

# CHALLENGES AND RESPONSES

## Environmental Challenges: A Geographic Perspective



Environmentalists protesting dam construction in the Donggang River

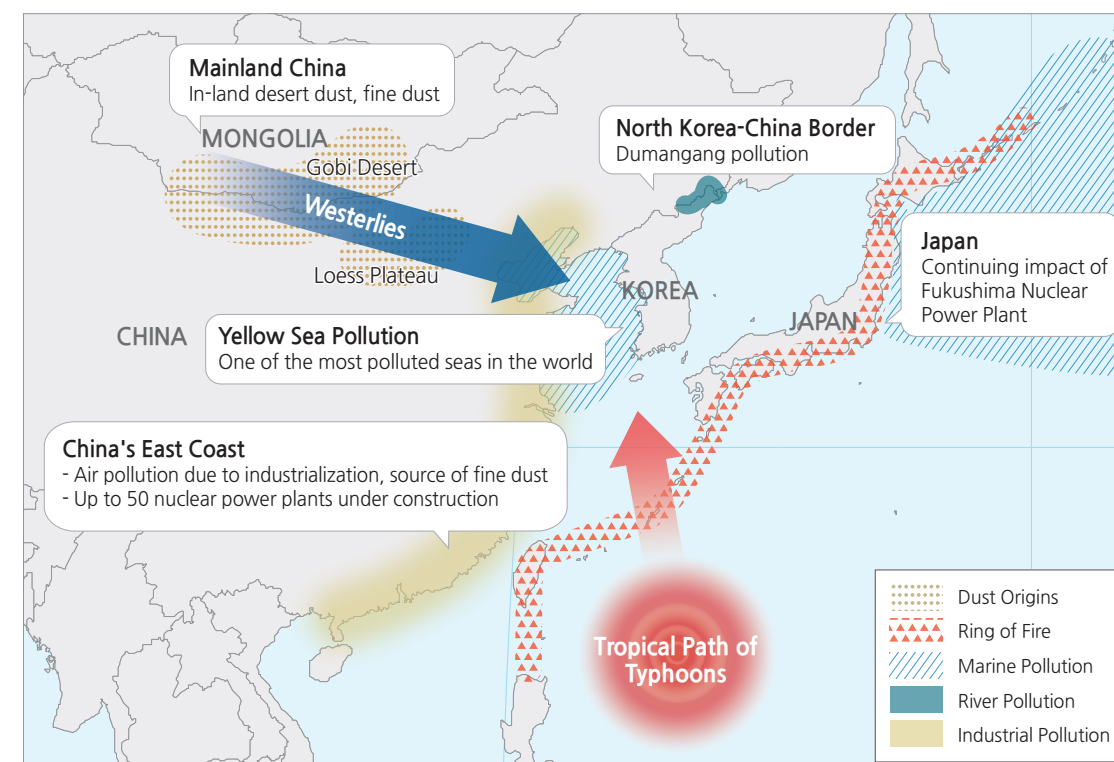
Korea currently faces many environmental challenges. Some problems, such as pollution, are caused by human activities while other problems, such as earthquakes, occur naturally. Many environmental issues are complex, involving both human and natural factors. And the problems occur over many different scales: local, regional, and global. The study of Geography offers a useful way to understand these problems. Geographers examine where things are located across the landscape—their spatial distribution—using maps, air photos, or satellite imagery. And geographers study

many different factors, such as human activities, ecology, or weather patterns for example, and how these factors interact.

The map below summarizes several regional environmental issues affecting the countries of northeast Asia. Some issues extend across national boundaries, affecting more than one country. Pollution can be spread far from its source by winds, rivers, and ocean currents. For example, wind picks up yellow dust from the Gobi Desert and loess plateau in China. The dust-laden wind becomes increasingly polluted as it passes over industrial areas in eastern China. The winds then cross the Yellow Sea and worsen air quality in Korea. Korea's geographic position also puts it within the path of many typhoons, which bring destructive wind, waves, storm surge, and rain. The proximity of tectonic plate boundaries along the Pacific Rim increase the risk of earthquakes and tsunamis.

South Korea has worked to develop sustainable solutions to many of these problems, both internally within its borders and internationally through agreements and partnerships with other countries. The Korean government supports research agencies, implements regulatory policies, and establishes protected conservation areas in response to environmental concerns. Civic environmental groups such as the Korea Institute of Pollution Research and the Antipollution Civic Movement Council also work to combat environmental degradation. Individual volunteers also help to restore and protect Korea's beautiful natural environment.

### Environmental Issues in Northeast Asia

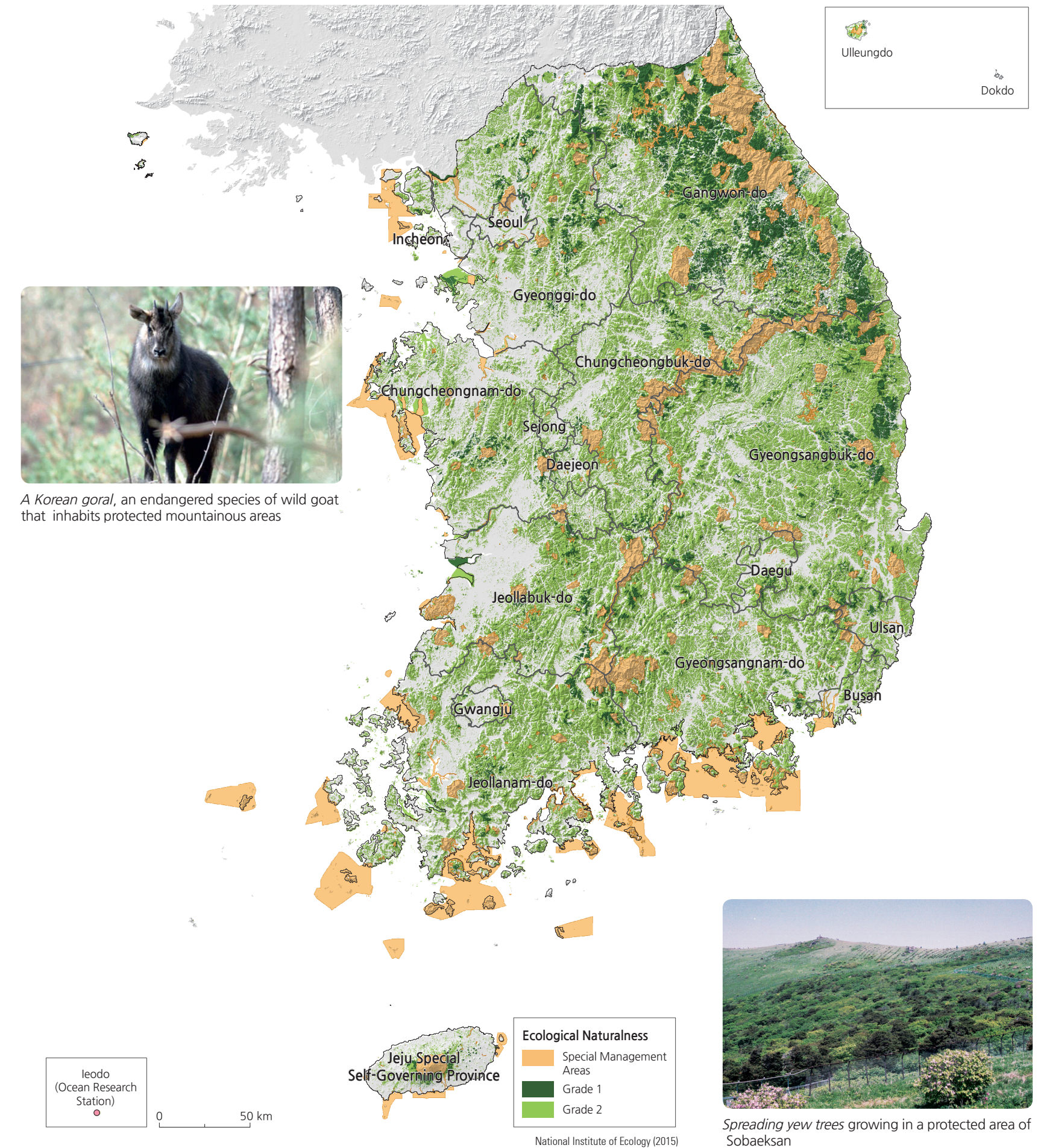


Asia Center, Seoul National University (2015), Chosun Ilbo (2014)



Volunteers cleaning up a beach after an oil spill

### Ecological Naturalness Map



Spreading yew trees growing in a protected area of Sobaeksan

Korean scientists actively monitor various natural and human systems nationwide. The collected data are used to assess the health of plant and animal communities and to identify areas that most need protection, as shown in the map here. In Grade 1 areas, construction and development are heavily restricted in order to preserve the natural environment. In Grade 2 areas, development is allowed, but with some measures in place to limit environmental

impacts. In Grade 3 areas, development and other activities are permitted with fewer regulations. The final category of 'Special Management Areas' are under the highest degree of protection and include parks, wildlife conservation areas, and nature preserves. Maps of land protection categories such as the one shown here, are used to support planning work by government and community leaders, developers, consultants, and environmental scientists.



