

## NATURAL SETTING

## Landforms and Topography



Woraksan National Park in the Sobaeksanmaek range

Korea has some of the most beautiful and varied scenery in the world. The scenery, or landscape, of a particular place is made up of the 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, with landforms such as rocky shorelines, rugged mountains, tranquil lakes, or meandering streams. Some landforms are the result of deposition (accumulation) of earth materials. For example, a dune is a deposit of wind-blown sand. Other landforms are the result of erosion (wearing away) of material. For example, the erosion of soil by a stream can produce a deep river valley.

Besides producing beautiful scenery, landforms have an important influence on many other aspects of geography and human activities. The study of landforms, called geomorphology, allows scientists to read the history of a landscape and learn about the environmental changes that might have occurred in the past. Topography at least partly determines the location of agricultural fields, cities, roads, and areas at risk of natural hazards.

The map to the right uses colors to indicate topography—how



A sand dune on the coast beside East Sea



A sandy point bar along a stream in the Taebaeksanmaek range

high the land lies above sea level, also called elevation. Lower land elevations are shown in green and occur mostly in the west and south. Mountain ranges with high elevations are shown in orange and yellow, mostly in the north and east. The highest peak is Baekdusan in North Korea, with an elevation of 2,744 meters. The Hamkyeongsanmaek and Taebaeksanmaek mountain ranges run roughly north-to-south along the shoreline of East Sea. Rivers on the east side of the ranges don't have far to go to reach East Sea, so they are short rivers. Rivers flowing west have farther to go across the lowlands toward the Yellow Sea and so are much longer.

The Korean Peninsula is bordered by water on three sides. The topographic map indicates the depths of these seas, with darker blue colors representing greater depths. As can be seen on the map, Yellow Sea is relatively shallow, less than 100 meters deep. East Sea, however, has depths of more than 3,000 meters. The peninsula has relatively long coastlines for its size. In contrast to its smooth eastern coastline, its southern and western coastlines are irregular and complex, with many islands.



## Sea stacks on the southern coast







## Landscapes and Scenery: Land Cover Classes

Korea's beautiful scenery can be classified into categories called land cover classes. Each class is mapped as a particular color on the map to the right. The land cover map indicates general patterns of how land is used on different parts of the peninsula.



**Urban Areas:** Urban land (shown as red on the map) includes developed areas with commercial or industrial buildings, apartments, roads, airports, parking lots, or schools, for example. Construction has mostly taken place in basins and along major rivers. Cities have gradually expanded with the growth of the populations. Roads and railways that connect cities have led to further development of new metropolitan centers in surrounding areas. Urban areas cover 2% of North Korea and 4% of South Korea.



**Forested Land:** Forests (shown as green on the map) are more common in mountainous regions and less populated areas on the eastern half of the Korean Peninsula. Forest cover has decreased due to urban and agricultural expansion. The fragmentation of forests has in turn threatened the livelihood of plants and animals living in the forest ecosystem. Because of this, efforts have been made to restore forests. Forests cover about 70% of the Korean Peninsula.



**Agricultural Land:** Farmlands (shown as yellow) for crop production and pastures for livestock animals have increased through the years. Hills were cultivated for farming upland fields, many of which have been converted into rice paddies using irrigation. Other crops grown in agricultural areas include ginseng, fruits, and vegetables. In coastal regions, some new farmland has been created by reclaiming land from the sea. Agricultural land covers 24% of North Korea and 20% of South Korea.



**Wetlands:** Wetlands (shown as purple) are low-lying areas that have water-logged soils or are frequently flooded with water. This class includes tidal flats that are covered with sea water at high tide. Also included are floodplains that are frequently flooded when streams go over bank. Wetlands are valuable animal and plant habitats and provide several ecological services, such as filtering contaminants from groundwater and helping to control flooding.



**Water:** Areas of water (shown as light blue) include lakes, artificial reservoirs, rivers, and the ocean. Although this class makes up a small percentage of land cover area, it is an important part of the environment. Water is used for drinking, irrigation, and industrial processes. Much effort has gone into ensuring a clean, safe, and consistent water supply for these uses.







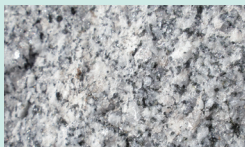
Columns formed in volcanic rocks at Mudeungsan Area Geopark

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 particular geological significance have been preserved as twenty two National Parks, seven Geoparks, and nine Ecological Landscape Conservation Areas across the country. Although Korea does not currently have active volcanoes, vigorous volcanic activity occurred at various times in the past and so there are volcanic rocks and landforms in various regions. Ulleungdo and Dokdo islands, for example, are the exposed peaks of a submarine volcano. Other regions have a soluble rock, limestone, which can be dissolved to form caves and dolines (sinkholes).

The geologic map shown in the next page 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 a sedimentation 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 very 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 safe from earthquakes compared to Japan, which is located on the plate margin, but it is not completely safe. Although not abundant in most cases, many kinds of mineral resources have been found on the Korean Peninsula.



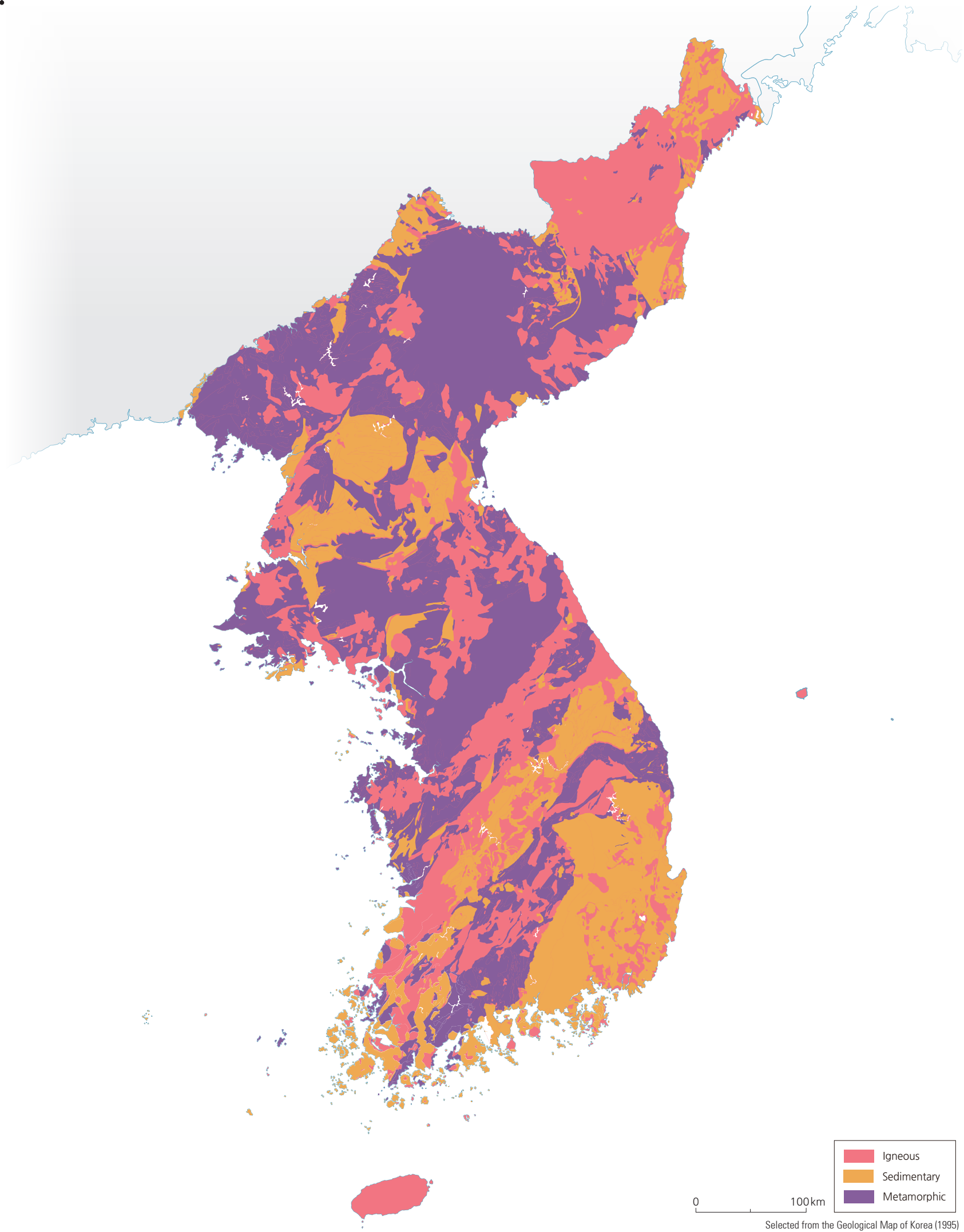
**Igneous Rock** forms by solidifying directly from a molten state. The most common igneous rock in Korea is granite, which solidifies while the body of molten magma is still underground. Many granite and volcanic rocks in Korea were formed during the Mesozoic period about 250 to 66 million years ago. 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 years 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.

