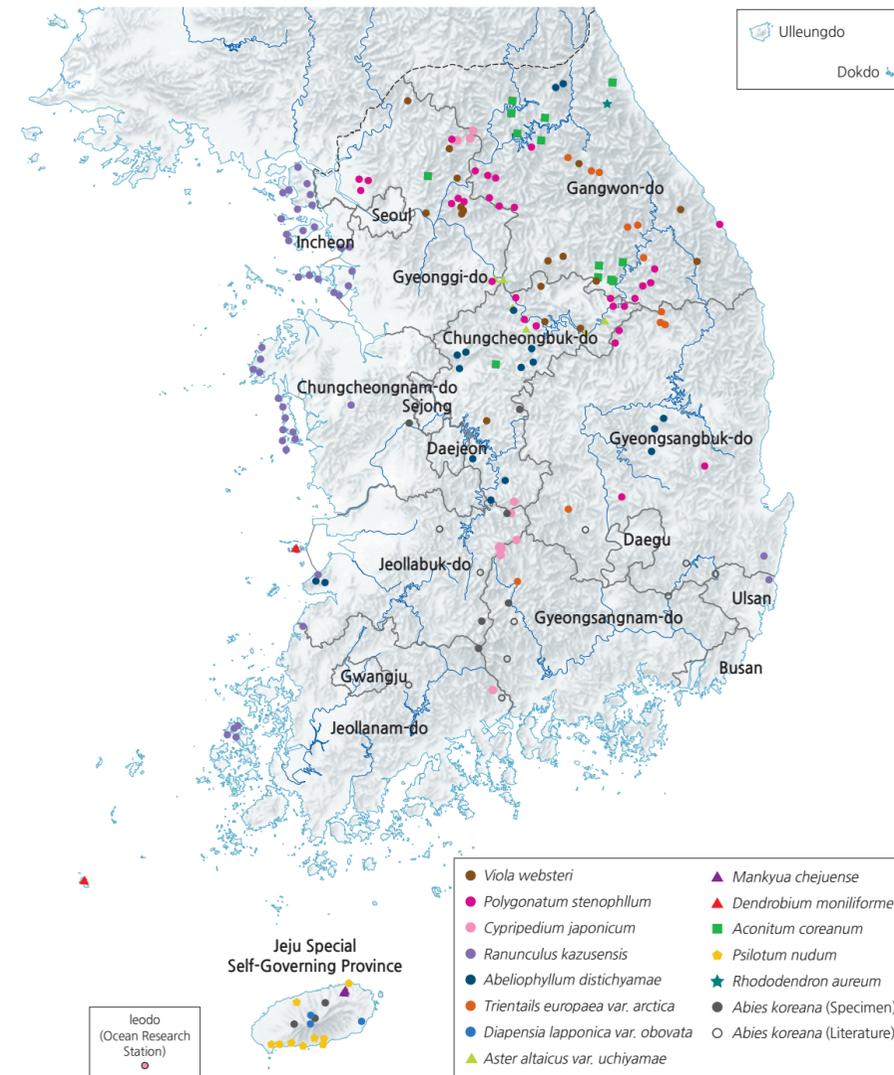
Digital mapping has become a critical tool for the management and protection of plant communities. These maps are compiled on a national scale, along with maps of other natural elements, such as topography, soil, and geology. Digital maps and their associated spatial data allow fast and accurate data search and effective support for various planning and decision-making processes.

## Forest Spatial Information Service



National Institute of Forest Science (2013)

## Distribution of Endangered Plants



*Bamboo in the Wind*, Early 17th Century, Yi Jeong, Metropolitan Museum of Art

# Migratory Birds



Civil-Official Hyungbae (Rank Badge) Depicting a Red-Crowned Crane, Late 19th Century, Metropolitan Museum of Art

Many migratory birds visit and use the Korean Peninsula as wintering, breeding, and stopover sites. In particular, shorebirds that spend the winter in Australia and New Zealand and migrate to Siberia for breeding usually visit Korea to feed in the tidal flats of the west coast in spring and autumn.

Among the nine flyways used by migratory birds worldwide for breeding and wintering, Korea is included in the East Asian-Australasian Flyway (EAAF). Small birds of the order Passeriformes visit the southwestern coastal islands of Korea while traveling between wintering areas in southern China and Southeast Asia and breeding grounds in Korea, Mongolia, China, and Russia in spring and autumn. According to the Bird Research Center of the Korea National Park Service, more than 370 species have been confirmed to pass through this flyway periodically in spring and autumn. Islands are also critical stopover points for these small migratory birds.