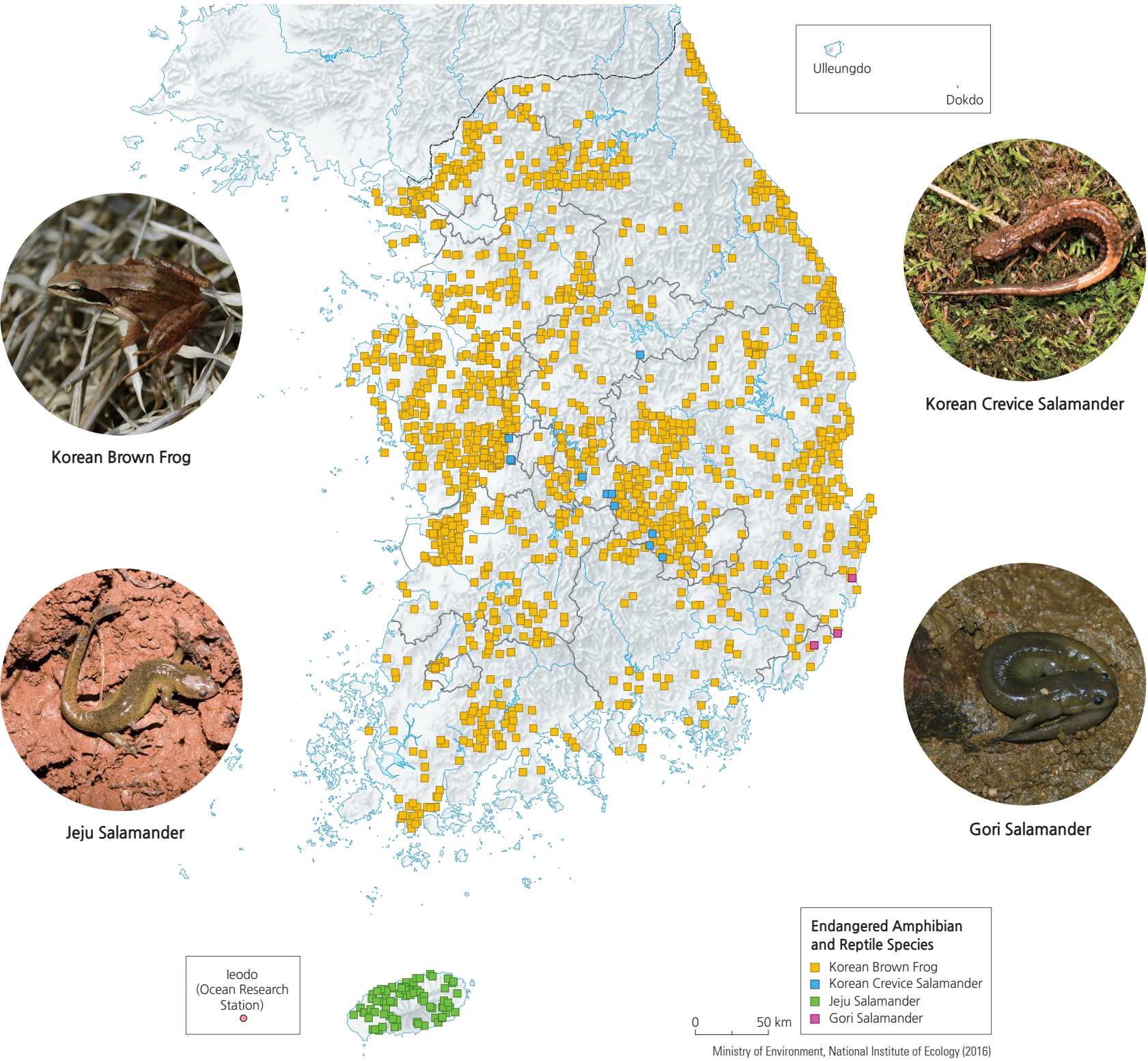


# Mapping Ecology

Although connected to Asia, Korea is ecologically isolated from the continent by the high mountain terrain of Baekdusan and two large rivers that act as barriers to limit the movement of animals. Because of this, Korea has many endemic species—those that are native to a particular geographic area and found nowhere else in the world. Scientists estimate that around ten percent of Korean species are endemic. A number of these are endangered or protected. Globally, amphibians populations have been in sharp decline, partly due to habitat destruction, especially the loss of wetlands.

Amphibians are also very sensitive to environmental pollutants. For this reason they are sometimes used as indicator species. The presence of healthy amphibians is an indicator of a clean environment. An important part of protecting these animals involves maintaining updated maps of their distribution, in order to determine the effects of development, wetland loss, climate change, or pollution. The four amphibians pictured and mapped here are endemic to South Korea.

Distribution of Endangered Amphibian and Reptile Species



In a densely populated country such as Korea, habitat destruction threatens to reduce the area available for many plant and animal species to live. In many places there is a complicated patchwork of developed areas in close proximity to threatened or endangered plant and animal communities.

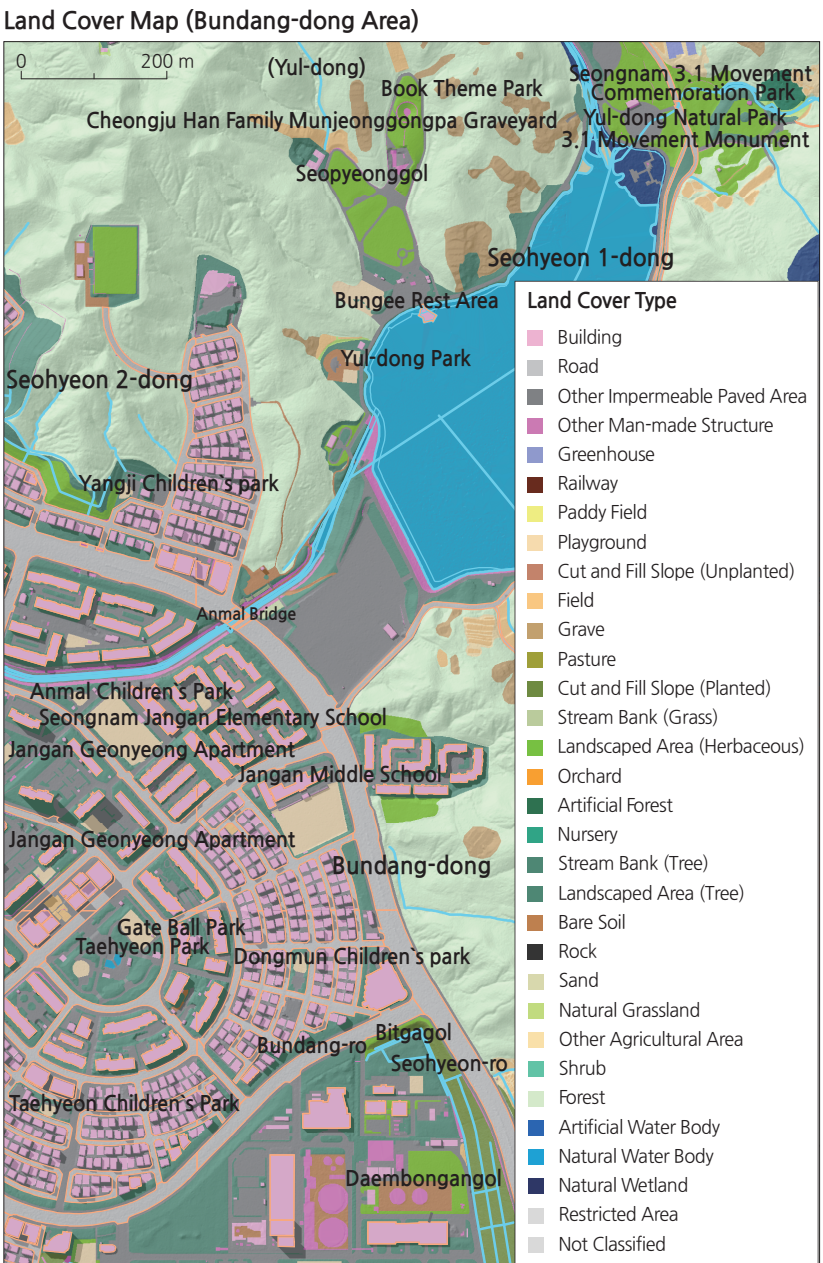
A land cover map, such as the one to the right for a section of Seongnam-si, is sometimes called a biotope map when used for ecological purposes. Such maps are useful for monitoring, planning, or evaluating risks to local wildlife and plants. Biotope maps are used for conservation projects, restoration of natural environments, and developing sustainable urban management plans. Local governments often use these maps for environmental assessment, development permits, and ecosystem management.

Mapping and other forms of geospatial analysis, such as Geographic Information Systems (GIS) area also used to display survey data or to make estimates of animal populations. As an example, the map below can be used to evaluate potential sources of pollution affecting amphibians in a particular watershed.