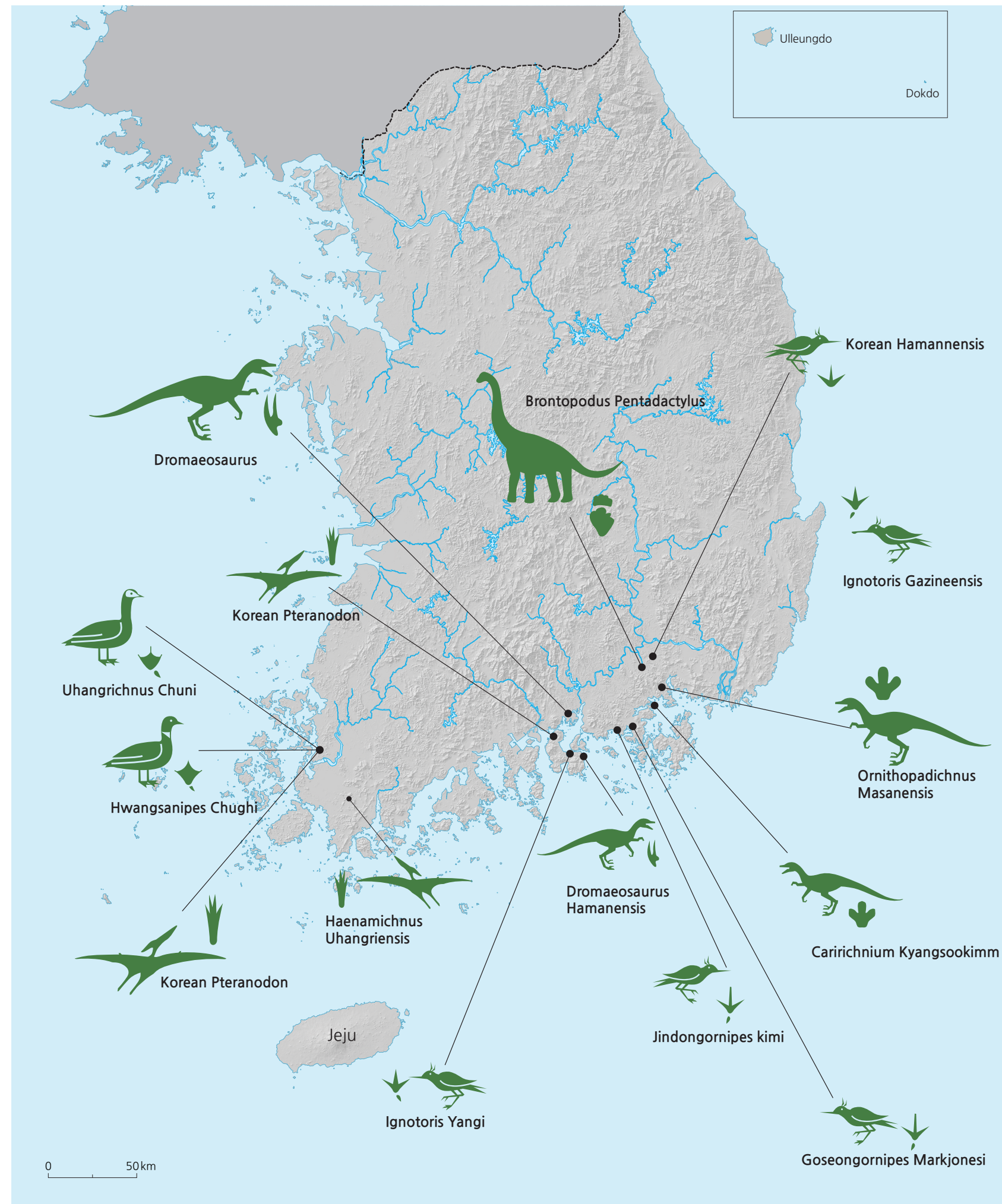






# Creatures of the Cretaceous: The Dinosaurs of Korea

Distribution of Dinosaur Fossils in the Korean Peninsula



The Cretaceous terrestrial (non-marine) sedimentary layers on the Korean Peninsula contain abundant dinosaur fossils, including footprints and egg and bone fossils. In 1972, the first dinosaur fossil found in the Korean Peninsula was an egg fossil from the seaside of Hadong-gun in Gyeongsangnam-do. After that, in 1982, a dinosaur bone was found in Eui-seong-gun in Gyeongsangbuk-do. Since 1996, many dinosaur footprints and egg and bone fossils have been found in Cretaceous sedimentary layers in Jeollanam-do and Gyeongsangnam-do.

Dinosaur footprint fossil sites are found in the 27 Cretaceous terrestrial sedimentary layers in the southern region of the Korean Peninsula; the Cretaceous terrestrial sedimentary layers in Haenam-gun, Hwasun-gun, and Yeosu-si within Jeollanam-do, and Goseong-gun within Gyeongsangnam-do, are representative sites. Ornithopod (bipedal, herbivorous dinosaur) footprints are very abundant in the Korean Peninsula, and representative theropod

(bipedal, lizard-hip dinosaur) footprints have been found in Hwasun-gun within the Neungju Basin. Abundant sauropod (four-legged, herbivorous dinosaur) footprints are reported from the Jindong sedimentary layer in the southeastern region of the Korean Peninsula and the diverse size, shape, and trackway of sauropod footprints indicate that diverse sauropods lived in the Korean Peninsula. The pterosaur, a flying dinosaur, found in Uhangri, Hanam-gun was internationally approved as a new species named Haenamichnus uhangriensis.

The largest number and the widest trackway of pterosaur footprints (443 and 7.3 m, respectively), are found in the Uhangri area. In this area the footprints of pterosaurs, dinosaurs, and birds occur together in the same sedimentary layer, which is very rare in the world. For the first time in Korea dinosaur bone fossils which are well preserved enough to identify the species of dinosaurs, were found in the sedimentary layer in Hadong-gun,

Gyeongsangnam-do; the bone fossil was identified as a new species and named as Pukungosaurus millenniumi. It was registered as the 931st dinosaur genus in the world inventory of dinosaurs.

During the Cretaceous many lakes that could be used as a source of drinking water for dinosaur, existed in the southern region of the Korean Peninsula. Around the lakes, gymnosperms, including conifers and ferns, were abundant, providing enough food to dinosaurs. Vertebrates including tortoises, crocodiles, early mammals and fish and invertebrates including mollusks, arthropods and lugworms were also abundant in and around lakes. These lake environments made the Korean Peninsula a good habitat for dinosaurs during the Cretaceous. As a result, dinosaurs thrived on the Korean Peninsula during the late Cretaceous when dinosaurs were on the decline in other parts of the world. The Korean Peninsula was one of the last sanctuaries for dinosaurs in the world.

Dinosaur Fossils in the Korean Peninsula



Representative dinosaur fossils from Korea ① and ② Dinosaur Eggs ③ and ④ Dinosaur Footprints ⑤ Pterosaurs Footprints ⑥ Dinosaur Bone





# Soil: A Critical Natural Resource

Soil is an important natural medium for supporting plant growth and crop production. Recent changes in global climate and ecosystems are placing greater emphasis on the role of soil as a surface medium that connects water, atmosphere, and terrestrial ecosystems. In order to respond to increasing societal demands for detailed knowledge in this field, it is necessary to gain a better understanding of the spatial distribution, temporal changes, and nutrient status of soils.

Soil classifications are generally made by utilizing the Soil Taxonomy established by the United States Department of Agriculture (USDA). According to Soil Taxonomy (which categorizes 12 orders of soil recognized on a global scale), Korea has 7 orders, mapped by color in the next page. A representative soil profile, a side view of a soil as seen in a soil pit, is shown for each of these soil orders below.

Over half of Korean territory is covered with Inceptisols, which can be defined as soils that do not have clear soil horizon development. The predominance of

Inceptisols indicates that the land surface has undergone radical changes. For instance, rapid soil erosion constantly removes topsoil from slope surfaces, and active deposition in areas such as alluvial fans, valleys, and riverside flats hinders soil horizonation. The characteristics of Korean summers also serve as crucial factors of fast erosion; concentrated precipitation, high temperatures, and high humidity interrupt the accumulation of organic matter and weaken soil formation processes. Additionally, freezing during the winter also prevents active differentiation of soil horizons.

Korea is well-known for its success in combating land degradation. By the end of the Joseon dynasty, many of its mountains were devastated due to long years of slash-and-burn farming and firewood logging. The Japanese Colonial Period and the Korean War further deteriorated the situation through severe forest degradation and consequent soil loss. Since the 1970s, however, many of the barren mountains have successfully been transformed into

lush green forest areas and soil quality has steadily improved. Korea’s case of overcoming land degradation serves as a valuable example of sustainable development, particularly for developing countries.

Soil Classification (Soil Taxonomy)

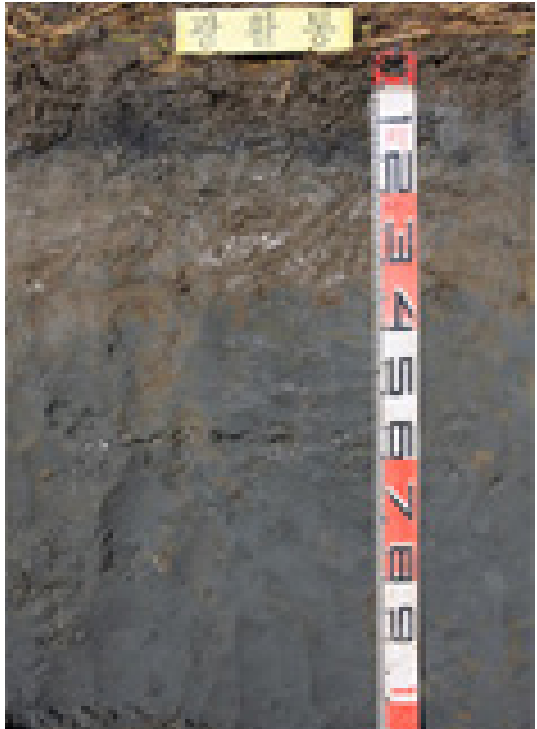
Order (7)	Area (ha)
Inceptisols	6,132,477
Entisols	1,066,184
Ultisols	1,246,385
Alfisols	820,246
Andisols	129,164
Mollisols	62,388
Histosols	409



This Inceptisol is in a well-drained, mountainous area. Colored bars represent 10-cm intervals.