Globally, cranes include four genera and 15 species. In Korea, Red-crowned Crane, White-naped Crane, and Hooded Crane are commonly observed in wetlands or grasslands. The wintering season in South Korea spans from October to March, during which time flocks migrate southward from their summer habitat. Cranes display diurnal behaviors, differentiating sleeping grounds and feeding territories in their wintering areas in South Korea, and mostly feed on plant bulbs, fallen grains, and invertebrates in cultivated fields. The Hooded Crane inhabits South Korea only temporarily as a migratory stopover; however, the population of Hooded Cranes has been increasing recently. Of the cranes in South Korea, the Red-crowned Crane and Siberian Crane are globally endangered species.



Red-Crowned Crane

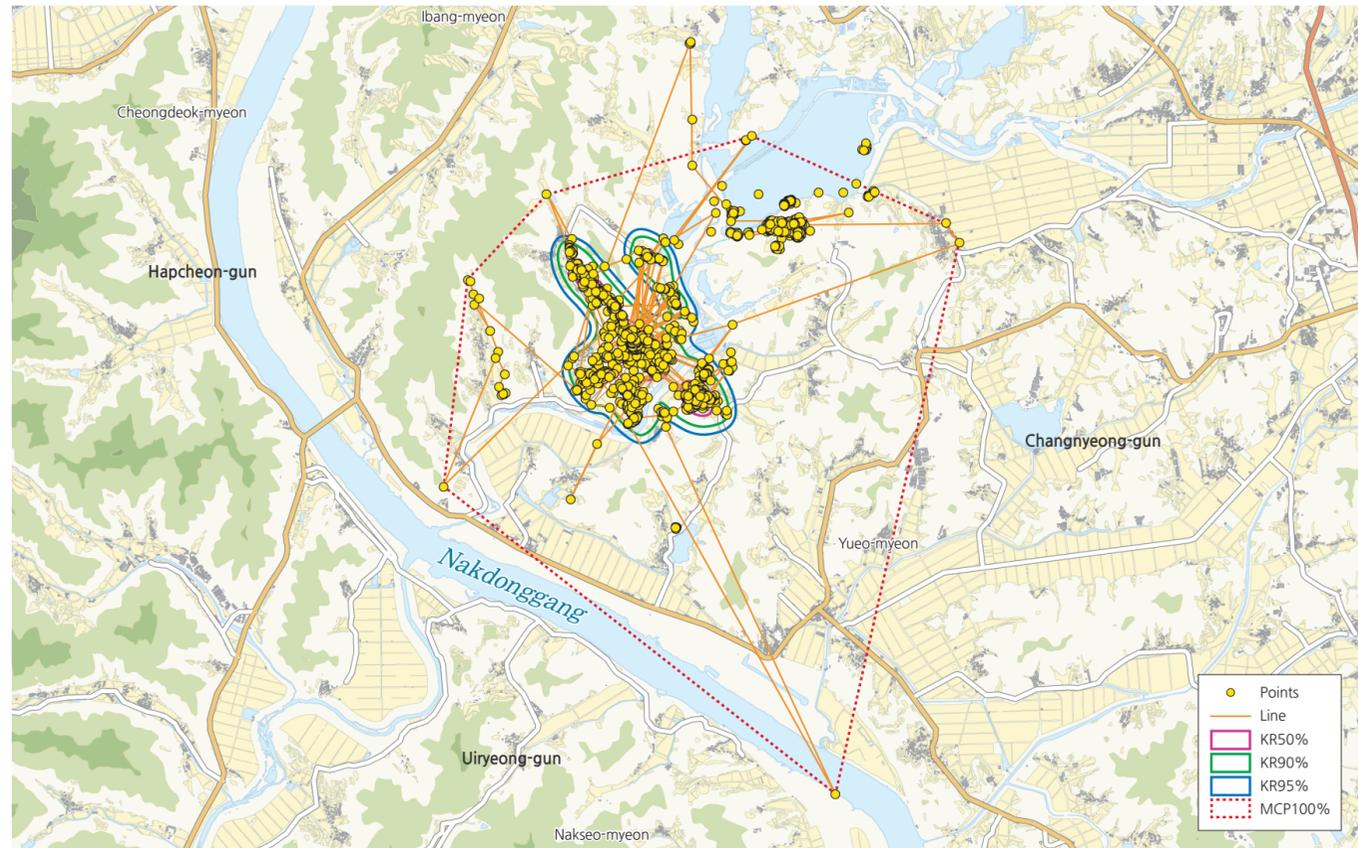


Black-Faced Spoonbill



Crested Ibis

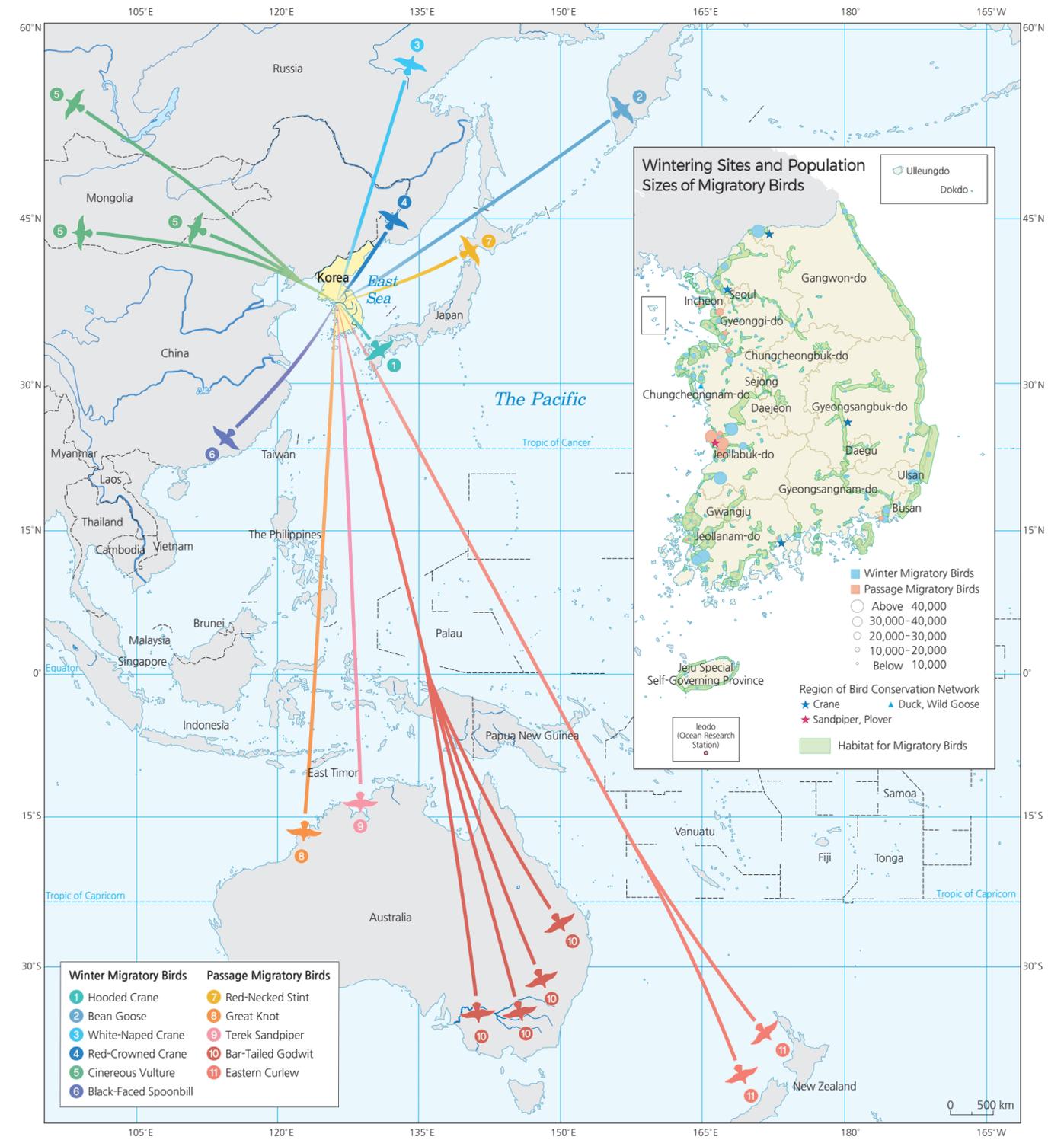
## Distribution of Crested Ibis in Upo Wetlands



• MCP (Minimum Convex Polygon Method), KR (Kernel Method)

Ministry of Environment, National Institute of Ecology (2020)

## Flyway



National Institute of Biological Resources (2015)

Of the 36 species of spoonbills in the world, five inhabit Korea. They live in shallow wetlands, such as tidal flats, rice paddies, and estuaries, and eat small fish, shrimp, amphibians, aquatic insects, and worms. Black-faced Spoonbills breed mainly on uninhabited islands at the border between South Korea and North Korea. They also breed on the west coast of the Korean Peninsula and an artificial island within the Namdong reservoir of Incheon. In 1994, Black-faced Spoonbill were in danger of extinction as only about 300 survived in the world. Since then, the population has steadily increased due to global protection efforts, and it is now more than 4,000. Black-faced Spoonbill are summer migratory birds, but less than

40 of them spend the winter in Jeju-do. Crested Ibis, also belonging to the Spoonbill family, arrived in Korea as a winter migratory bird in the past. It is believed that Crested Ibis breed in the northern part of the Korean Peninsula. After 1978, no wild Crested Ibis had been reported in Korea. Therefore, beginning in 2008, a restoration project was started in the Upo wetlands in Changnyeong-gun, Gyeongsangnam-do. A total of 401 Crested Ibises were artificially propagated from four introduced Crested Ibises. Since 2019, 40 of them have been released into the wild.