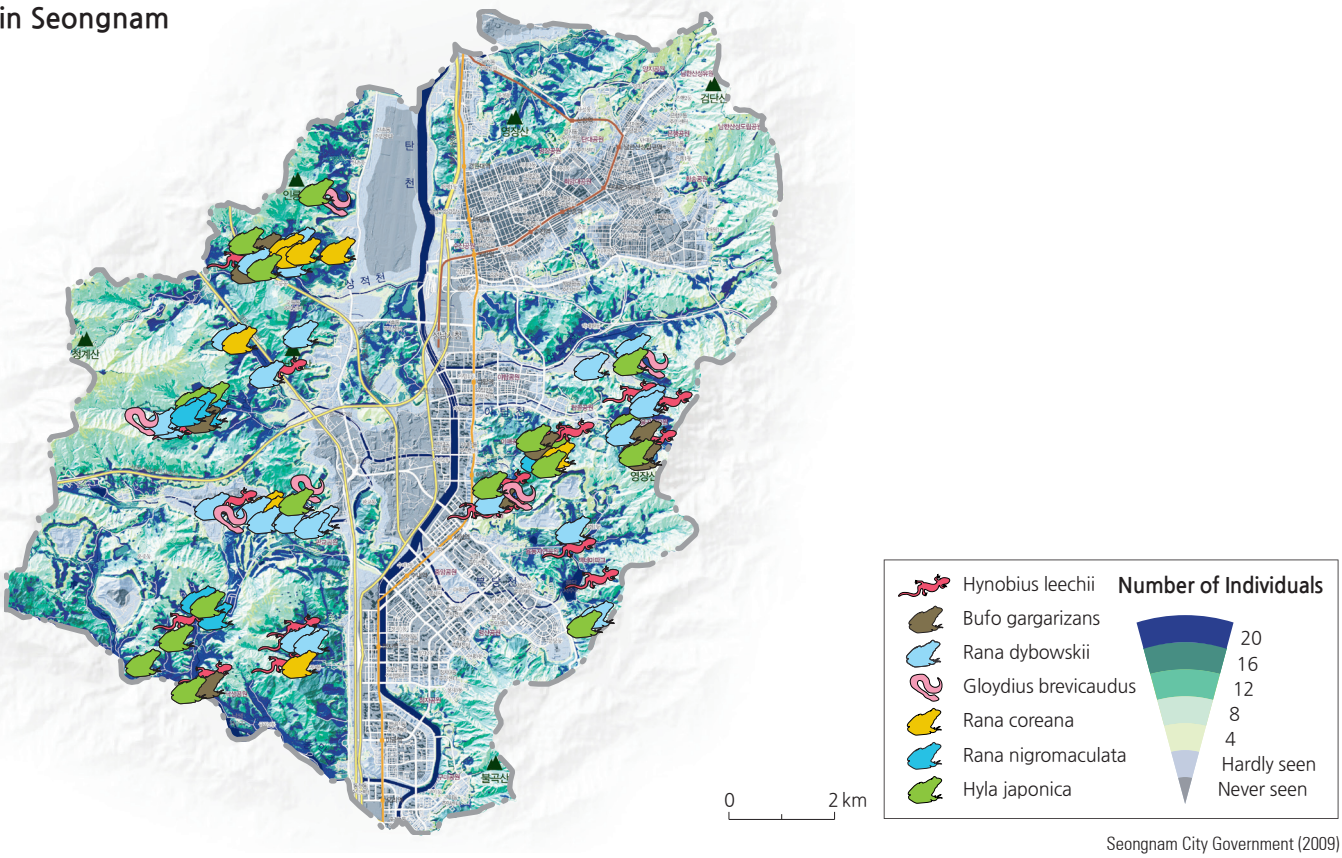
Diverse land cover in the vicinity of Yecheon-gun, Gyeongsangbuk-do

Biotope Map of Seongnam-si (2009)



Land Cover Map (Bundang-dong Area) Seongnam City Government (2009)

Estimates of Amphibian and Reptile Population Densities for a Watershed in Seongnam



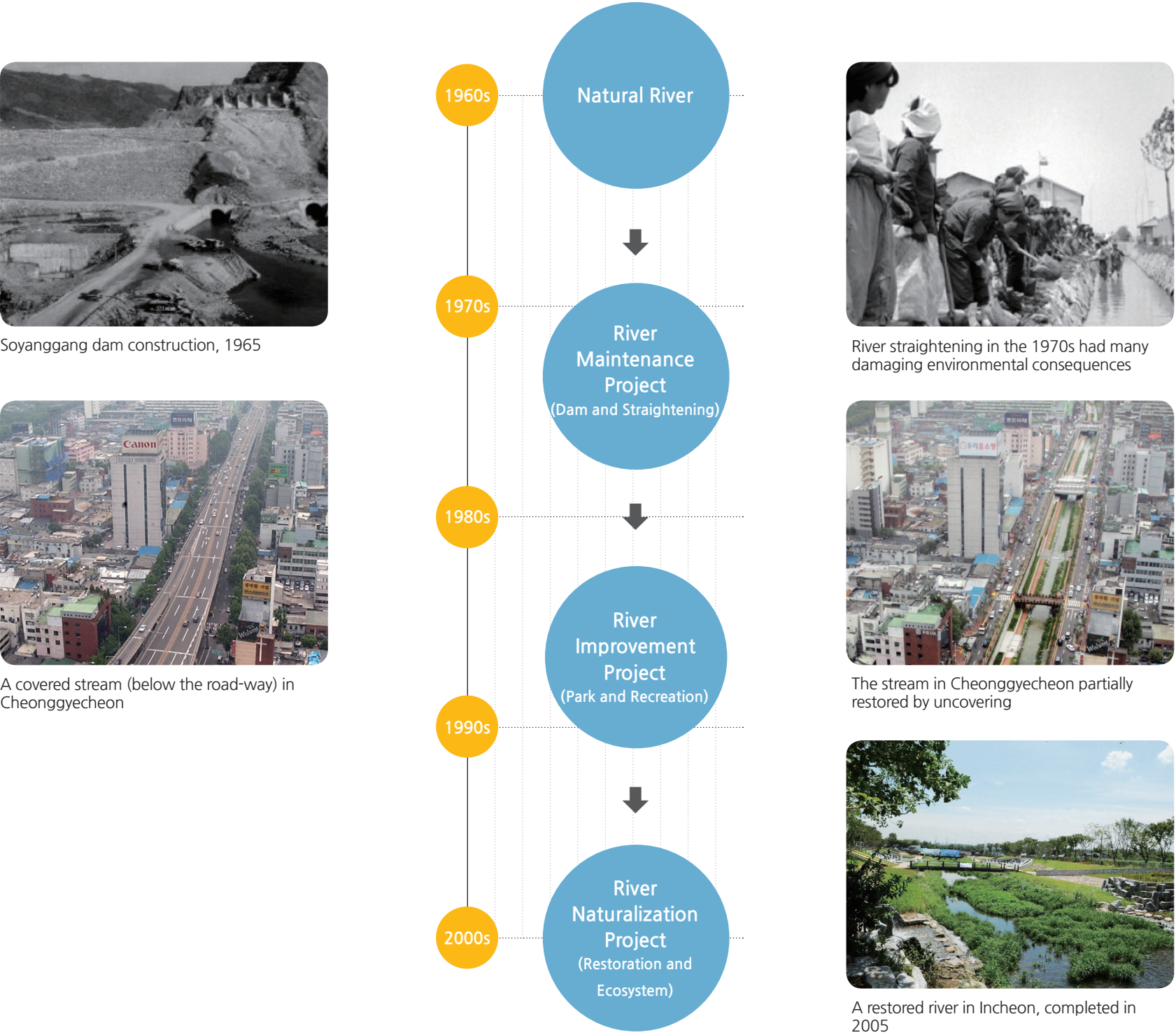


# River Restoration

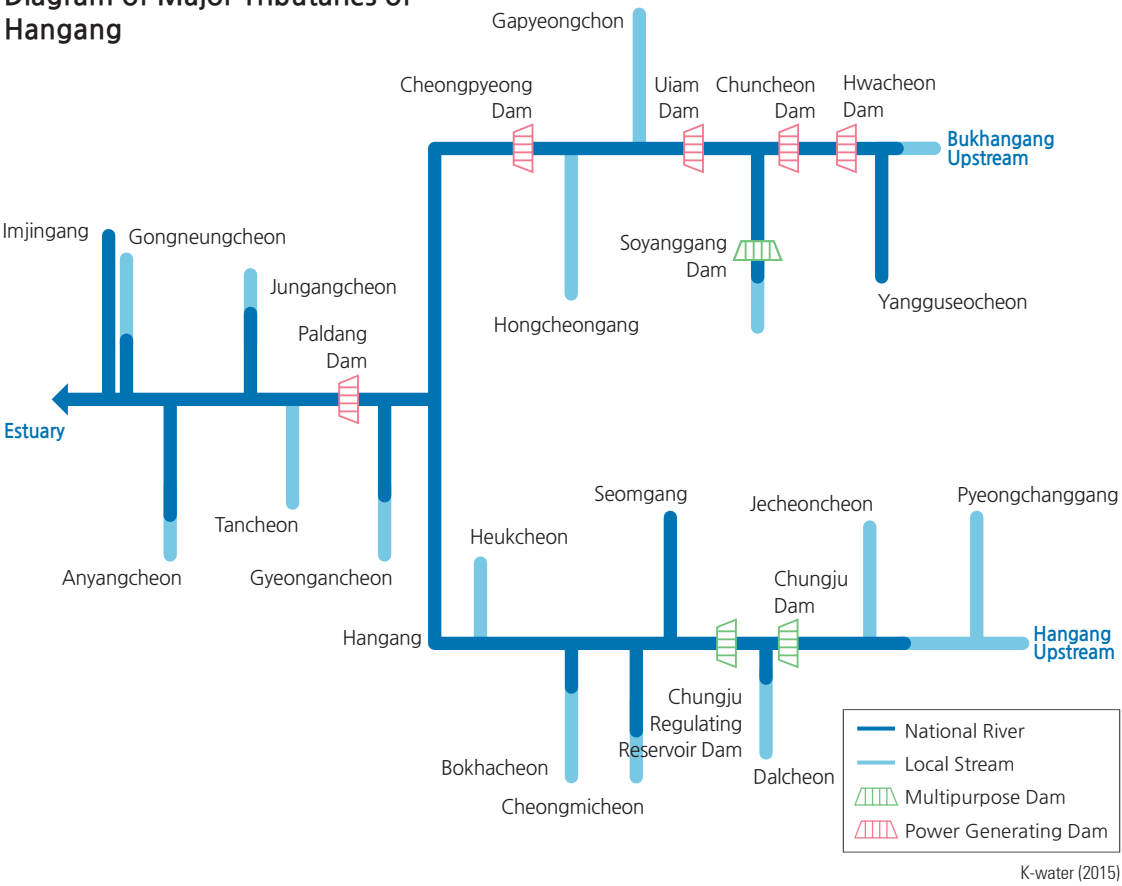
Until the 1960s most rivers in Korea were in their natural form. However, during the rapid urbanization of the 1970s many streams were covered or re-routed. In rural areas many meandering channels were straightened and dams were constructed for irrigation, drinking water, and hydroelectricity. As environmental issues gained light in the 1990s various improvement projects, such as the construction of waterfront parks and promenades, were started in areas around rivers. In the 2000s, people began to recognize the ecological value of rivers and wetlands and projects were started to restore

rivers to their natural form. As an example, the Aquatic Ecosystem Restoration Project developed the Physical River Naturalness Index (PRNI) to help identify streams most critically in need of conservation and restoration. Stream classifications range from badly damaged to natural. Stream restoration efforts improve water quality, decrease flooding hazards, and improve habitat for aquatic animals such as fish. Fish habitat maps are useful for monitoring fish populations and identifying potential threats.