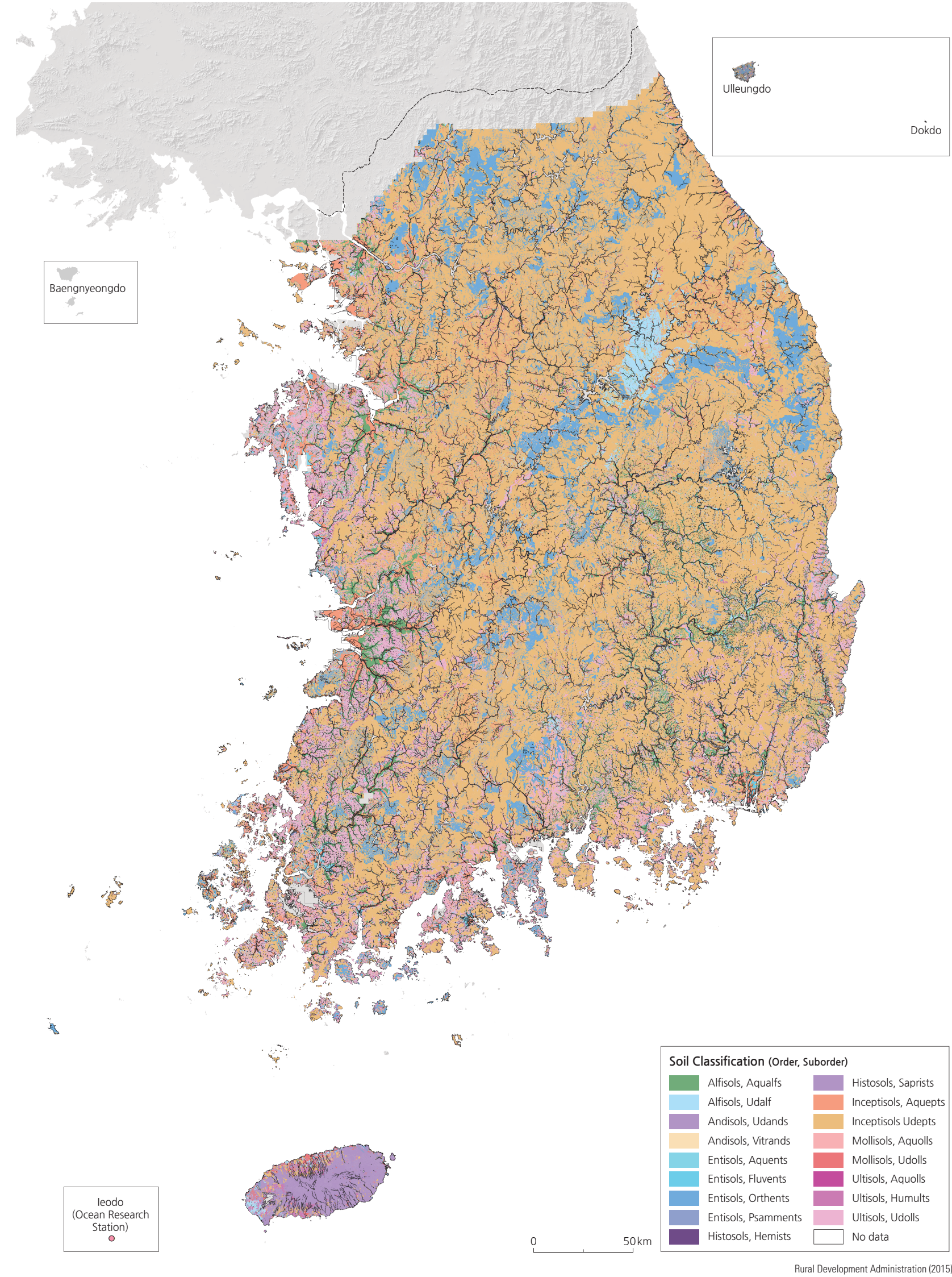


Andisols are black, organic-rich soils that form in volcanic ash.



This Entisol is in a poorly-drained rice paddy field.

Soil Map of Korea



Rural Development Administration (2015)





# Climate of Korea

The spatial distribution of climate in Korea is determined by key factors such as latitude, elevation, geographic location, the different heating properties of land and sea, ocean currents, and the East Asian Monsoon system. Because of the East Asian monsoon, it is hot and humid during the summer, but cold and dry during the winter.

The difference in temperature between the north and south is because areas closer to the equator receive 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 between different latitudes.

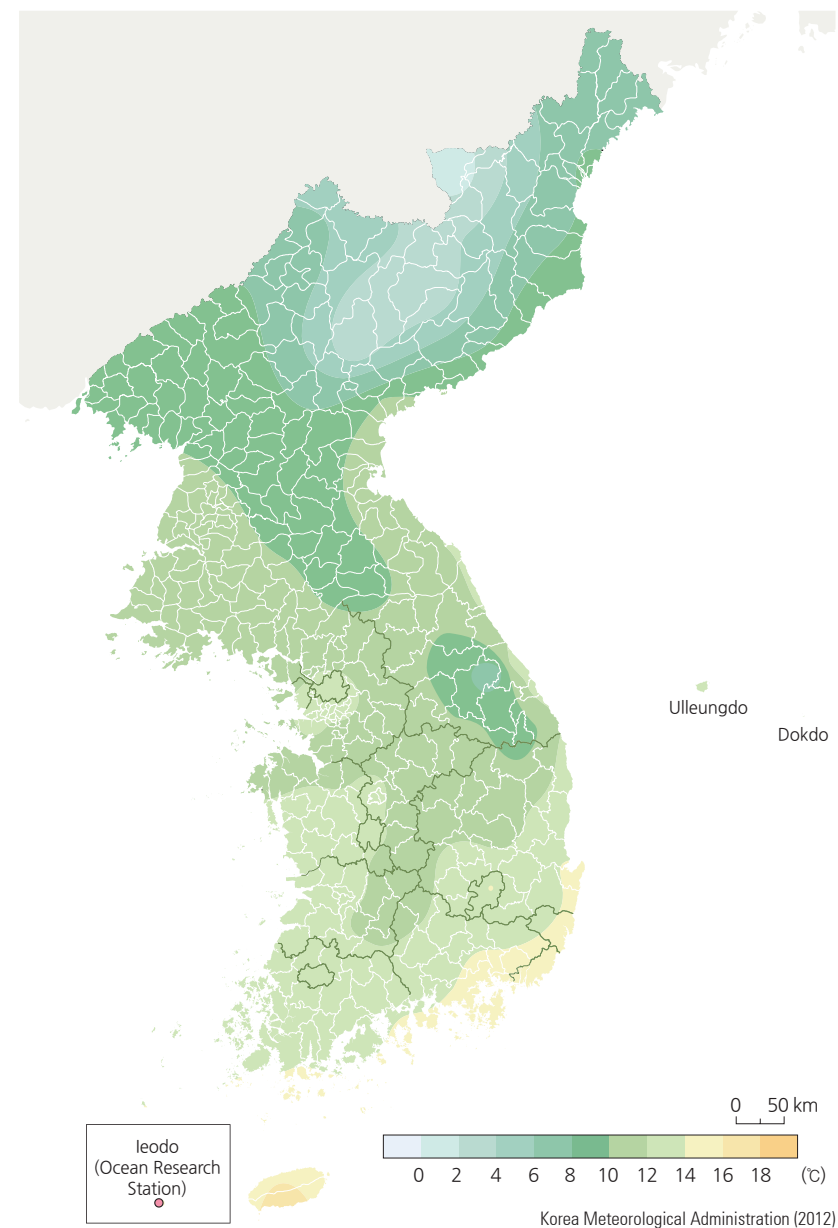
Climate also depends on elevation. The annual mean air temperature at Daegwallyeong (773 m above sea level), the highest weather station in South Korea, is 6.6°C. Hongcheon is at a similar latitude but lower elevation (141 m above sea level) and has a higher

temperature of 10.3°C.

