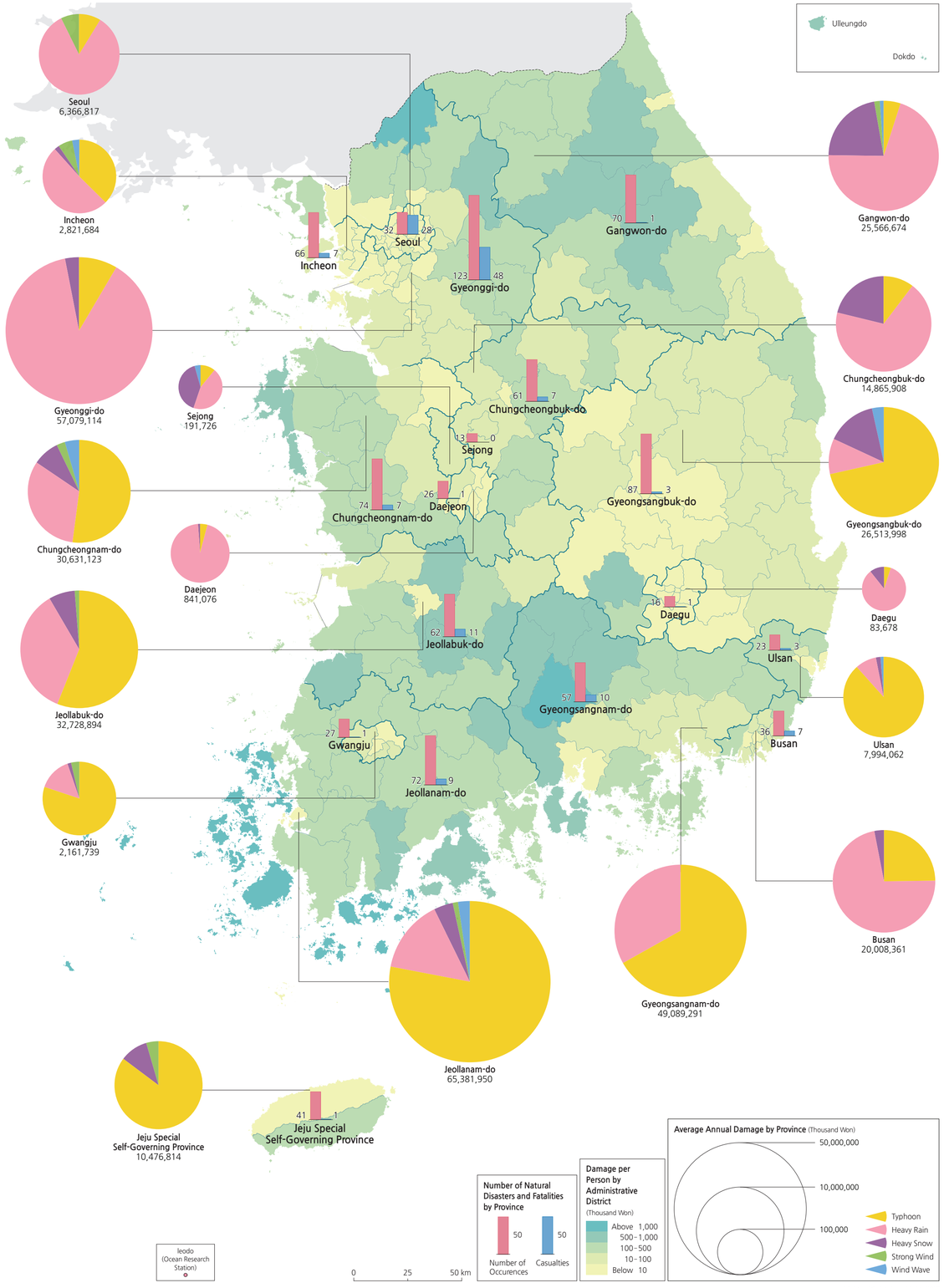
Natural disasters threaten human safety, and their magnitude has caused unprecedented damage in recent years. The severity and frequency of natural disasters are increasing while the summers are getting warmer and the winters are getting colder due to the effects of global warming. Korea is frequently hit by heat waves, heavy rains, and typhoons in the summer, and heavy snows are frequent in the winter. These events often bring detrimental effects to Korea. The most critical natural disasters in Korea are typhoons and heavy rains. An increase in heavy rains and snowfall has been observed since 1991, and this increase has been especially remarkable since the early 2000s. Damage from heavy snow has also risen due to its increasing frequency.

In Korea, the impact of natural disasters varies and is much more severe for certain typhoons and heavy rains. In 1987, more than 1,000 people were killed or missing due to Typhoon Thelma. In 1988, Typhoon Yanni struck the Homan region and the subsequent flooding killed 384 people, with an additional 307 missing. A huge number of victims suffered from floods and typhoons from 1984 to 1990. There were over 360,000 flood victims around the Seoul and Gyeonggi-do area in 1984. The incredibly disastrous flood that occurred in 1990 left more than 200,000 victims and one trillion-won worth of damage. During the past 30 years, the most adverse natural disaster in Korea was Typhoon Rusa in 2002, whose damage cost the nation more than 8 trillion won. In 2003, Typhoon Maemi caused a loss of more than 6 trillion won. In 2006, Typhoon Ewiniar inflicted economic losses totaling more than 2 trillion won. Since then, natural disasters have inflicted less serious damage, causing 141.3 billion won of property damage in 2018.

Damage caused by natural disasters has been slightly increasing since 2000. Heavy rains and typhoons have intensified as a result of global warming, and inflation has led to increases in the cost of living. However, the number of casualties, disappearances, and victims has been gradually decreasing as people are more aware of natural disasters than in the past. Also, the government has invested heavily in preventing damage and health hazards from natural disasters. In addition, forecasting technologies have improved over the years, which has played a greater role in preparing for and mitigating the damages from natural disasters.