## River Management Policy



## Diagram of Major Tributaries of Hangang

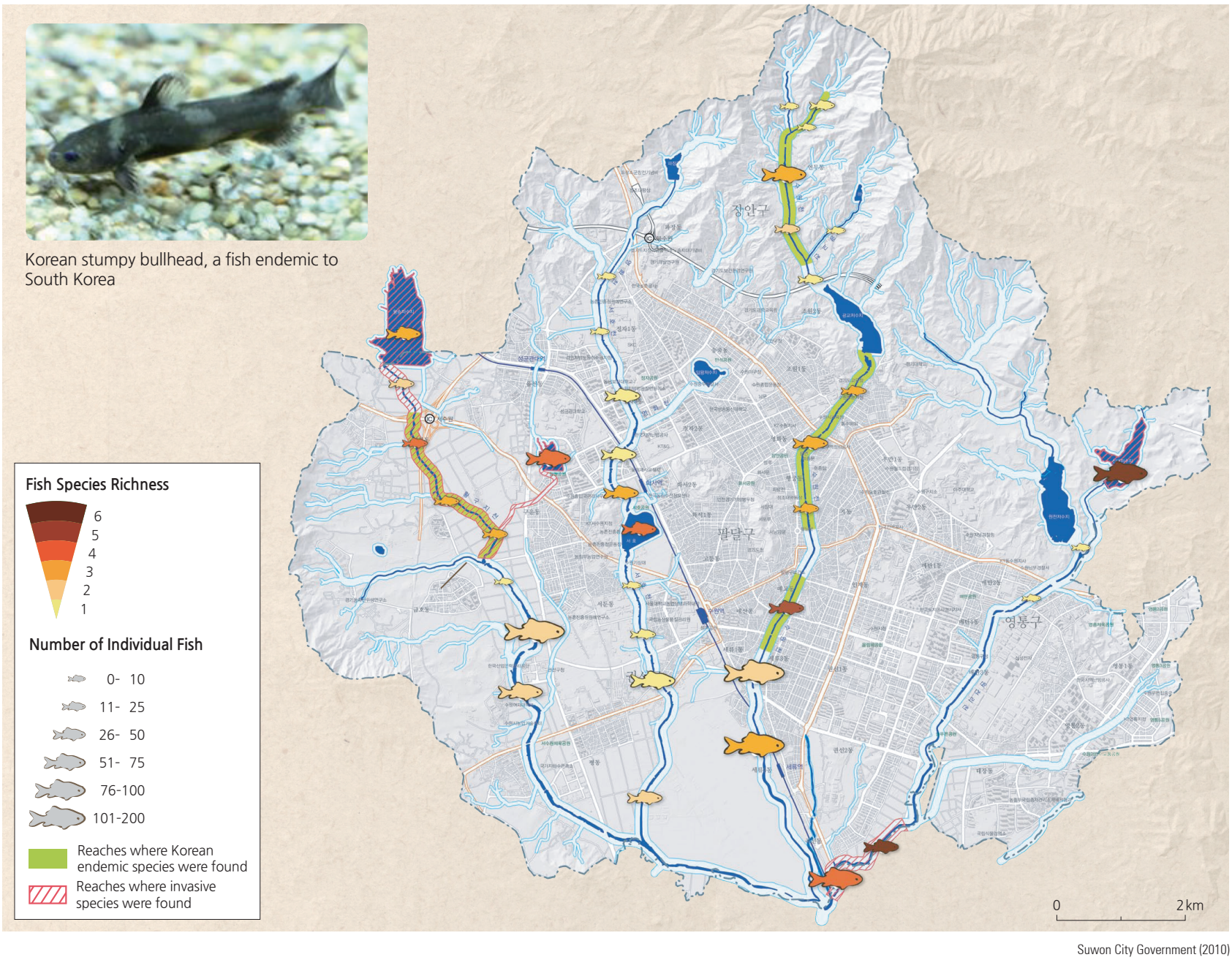


## Characteristics of PRNI Classes

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)

## Fish Habitat Map



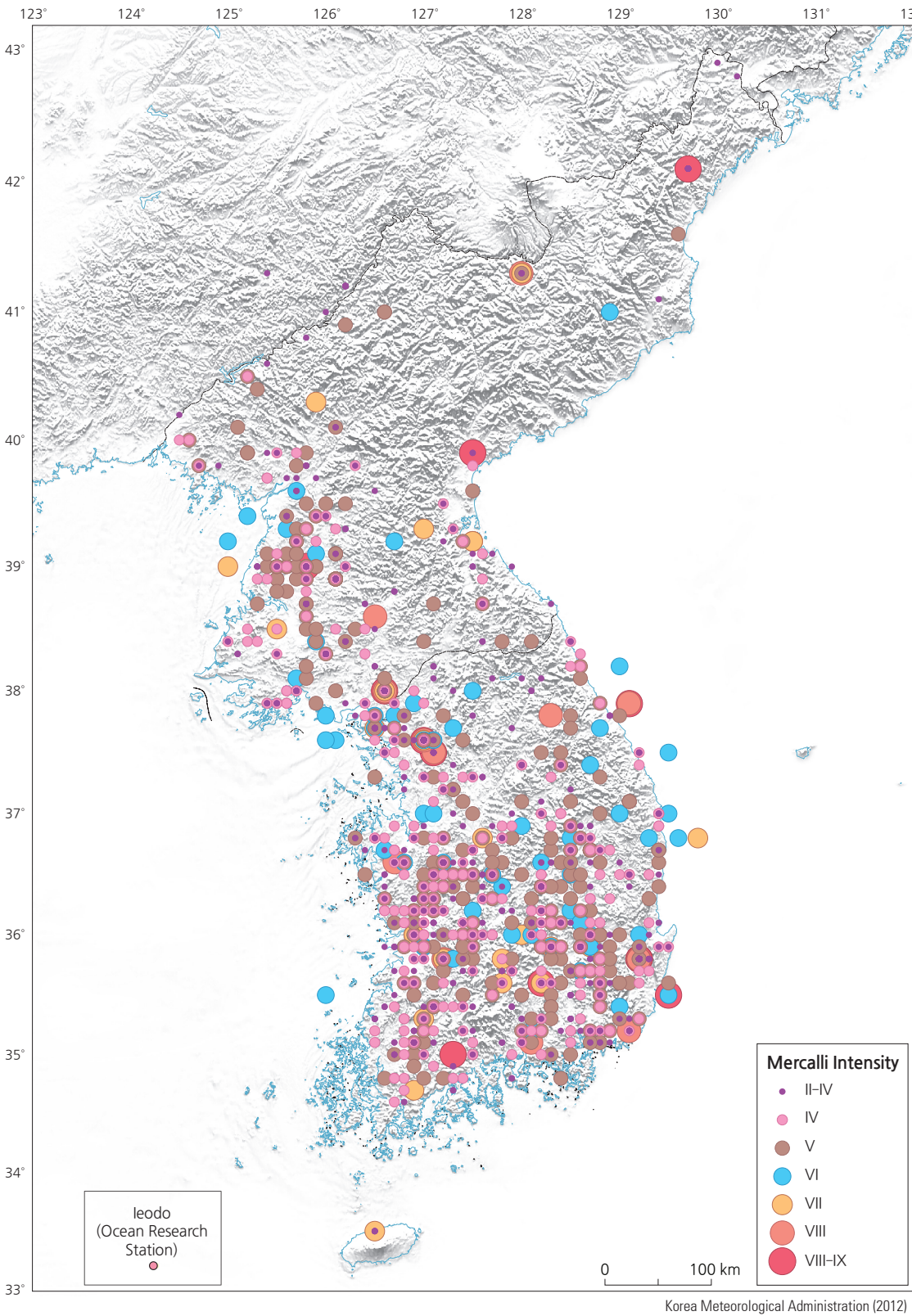




# Natural Hazards: Earthquakes and Typhoons

Although the Korean Peninsula does not lie directly along a tectonic plate boundary, as does Japan, nevertheless earthquakes can occur in Korea. There are historical records of strong earthquakes in the past that resulted in casualties and damage to structures. For example, during the reign of King Injo, in 1643, a strong earthquake collapsed castle walls in the Ulsan area and caused a tsunami.