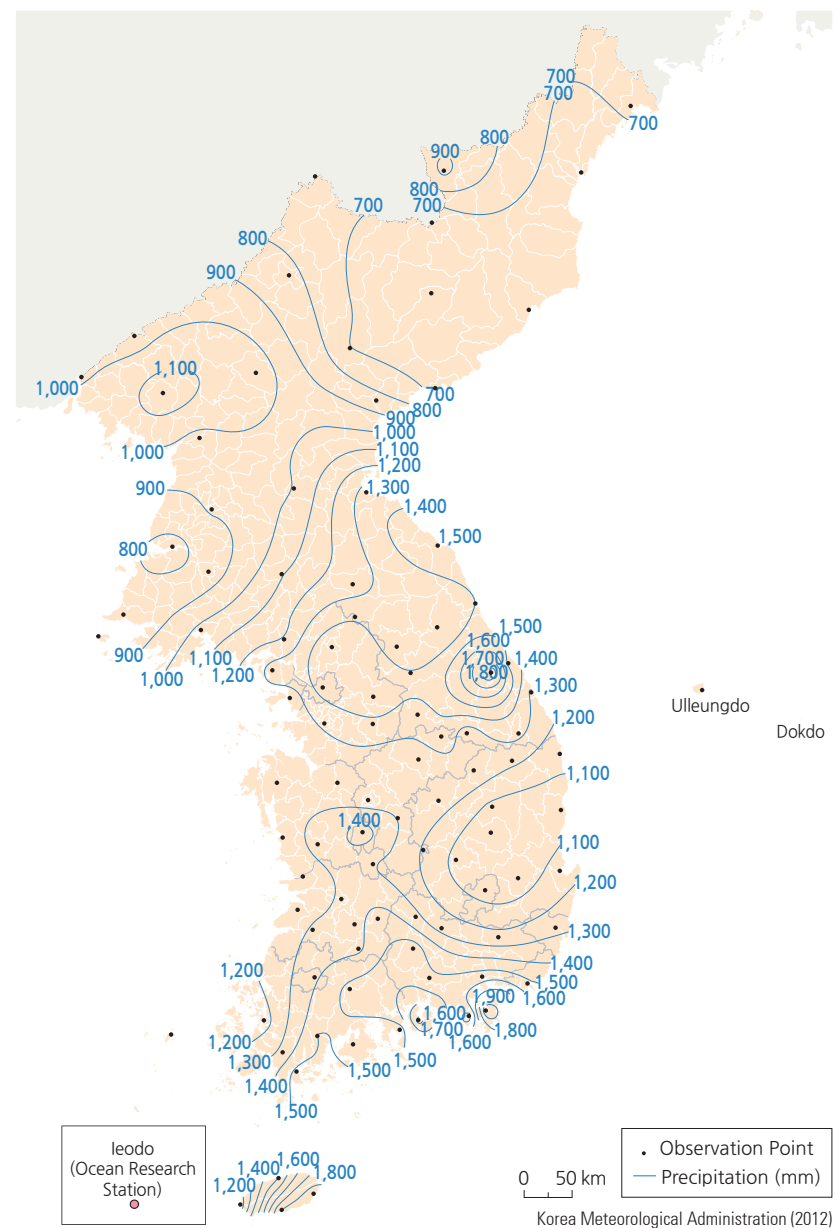
Korea is largely characterized by a continental climate due to the effects of the Eurasian continent. However, the climate of the coastal areas, mostly governed by the ocean, differs from that of the inland areas. The annual mean temperature range for Daejeon is only 0.3°C greater than that of Boryeong, which is adjacent to the coast. The average temperature during the summer (June, July, and August) in Daejeon is approximately 1.3°C higher than that in Boryeong.

The Asian monsoon system over East Asia (including Korea, China, and Japan) is formed due to the land-sea distribution and the associated difference in heating properties. While cold, dry wind blows into the Korean Peninsula in the winter due to the continental effect, hot and humid wind blows into Korea during the summer due to the effect of the North Pacific. The climate of Korea is also under the influence of various air masses such as the Siberian, the North Pacific, the Okhotsk Sea, and equatorial air masses.

Annual Mean Air Temperature



Annual Mean Precipitation



## Climographs

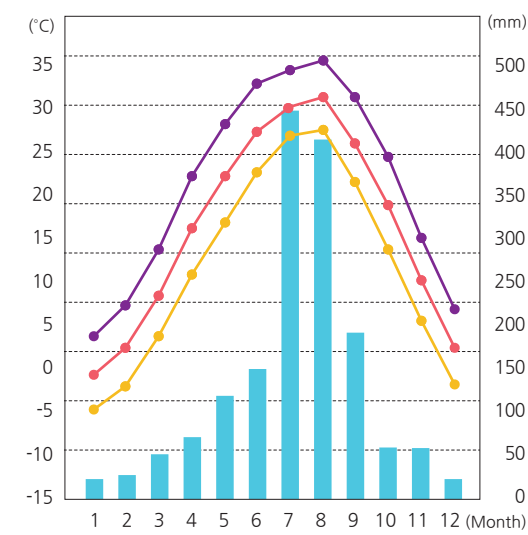
A useful way to quickly illustrate climate differences is to plot changes in temperature and precipitation through the year. The resulting graph, called a climograph, can show major differences at a glance. The horizontal axis below each plot represents the month of the year from January (1) to December (12). The lines on the graph

represent monthly average temperatures through 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. Precipita-

tion, which includes rainfall as well as snow or sleet, is shown by the blue bars, which are read along the vertical axis on the right in millimeters.

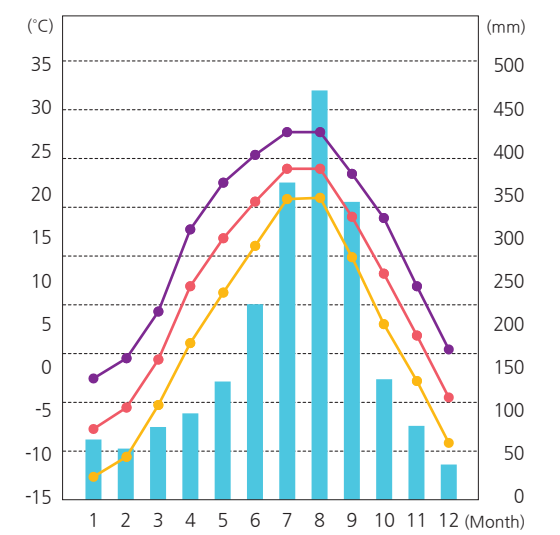
As shown in these climographs, summer tends to be hot and wet, while winter is cold and dry. In Seogwipo, temperature does not drop below zero Celsius.

Seoul



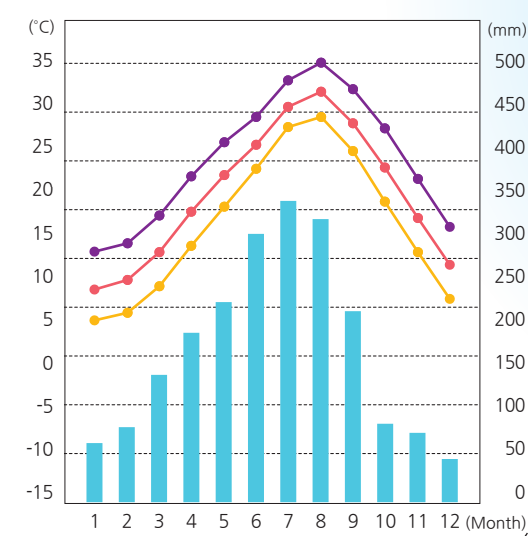
Seoul has an mean annual air temperature of 12.5°C and receives 1,450.5 mm of precipitation annually.

Daegwallyeong



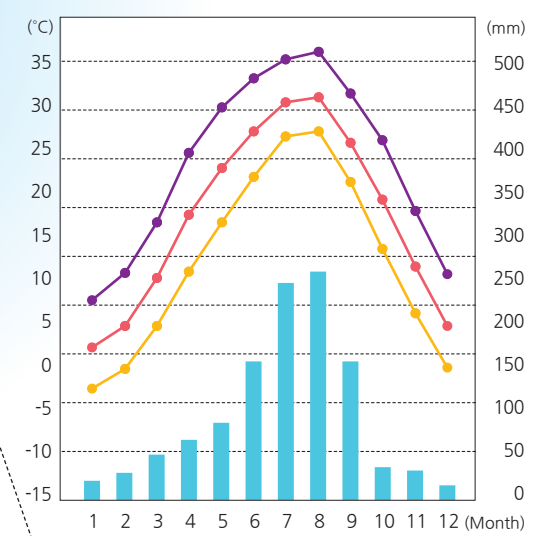
The highest weather station in Korea is in the Taebaeksanmaek range at Daegwallyeong, with an elevation of 773 m. Because of its mountainous location, Daegwallyeong is cool and wet. The annual mean temperature is 6.6°C and the annual precipitation is 1,898.0 mm.

Seogwipo



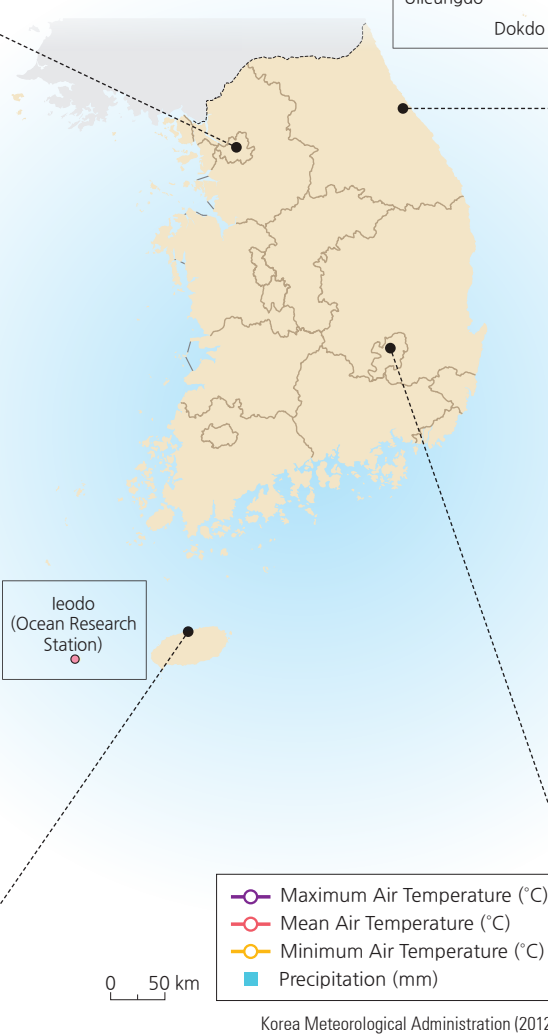
Seogwipo, on Jeju Island, has the highest mean annual temperature in Korea at 16.6°C. Seogwipo remains warm throughout the year. Annual precipitation is 1,923.0 mm.

Daegu



Because of its inland location, Daegu has a high annual temperature range (the difference between summer and winter temperatures) of 25.8°C. Owing to its location on the downwind or leeward side of mountain ranges, Daegu is fairly dry, receiving only 1,064.4 mm of precipitation each year.

Climate of South Korea







## Forests of Korea: Diverse and Unique

Korea's forests exhibit a high biodiversity, with many different plant species living together. In addition many of these plants are found only in Korea. 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. So in Korea, older Tertiary plants were able to survive and to be joined by species from the north.