### Historical Earthquakes on the Korean Peninsula



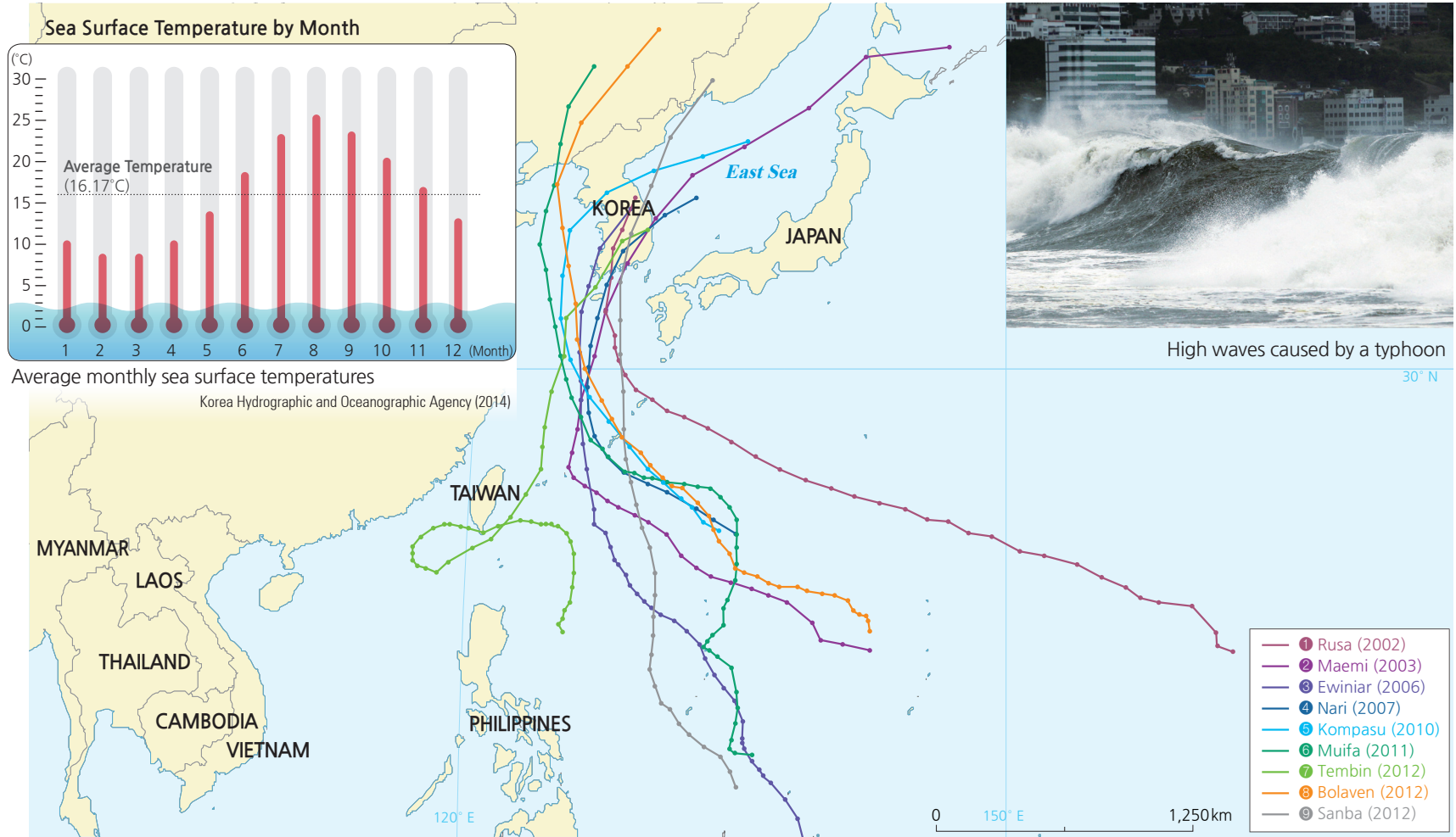
The Korean Meteorological Association and the Korean Institute of Geology and Mining operate 180 stations that monitor seismic activity. The map below shows recent earthquakes with the magnitude (strength) shown by the size and color of circles. In recent times, the strongest earthquake on record occurred in 2016 near Gyeongju, with a magnitude of 5.8 on the Richter scale (see chart).

A typhoon is a type of tropical cyclone that originates in the western part of the North Pacific Ocean when sea surface temperatures are high, typically during the late summer and early autumn months. Typhoons have high wind speeds over 17 meters per second and bring with them storm surge, large waves, and heavy rains. The Korean peninsula lies in their normal path and so is at risk for severe damage from typhoons. Over the past 30 years, the worst natural disaster to hit Korea was Typhoon Rusa, in 2002, whose damage cost more than 6 trillion won.

The government has responded by investing heavily in preventative measures and spreading awareness of the hazards. In addition, forecasting technologies have improved over the years, which has played a role in preparing and mitigating damage from typhoons. As a result, the number of casualties and injuries has been decreasing in recent decades. One complicating factor that makes typhoons more threatening along the coast is that sea levels are rising. Monitoring stations along the coast indicate sea level is rising at a rate of up to about half a centimeter per year. Thus the coastal flooding associated with typhoons might be expected to worsen over the next several decades.

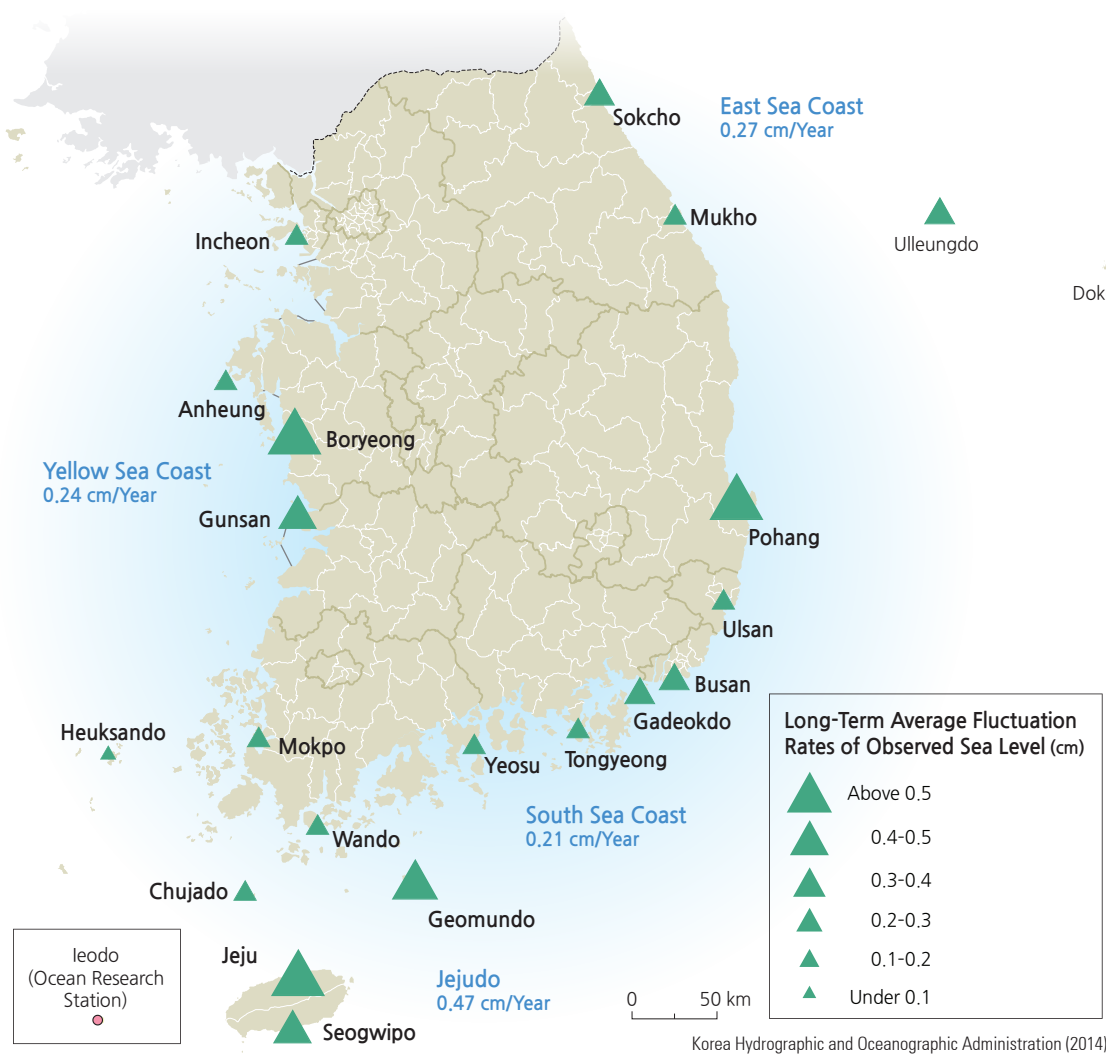
Richter Magni-tude	Modi-fied Mercalli Scale	Expected Damage in Populated Area
1.0 - 3.0	I	Not felt except by a very few under especially favorable conditions.
3.0 - 3.9	II, III	Felt only by a few persons (II). Felt quite noticeably by persons indoors (III).
4.0 - 4.9	VI, V	Felt indoors by many and felt outdoors by few. Dishes, windows, doors disturbed (IV), Felt by nearly everyone. Some dishes, windows broken (V).
5.0 - 5.9	VI, VII	Slight damage (VI), Considerable damage in poorly built or badly designed structure (VII).
6.0 - 6.9	VII, IX	Considerable damage in poorly built or badly designed structures (VII), Considerable damage in ordinary substantial buildings with partial collapse (VIII).
7.0 -	VIII or Higher	Considerable damage in ordinary substantial buildings with partial collapse (VIII). Most masonry and frame structures destroyed (X). Damage total (XI).

### Routes of Typhoons (Special Disaster Zones Declared)



High waves caused by a typhoon

### Long-Term Average Fluctuation Rates of Observed Sea Level



Typhoon damage



A traditional roof designed to withstand the high winds of Jeju Island. The straw roof is tied down and pitched at a low, curved angle.





# Natural Hazards: Rain and Snow Storms

During the rainy season, especially in summer, Korea can experience heavy rains that sometimes exceed 300 mm per day. The resulting floods can cause damage to buildings, crop fields, roads, and other infrastructure. Meteorological forecasts help predict heavy rains and special advisories or warnings are issued to help people prepare. Korea has a long history of meteorological record keeping and developed an early rainfall gauge around 1440

A.D. Today Korea has a network of precipitation and water level gauging stations in streams across the country that measure and record conditions every ten minutes. A flood control system with a total of 46 flood control offices is spread nationwide. These offices help prevent floods by holding and shifting waters in response to changing river levels.

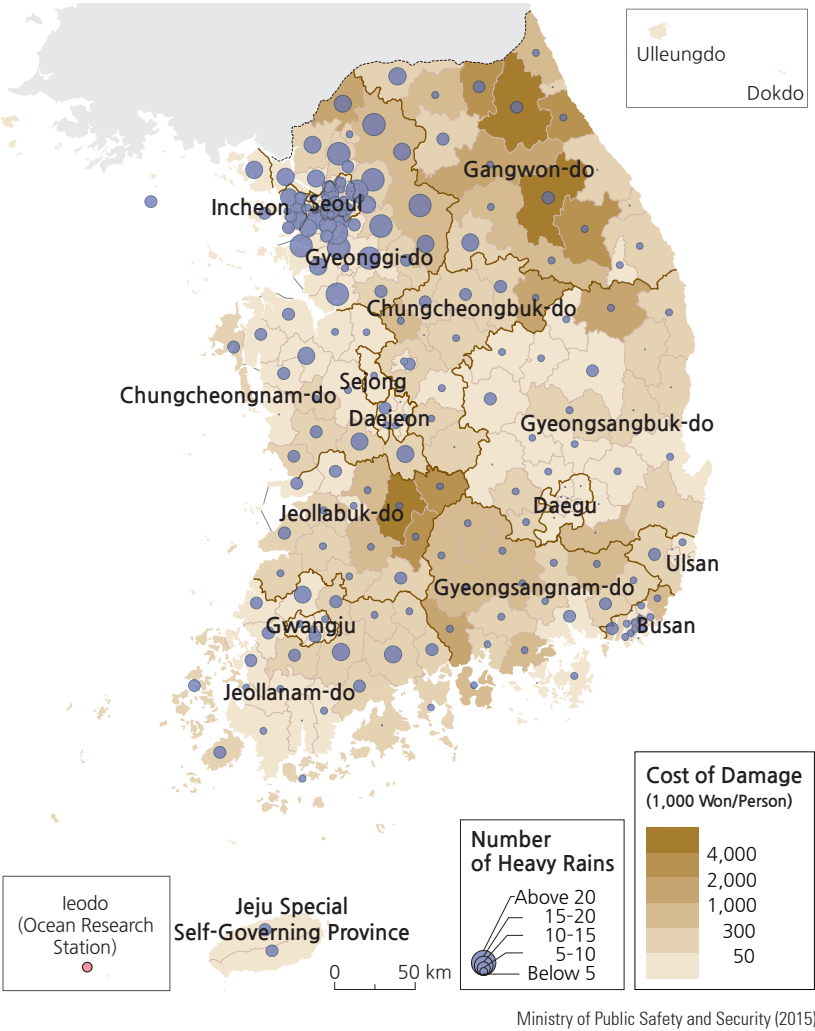


Representative Picture of Heavy Rain



Representative Picture of Flood

## Heavy Rain Occurrences and Cost of Damage per Person (2005-2014)

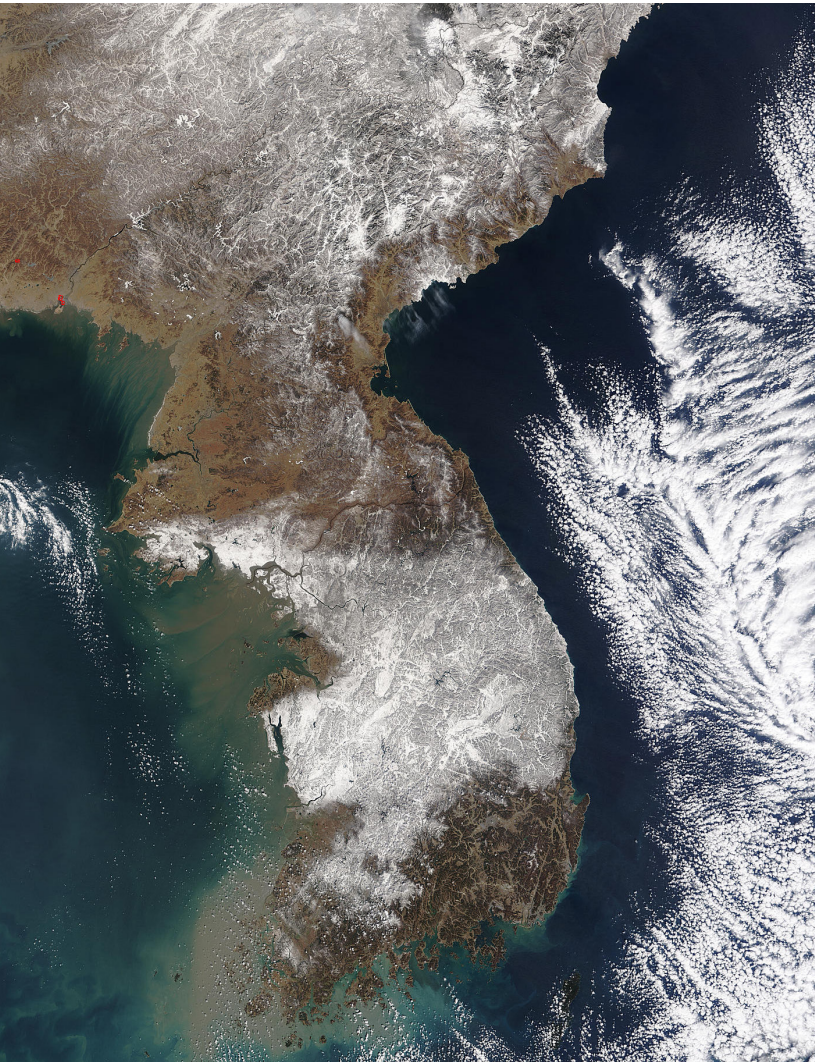
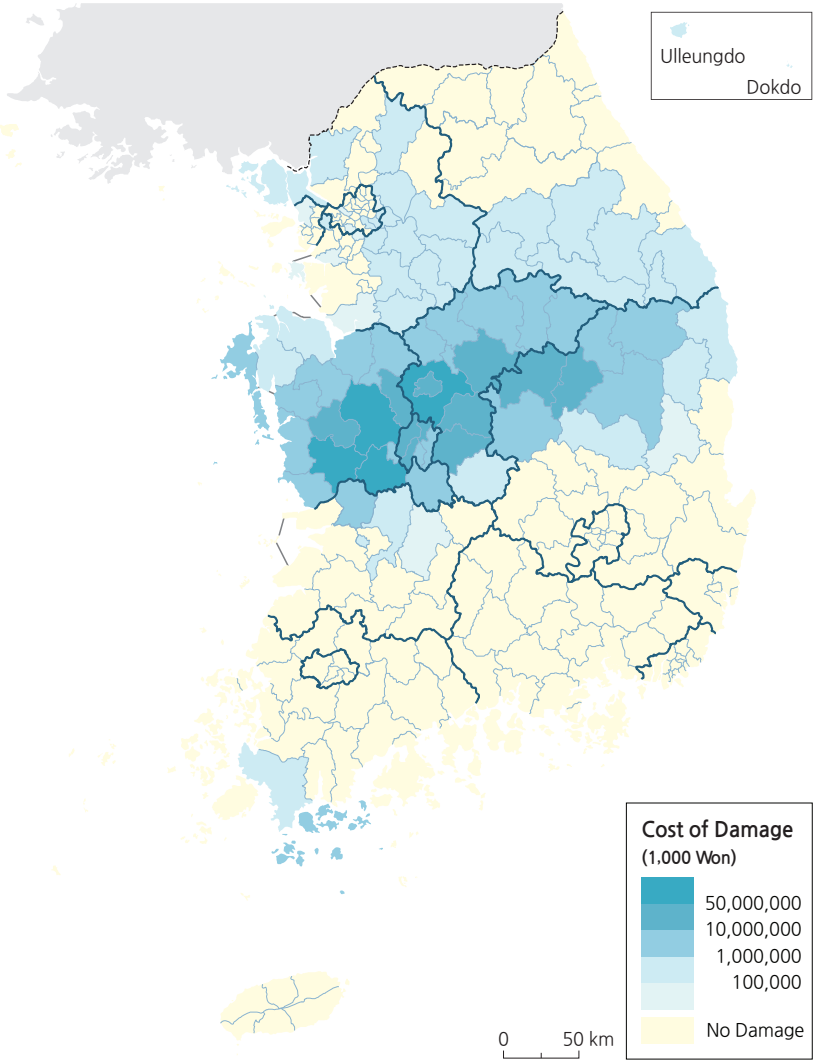


A rainfall gauge developed around 1440 in the Joseon Dynasty.



In frequently flooded areas houses are often built on top of raised foundations

## Cost of Damage from Heavy Snow in March 2004



Winter conditions in Korea can sometimes be favorable for heavy snowfalls. This can result in buildings being damaged, roads becoming inaccessible, and businesses temporarily closing. The Korea Meteorological Administration issues advisories and warnings in advance of heavy snowfalls. The satellite image above was taken after a heavy snowfall in March 2004. Cold winds

blowing from China picked up moisture from the warmer Yellow Sea, dumping thick snow across Korea. The white area across the middle of the Korean Peninsula is snow cover. White areas over the East Sea are clouds. The government declared special disaster zones for areas damaged during this storm.