The major forest types are mapped below. Coniferous forests are 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 forests are actually composed of a large grass. Bamboos grow 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.

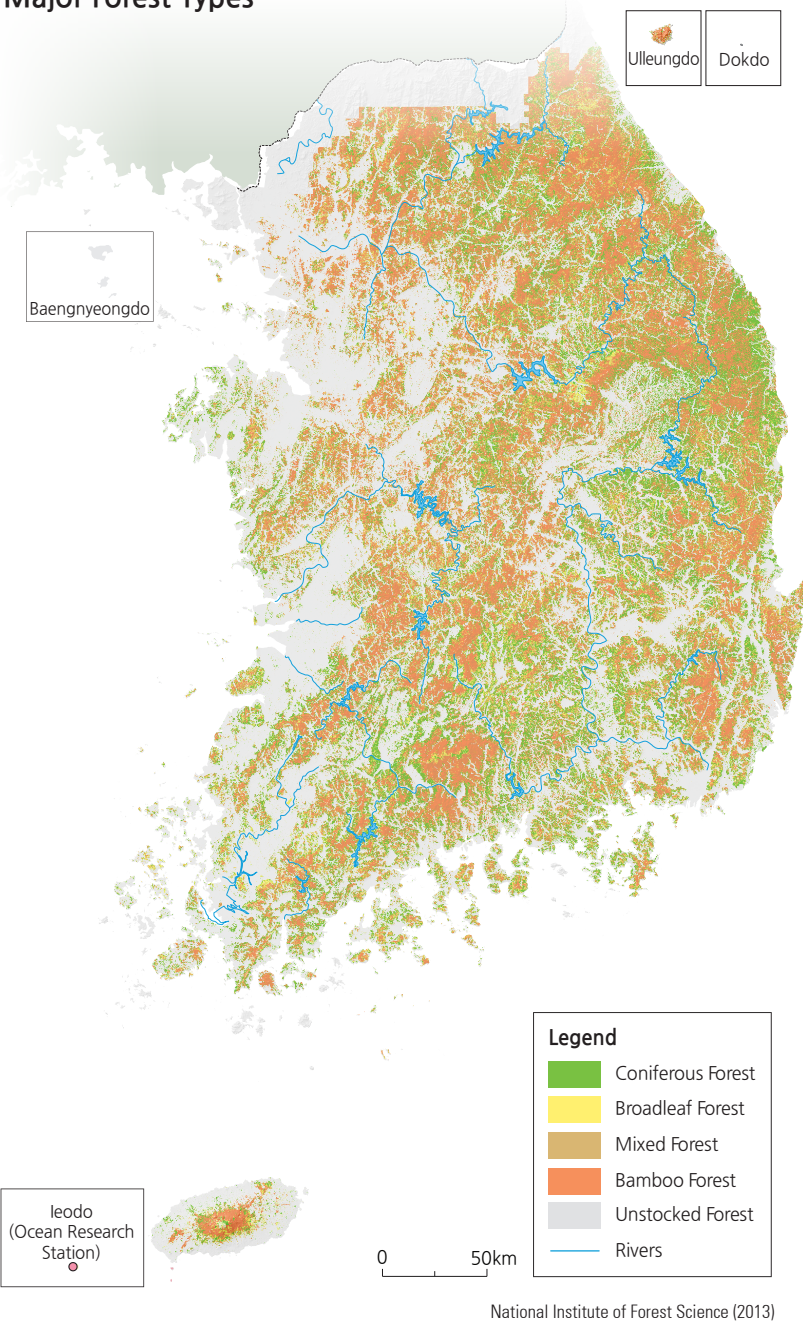
### Major Forest Types



Korean Red Pine



Oriental Cork Oak



Mongolian Oak

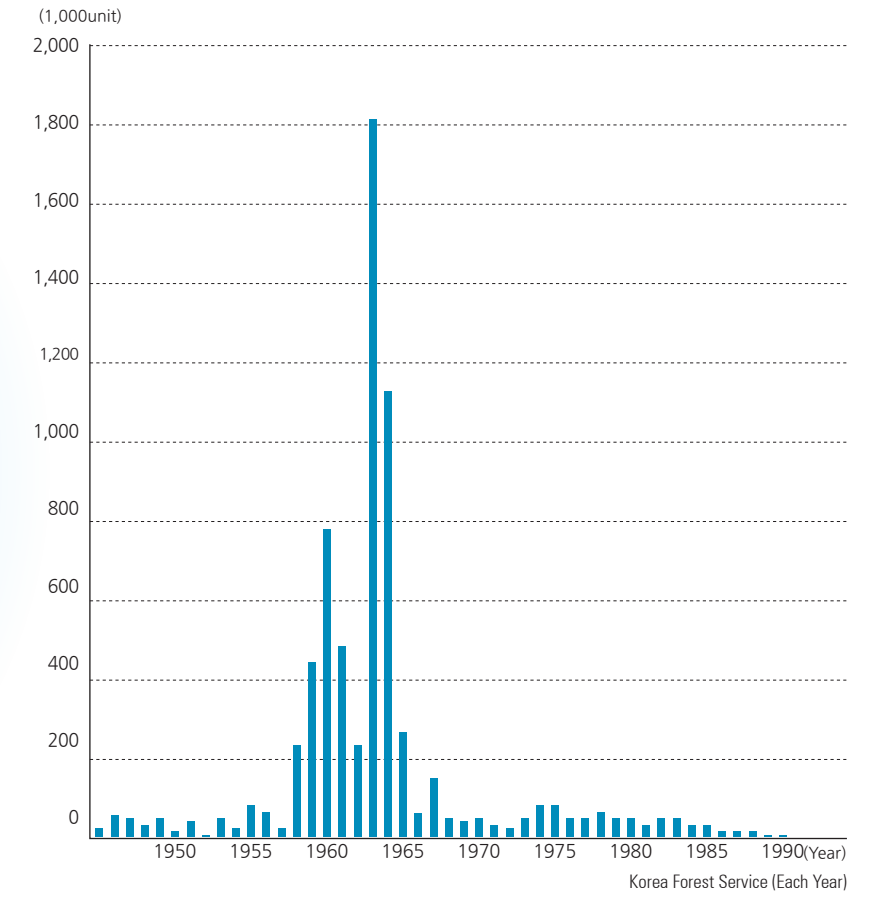


Korean Red Pine-Mongolian Oak

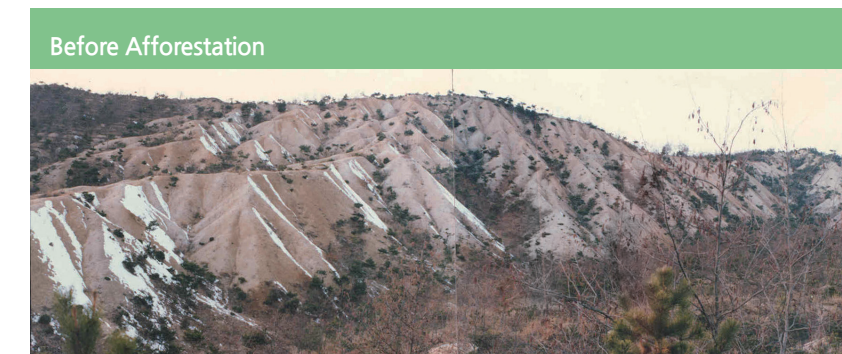
### Major Afforestation Areas



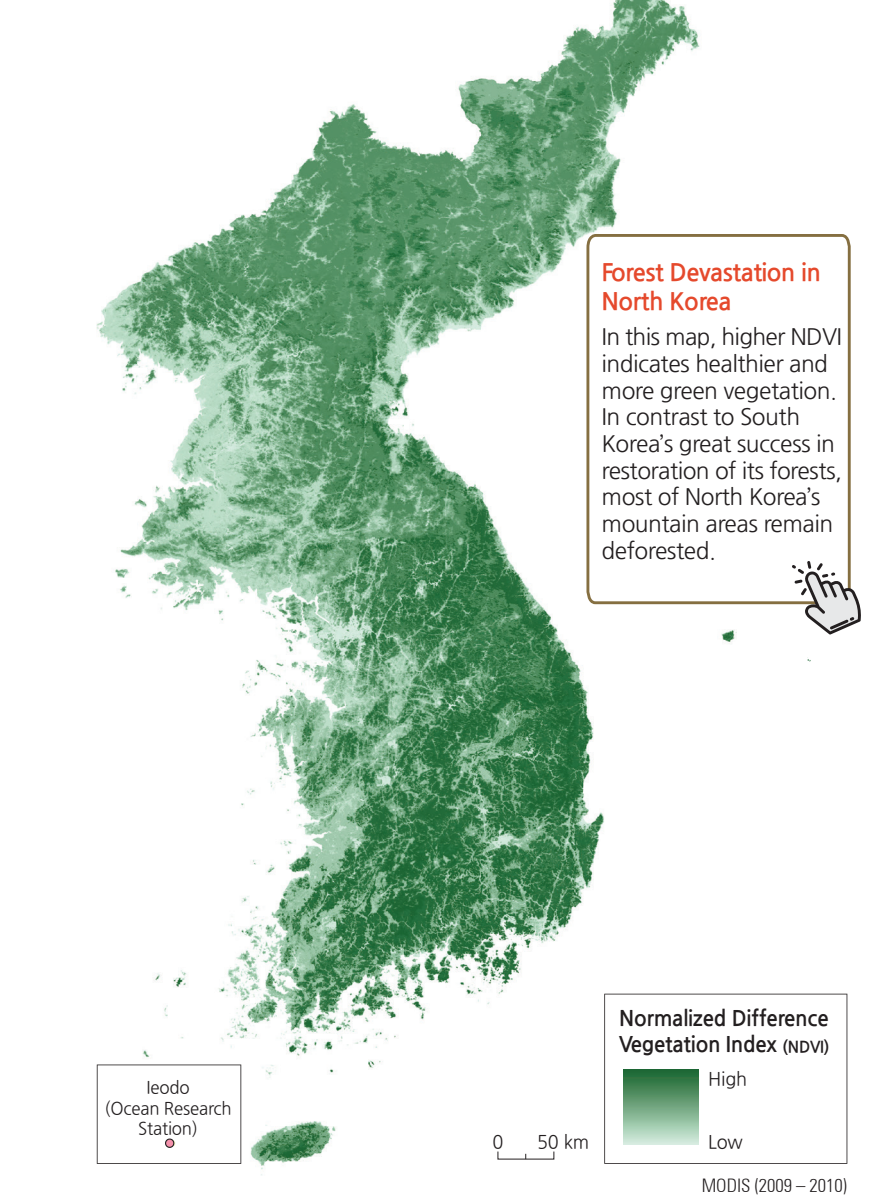
### Mountain Afforestation Areas by Year