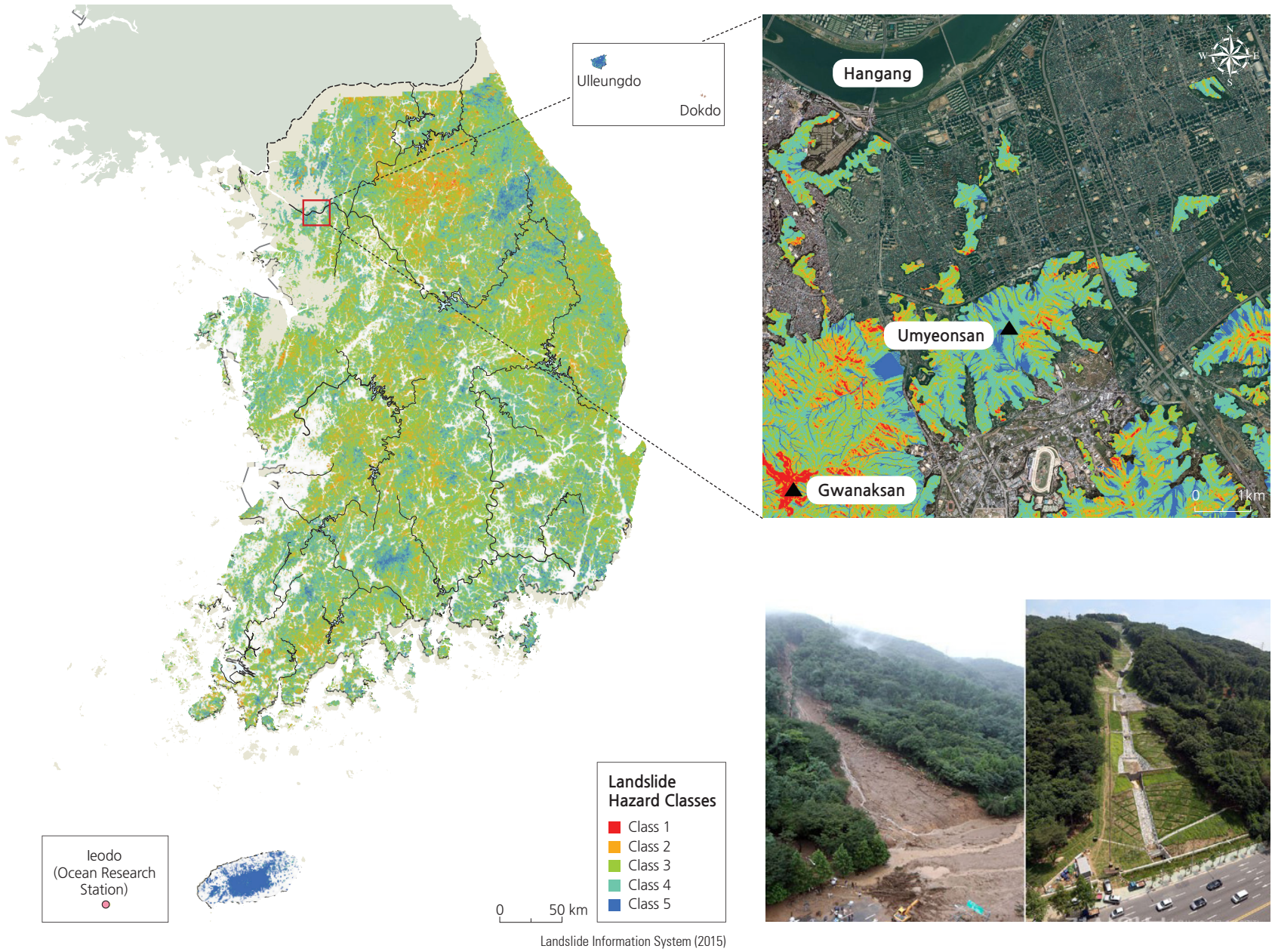
Street scene with heavy snow





# Soil Erosion and Landslides

Landslide Hazard Map



In mountainous regions with slope angles of over 30 degrees, landslides can be triggered by heavy rains, and less-commonly by earthquakes, volcanic eruptions, and even thunder. It can be very hard to predict landslides because they most often occur when heavy rains saturate the soil in a short period of time. Landslides generally cause less total damage to property than floods, because they have a more limited extent, but they can cause more casualties.

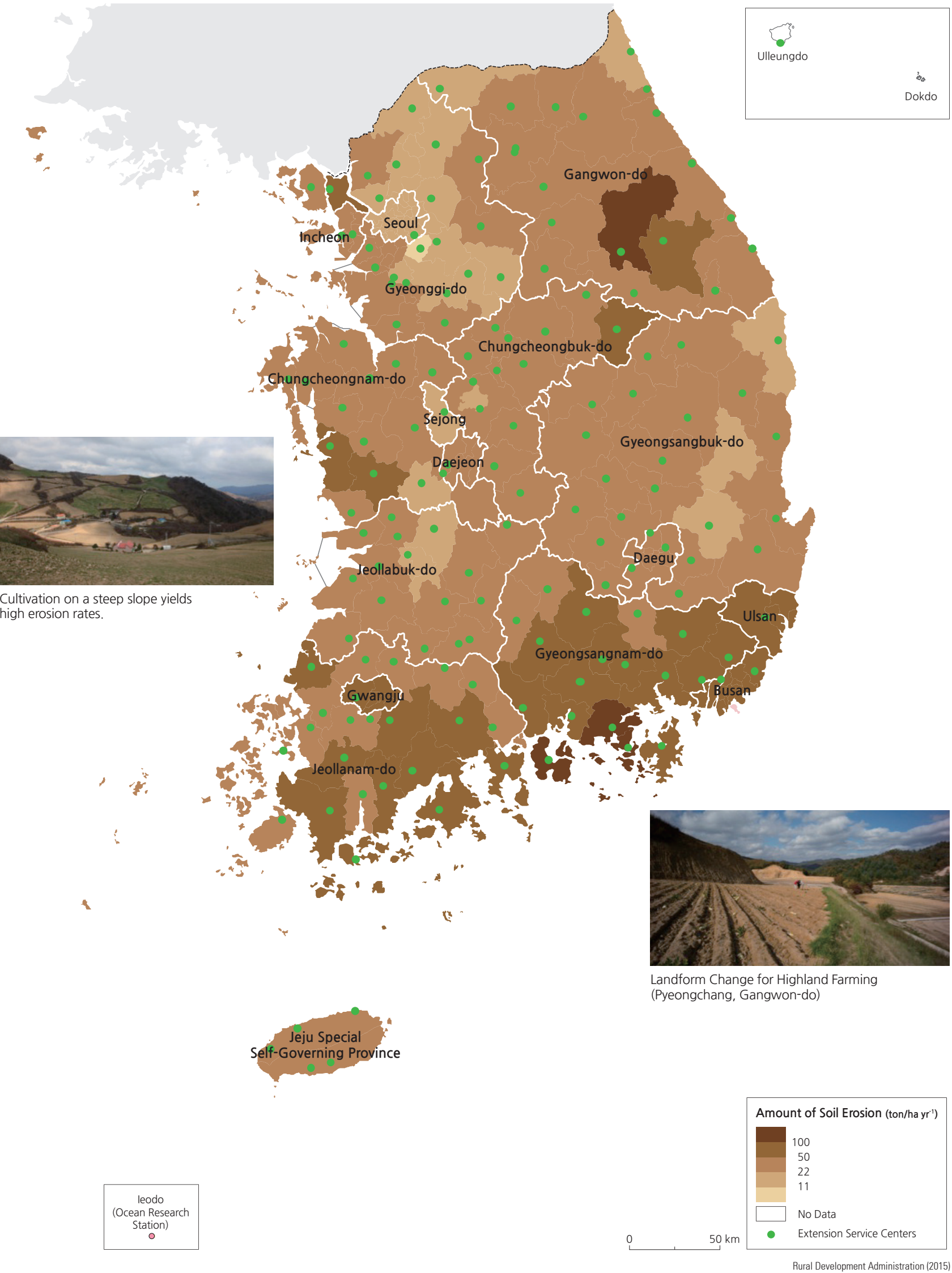
A landslide hazard map is used to better anticipate landslides. Five risk classes are determined based on internal and external triggering factors for landslides. Detailed risk maps are useful tools for planning development and emergency response. The photos above show a landslide which caused 67 casualties in the Umyeonsan area in July 2011. The image at right shows the area after it has been repaired and stabilized following the landslide.

A less dramatic but still costly problem is that of soil erosion.

Currently the annual net loss of soil is estimated to be more than 50 million tons, mostly removed from agricultural lands. The total loss is about 37.7 tons per hectare on average from farm fields, about ten times the loss rate from forests. Recent expansion of farms to highland areas has added to the rapid soil loss. Eroded soil eventually flows into nearby streams, impairing water quality and causing difficulties for aquatic organisms.

As with landslides, the risk of soil erosion is greater in areas that receive more intense rainfall and which have steeper slopes. Crop management practices also greatly influence erosion risks. To combat soil erosion, Korea has established agricultural technology centers across the country to encourage proper soil management practices. They develop and disseminate new crop breeds, educate about proper cultivation, and evaluate and treat soils for enhanced productivity.

Risk of Soil Erosion (Farm Soils)







# World’s Largest Land Reclamation Project

In a densely populated country like Korea, land is very valuable. Many efforts have been made over the years to “reclaim” land from the sea. Dikes and other protective embankments are placed in shallow areas off the coast to reduce tidal and wave erosion and enable sediment to be deposited in estuaries and along the coastline. This allows large areas of once-shallow seas to be turned in to agricultural lands and building sites. The largest land reclamation project in Korea, and indeed in the world, is the Saemangeum Reclamation Project, which began in 1991 and was completed in 2006. The total length of the embankment is 33.9 km. 28,300 hectares of land and 11,800 hectares of lake were created from the project.