### Example of Afforestation on Devastated Forest Land



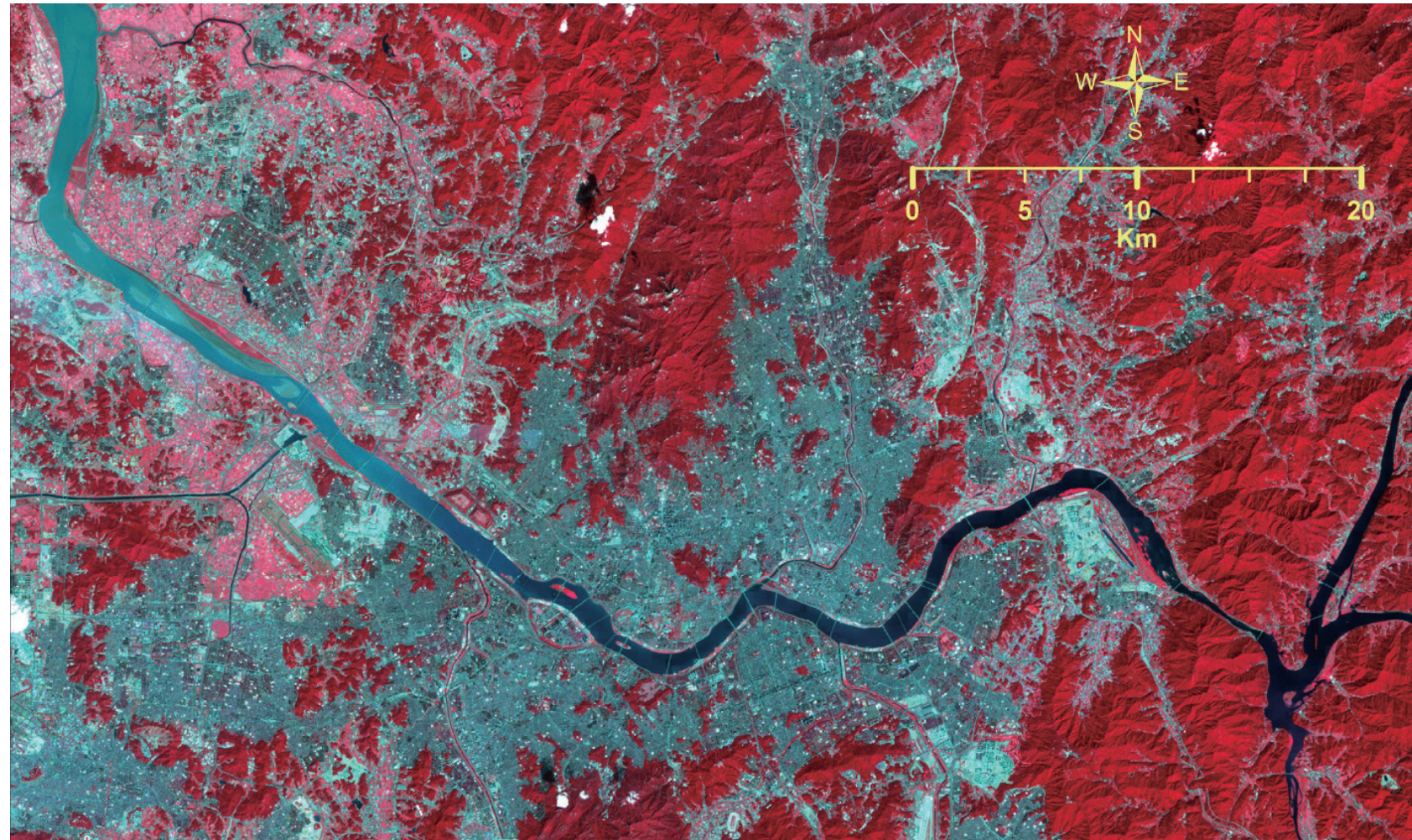
### Normalized Difference Vegetation Index (NDVI) on the Korean Peninsula (2010)







## Rivers and their Watersheds



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 (right to left).

The terrain of Korea is characteristically high along the east coast and low along the west coast. Consequently, most of the rivers flow into the Yellow Sea and the South Sea. The shoreline of the east coast is monotonous and rivers flowing into the East Sea are relatively short and steep-sloped. On the other hand, the shoreline of the west coast is more complex and many rivers flowing to the western and southern coasts are relatively long; they have gentle slopes and wider basins that result in higher flows. In these areas, river sediments shape extensive alluvial plains and alluvial basins, and meandering channels are often formed as well. In Korea, there are five large rivers: Hangang, Nakdonggang, Geumgang, Seomjingang, and Yeongsangang.

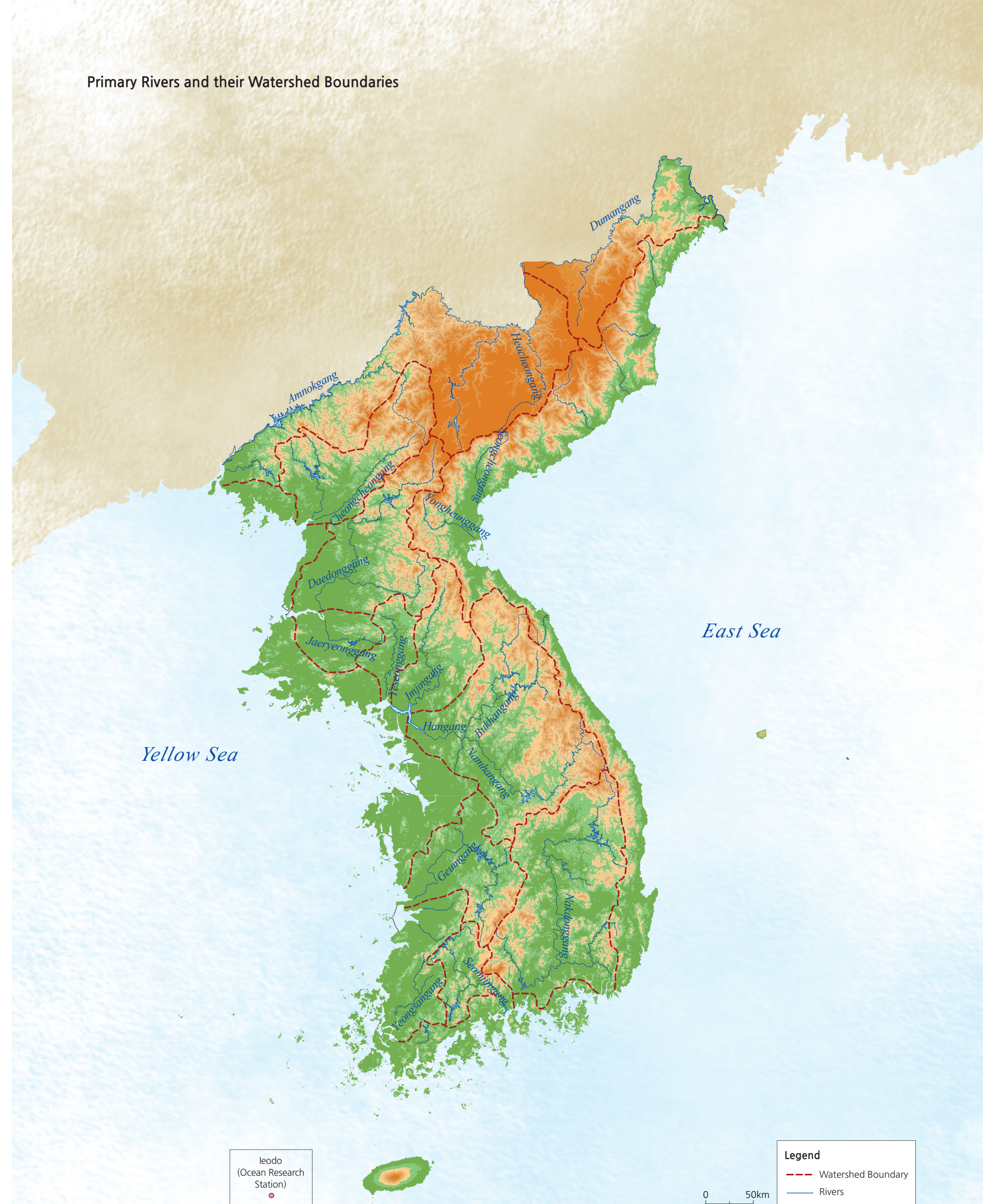
From 2005 to 2014, the average annual precipitation in Korea was approximately 1,323.7 mm, which is equivalent to about 1.6 times the world average. This is enough to classify Korea as a high rainfall region, although seasonal variability is extremely high. Due to seasonal rain and typhoons, 735.8 mm of rainfall (55.6% of the annual rainfall) is concentrated during the summer and often causes floods. Furthermore, rainfall has the tendency to quickly collect in the 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, often causing extensive floods and severe droughts.



A large river meandering through agricultural fields.

Up until the 1950s and 1960s, most rivers in Korea were in their natural form. However, in accordance with the rapid urbanization of the 1970s, many tributaries were covered or revamped and meandering channels were straightened out in rural areas. As environmental issues gained light in the 1990s, various environmental improvement projects (such as the construction of waterfront parks and promenades) were launched in areas around rivers. In the 2000s, the concept of improvement evolved beyond the simple concept of parks to recognize the ecological and scenic conservation value of rivers for ecosystems and humans.

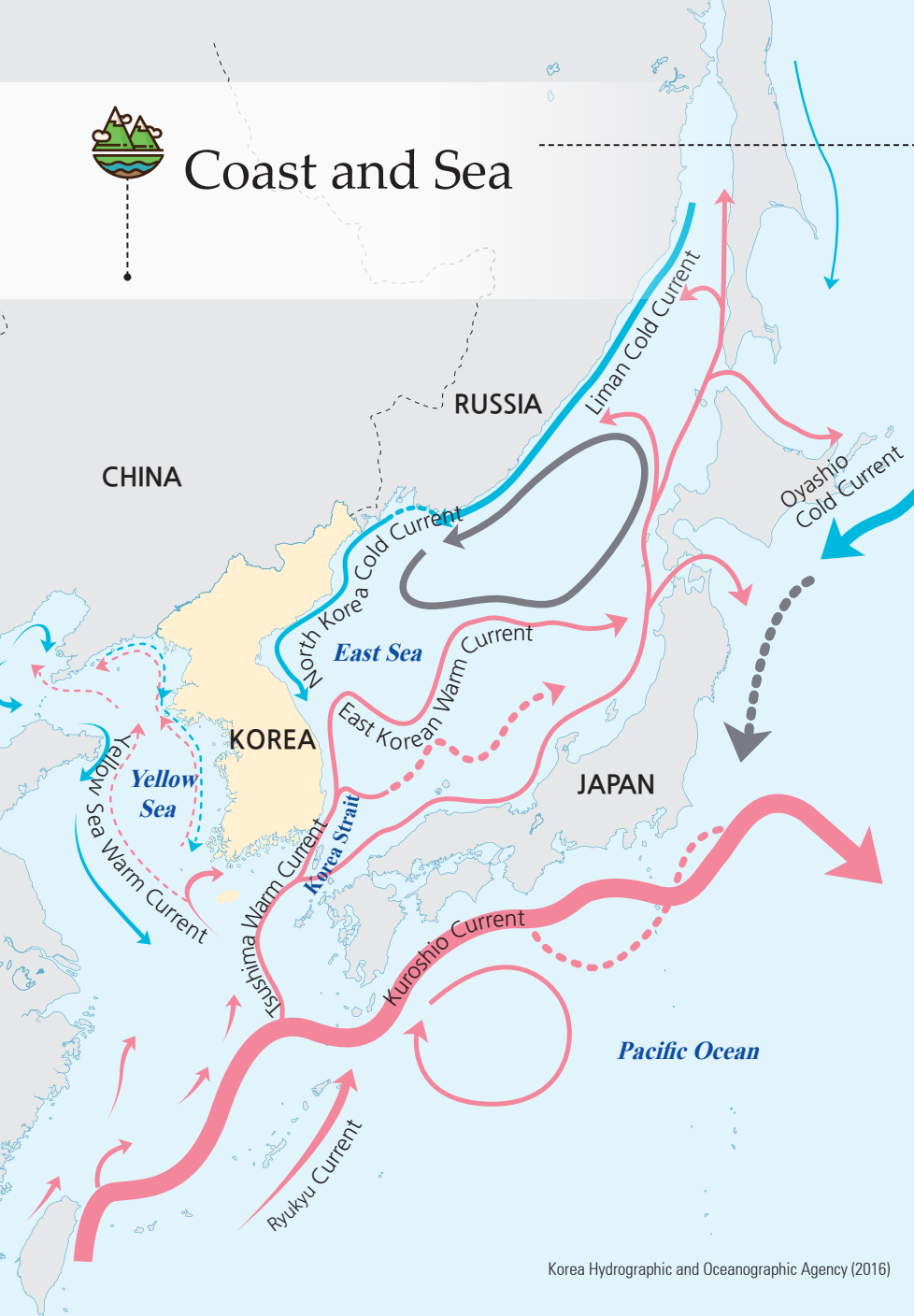
## Primary Rivers and their Watershed Boundaries







# Coast and Sea



Korea Hydrographic and Oceanographic Agency (2016)

## Seas and Oceans surrounding Korea

The Korean Peninsula is surrounded by water on three sides, and is connected to China to the north. As South Korea is located at the gateway to the continent, it has a long history of active trading through the ocean. Through the centuries, Korean navigation techniques involving tidal currents, ocean currents, and wind have been more advanced than what was widely known. Korean seas have complicated physical, chemical, and geological factors—such as seasonal ocean currents, tides, and complex topographical features—and have a range of marine habitats with unique ecological communities.

The Yellow Sea, which extends into the East China Sea, is characterized by shallow water less than 80 m deep and gently sloping submarine topography. It is named after its yellowish color, which arises from sediment-rich river water from the Yangtze and the Yellow River of the Chinese mainland.

The Korea Strait separates Korea and Japan. It is greatly affected by changes in the warm Kuroshio Current, which flows northward, bringing warm waters to Japan. Other ocean currents are shown on the map at left, warm currents in red and cold in blue.

The east coast has a relatively simple coastline with deep water that reaches depths of 2,000–3,000 m. It has well-developed, narrow beaches, but the steep slopes of coastal and seabed topography prevent the development of tidal flats and continental shelves. The Tsushima Current—which flows into the East Sea through the Korea Strait—spreads along the surface of the East Sea.



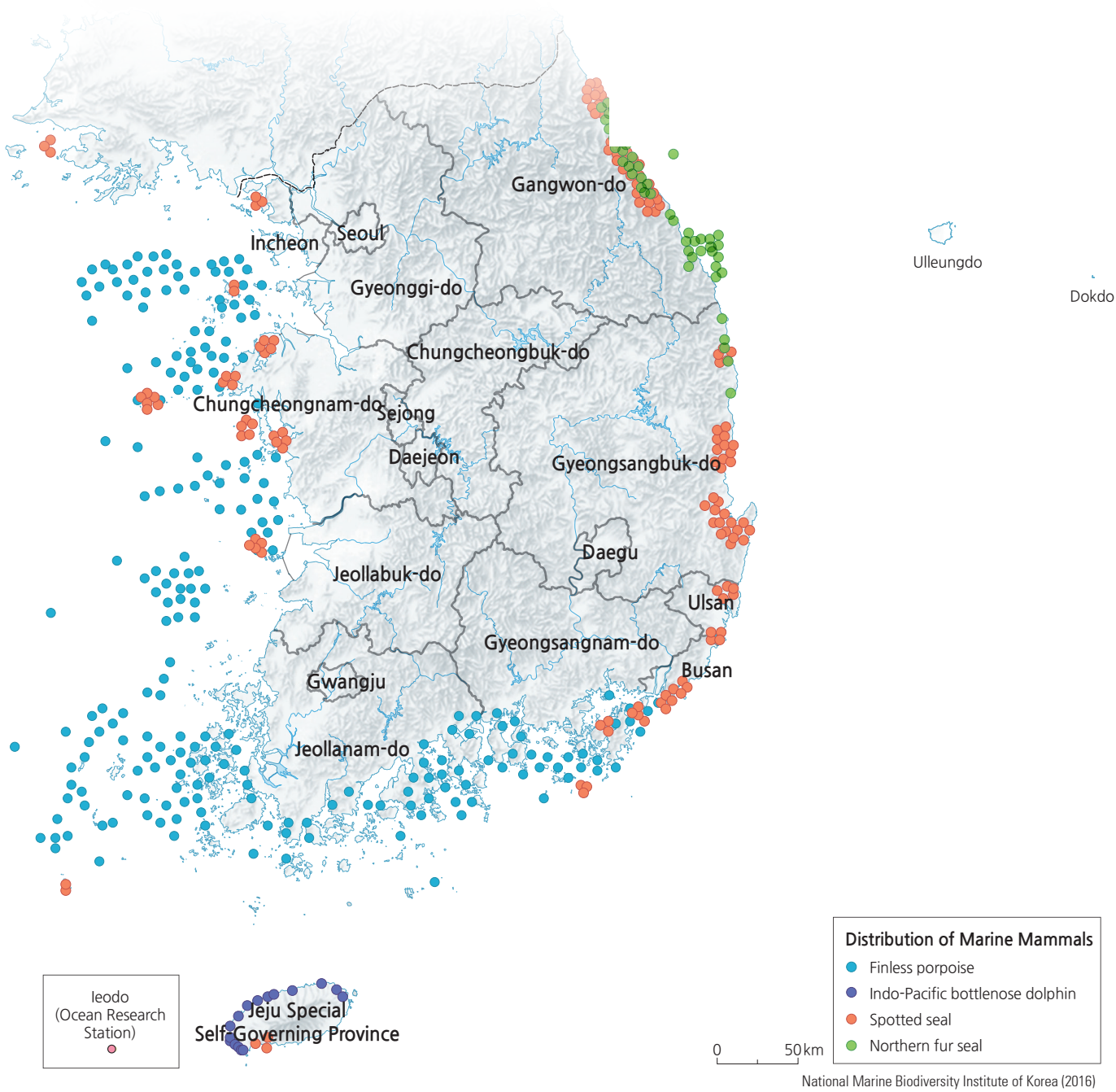
Gomsoman Tidal Flat

Tidal flats are muddy or sandy coastal areas that are underwater at high tide and exposed at low tide. They can be strongly affected by tidal currents and waves or by the flow of estuaries (river mouths where they flow into the sea). Tidal range in Korea can be quite high, in places there can be 10 m difference between high and low tide.