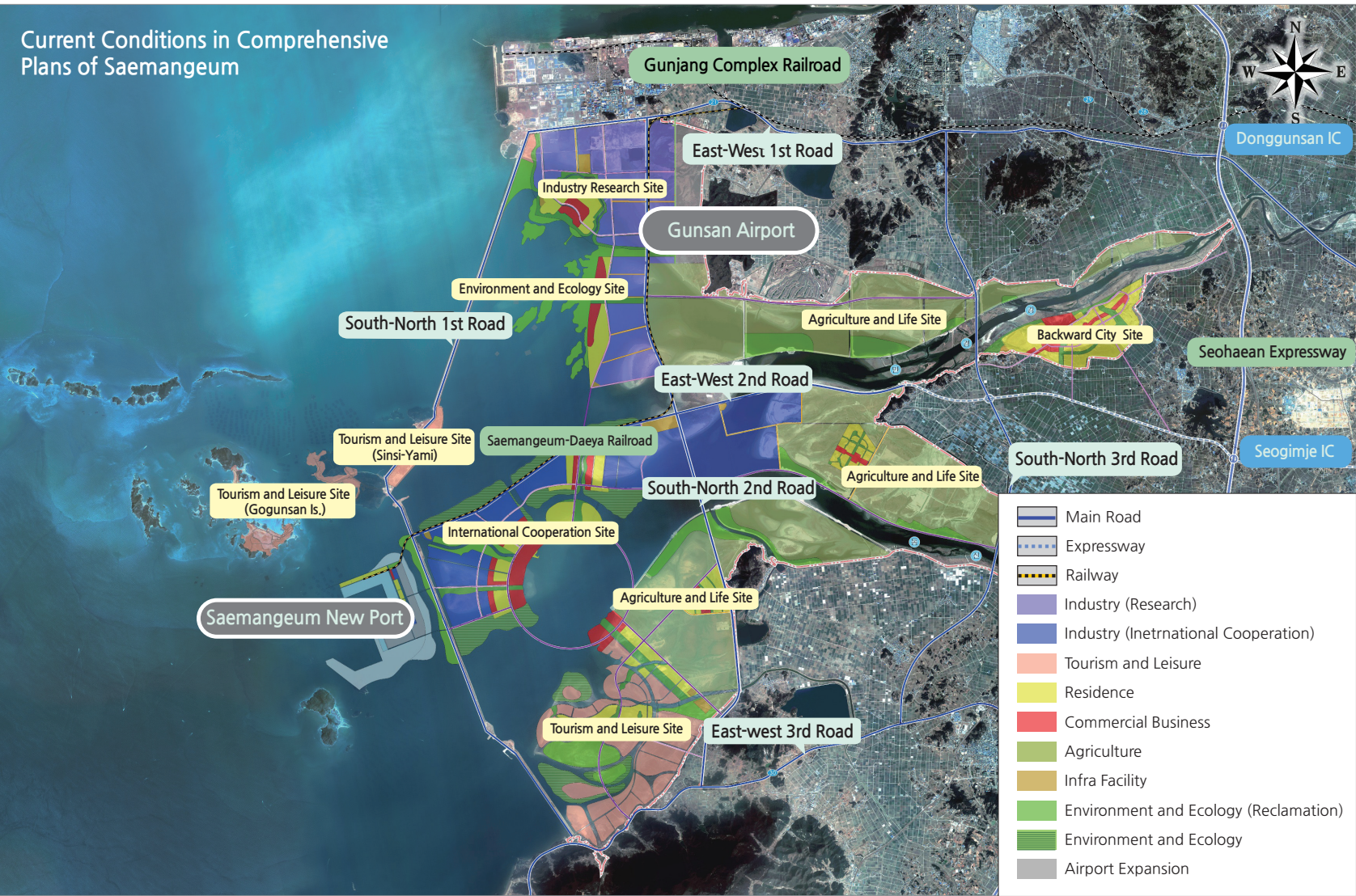
The images here show how the area has changed as a result of the project from 1990 to 2015. Current plans are for six types of land to be developed: industrial/research, international cooperation, tourism/leisure, agricultural, urban, and nature/ecosystem. The Saemangeum project is expected to help the local economy by extending its land, creating rich agricultural space, securing water resources, and creating a tourism district. Some problems have arisen during the development process, including damage to mud flats and water pollution. Restoring coastal ecosystems is an essential task in order to maintain ecological integrity of the shores and to promote further economic sustainability.



Satellite Images of Saemangeum Reclaimed Land (2015)



U.S. Geological Survey (USGS)



Saemangeum Development and Investment Agency (2014)





## Energy Challenges

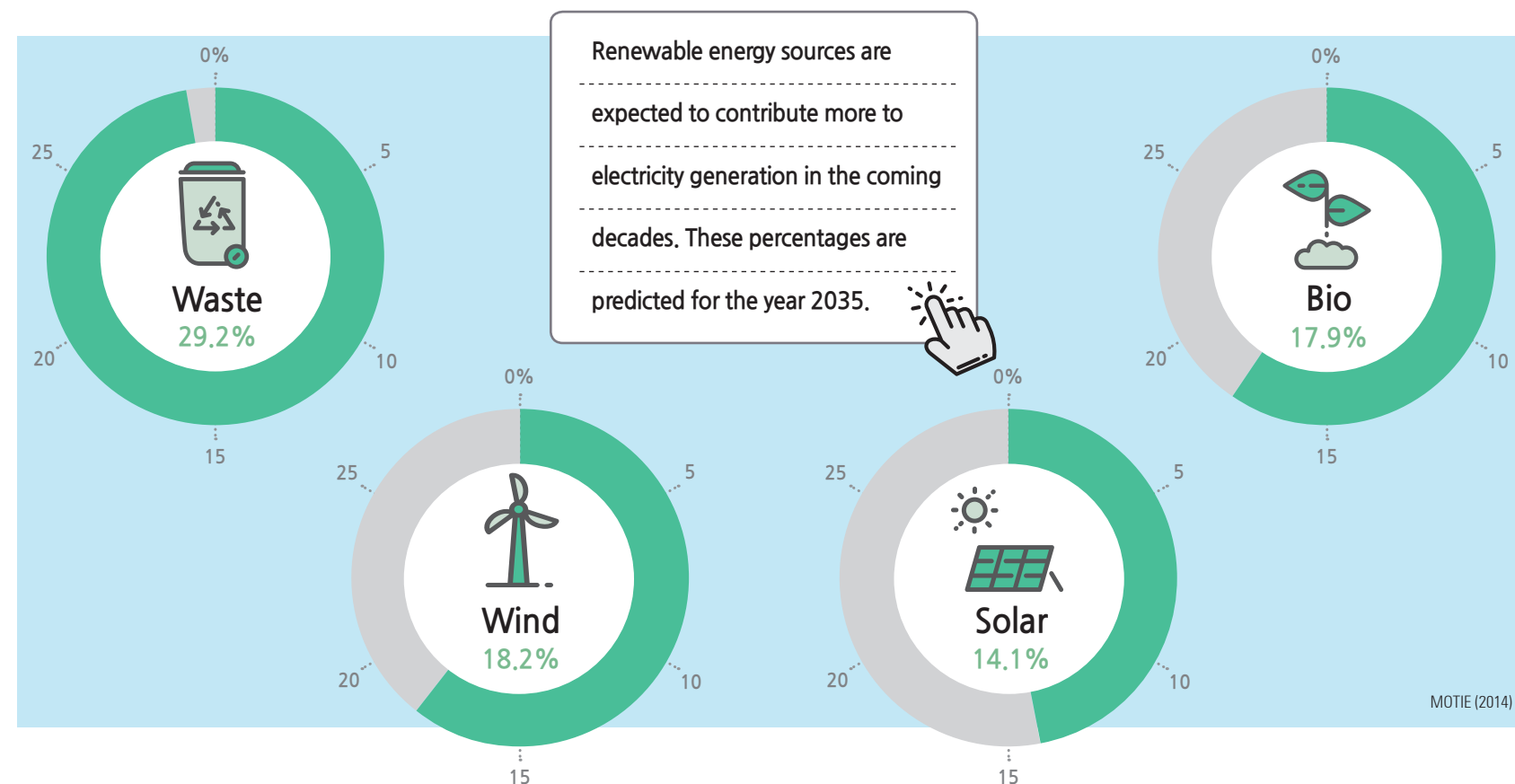


A wind farm for generating electricity in the Baekdudaegan Mountain Range

To power its diverse economy Korea relies on energy generation from a variety of sources. Transportation generally relies on petroleum products, such as gasoline and diesel, for an energy source. Commercial and industrial buildings, as well as residences and institutional buildings, such as schools, largely depend on electricity for their energy. Thermal sources of electricity are the result of combustion (burning) of a fuel that heats water to run steam generators. Examples include coal liquefied natural gas (LNG). Coal combustion has some environmental problems and puts some pollutants into the air. LNG burns more cleanly, but there are also environmental problems associated with the collection of natural gas. These thermal power sources, fairly evenly distributed across the country, add carbon dioxide to the atmosphere. Korea has 23 nuclear power plants concentrated in three areas:

Busan, Gyeongsangbuk-do, and Jeollanam-do. Nuclear power has no pollution emission, but it does generate nuclear waste and there are some risks associated with nuclear power generation. Even water power requires damming of streams with the associated environmental problems. In 2013, the energy sector accounted for the largest portion of greenhouse gas emissions in Korea, estimated at 606.2 million tons of carbon dioxide. The Korean government established the Greenhouse Gas Inventory and Research Center of Korea (GIR) which conducts monitoring and research on greenhouse gas emissions. Because of the environmental effects of more traditional sources of power, many industrialized nations are shifting to new recycled waste, such as solar and wind power.

### Major New Renewable Energy Sources in 2035



### Energy Supply (2013)