# Marine Mammals of Korea

## Marine Mammals



Thirty species of cetaceans and three species of pinnipeds are found in Korea, and species have been designated as Endangered Marine Species, including the North Atlantic right whale (*Eubalaena glacialis*), gray whale (*Eschrichtius robustus*), humpback whale (*Megaptera novaeangliae*), blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), sei whale (*Balaenoptera borealis*), Bryde's whale (*Balaenoptera edeni*), sperm whale (*Physeter microcephalus*), Indo-Pacific bottlenose dolphin (*Tursiops aduncus*), spotted seal (*Phoca largha*), northern fur seal (*Callorhinus ursinus*), and steller sea lion (*Eumetopias jubatus*). Recently, the finless porpoise (*Neophocaena phocaenoides*), which is experiencing a drastic decrease in its numbers, has also been added to this list. The Indo-Pacific bottlenose dolphin, spotted seal, northern fur seal, and finless porpoise are still frequently observed in domestic waters.





## Birds as Migrants

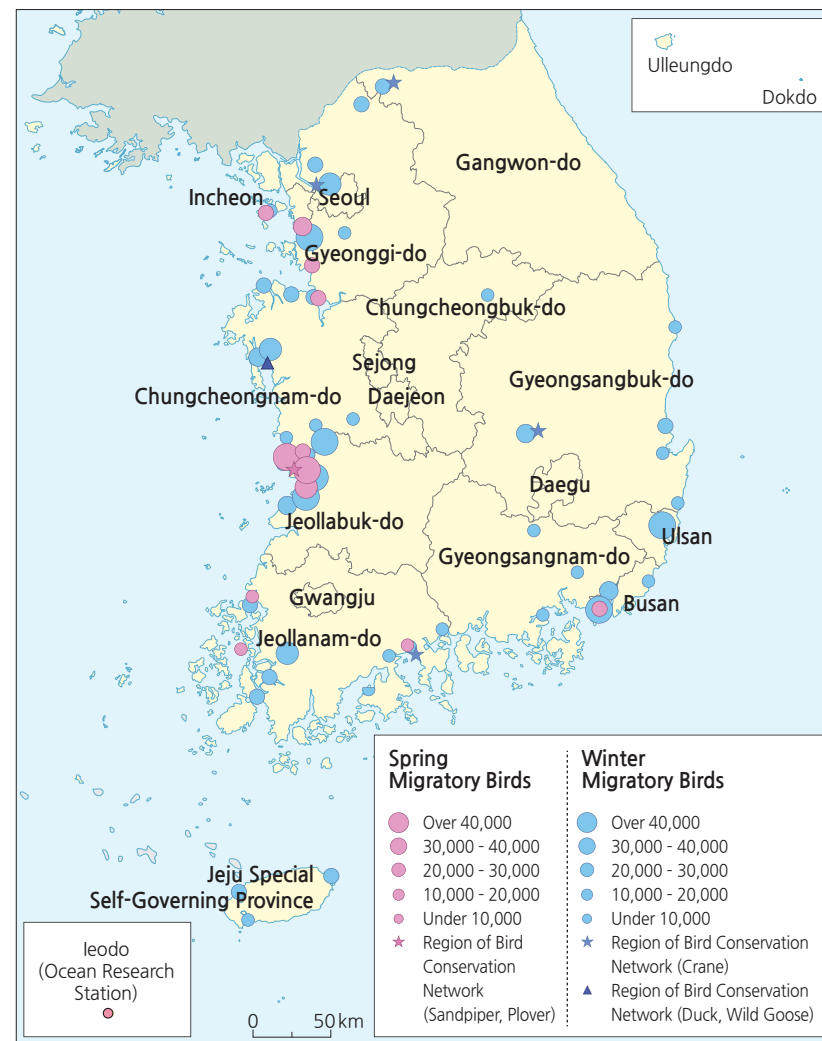


Leucogeranus leucogeranus

Birds have been migrating across long distances for millions of years. They are a symbol of the interconnectedness of places. They rely on healthy environmental conditions and preservation of habitat across many countries. Environmental problems in one part of the world can have global effects. Habitat loss in one area can result in the disappearance of birds thousands of kilometers away. Proper management and restoration of wildlife habitat in Korea means that countries across Asia and Oceania benefit from a more robust population and diversity of bird life.

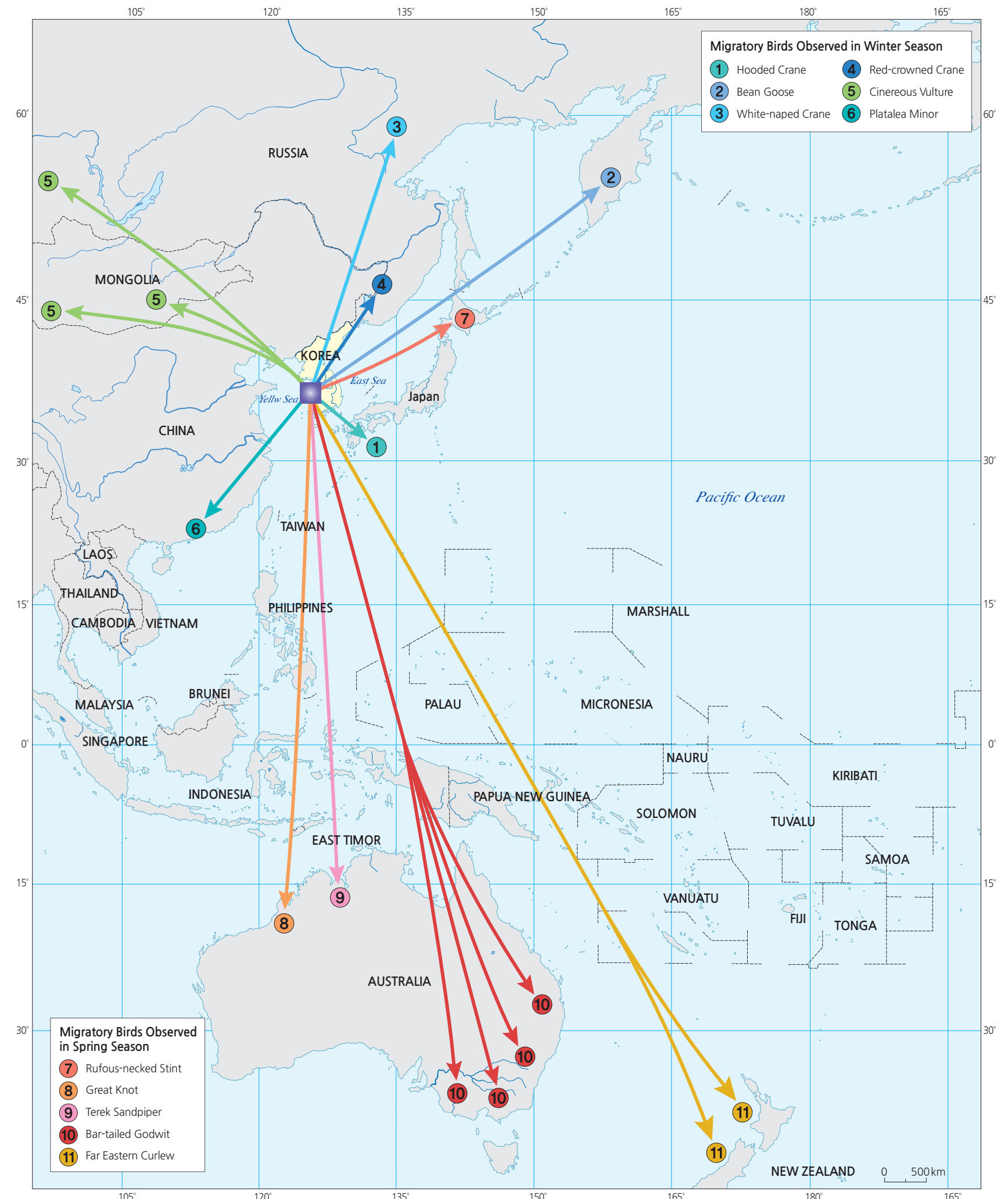
Many migratory birds that are internationally endangered visit the Korean peninsula for over-wintering sites, breeding sites, and stop-over sites. Shore birds that spend winter in Australia and New Zealand and then migrate to Siberia for breeding stop to feed in the tidal flats of the west coast of Korea during spring and autumn. Sandpipers and plovers visiting South Korea follow the East Asia-Australia Flyway (EAAF), one of the nine major flight paths used by migratory waterfowl in the annual bird migration for breeding and wintering. It has been reported that 35 species of globally endangered waterfowl, 13 species of near-threatened waterfowl, and 50 million birds belonging to more than 250 population units travel along the EAAF.

### Seasonal Sites and Population Sizes of Migratory Birds



For managing healthy ecosystems, it's important to develop a global perspective. The flyway map shows the routes of birds that spend part of the year in Korea. Birds that spend the winter in Korea generally fly toward the north during summer to places such as Russia and Mongolia. Their routes are shown by green or blue lines. Birds that spend the spring in Korea generally fly south for the winter to places such as Australia and New Zealand. Their routes are shown in orange or red.

### Flyway of Major Migratory Birds



National Institute of Biological Resources (2015)