Natural Disasters

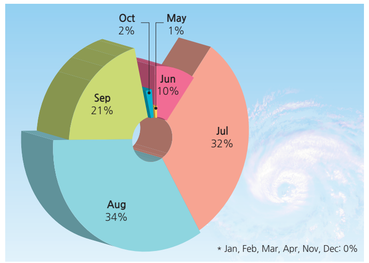
Damage Caused by Natural Disasters (2009–2018)



Ministry of the Interior and Safety (2018)

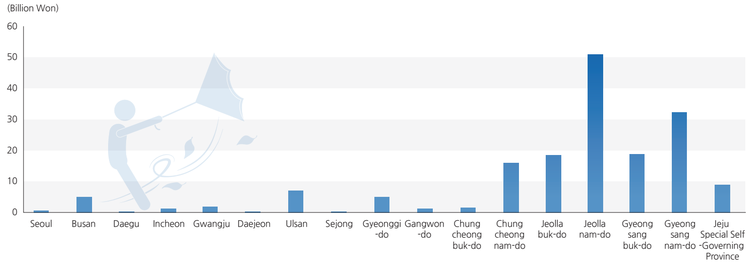
Storm and Flood

Monthly Occurrence of Typhoons in Korea (1951–2019)



Korea Meteorological Administration (2019)

Average Annual Damage Caused by Typhoons (2009–2018)



Korea Meteorological Administration (2018)

Routes of Typhoons (Special Disaster Zones Declared) (2010–2018)

Korea Meteorological Administration (2018)

Typhoons occur when the wind speed exceeds 17 m/s, accompanied by heavy rain. A typhoon is a type of tropical cyclone that originates in the western part of the North Pacific Ocean. Typhoons vary in size; small typhoons are measured as 200 km in diameter, while large typhoons span over 1,500 km.

Since 1995, Special Disaster Zones have been designated 17 times. Among them, 11 were due to typhoons, including Rusa (September 16, 2002), Maemi (September 22, 2003), Ewiniar (July 18 and August 10, 2006), Nari (September 20 and October 8, 2007), Kompasu (September 16, 2010), Muifa (August 19 and September 2, 2011), Tembin and Bolaven (September 3, 4, 5, and 13, 2012), Sanba (September 26, 2012), Chaba (October 10 and 17, 2016), and Soulik (September 26, 2018).

Damage Caused by Typhoons (Special Disaster Zones Declared)

Period of Occurrence, Fatalities, and Damaged Property of Sanba

Sanba	
Typhoon Number	2012-16
Period of Occurrence	2012.09.11–2012.09.18
Period of Damage	2012.09.14–2012.09.17
Victims	3,843
Deaths and Missing Persons	2
Converted Damages Based on 2018 (1,000 Won)	355,951,350
Damages Based on that Year (1,000 Won)	365,715,966

Period of Occurrence, Fatalities, and Damaged Property of Chaba

Chaba	
Typhoon Number	2016-18
Period of Occurrence	2016.09.28.–2016.10.06.
Period of Damage	2016.10.03.–2016.10.06.
Victims	6,714
Deaths and Missing Persons	6
Converted Damages Based on 2018 (1,000 Won)	226,302,699
Damages Based on that Year (1,000 Won)	214,464,271

The Ministry of the Interior and Safety (2016)

Period of Occurrence, Fatalities, and Damaged Property of Soulik

Soulik	
Typhoon Number	2018-19
Period of Occurrence	2018.08.22.–2018.08.25.
Period of Damage	2018.08.22.–2018.08.25.
Victims	39
Deaths and Missing Persons	-
Converted Damages Based on 2018 (1,000 Won)	9,250,951
Damages Based on that Year (1,000 Won)	9,250,951

The Ministry of the Interior and Safety (2018)

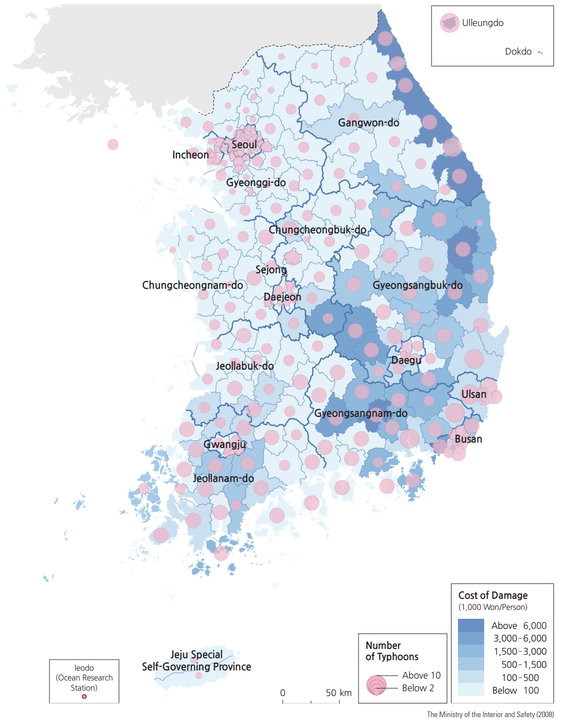
Period of Occurrence, Fatalities, and Damaged Property of Kongrey

Kongrey	
Typhoon Number	2018-25
Period of Occurrence	2018.10.04.–2018.10.07.
Period of Damage	2018.10.04.–2018.10.07.
Victims	2,381
Deaths and Missing Persons	2
Converted Damages Based on 2018 (1,000 Won)	54,948,620
Damages Based on that Year (1,000 Won)	54,948,620

The Ministry of the Interior and Safety (2018)

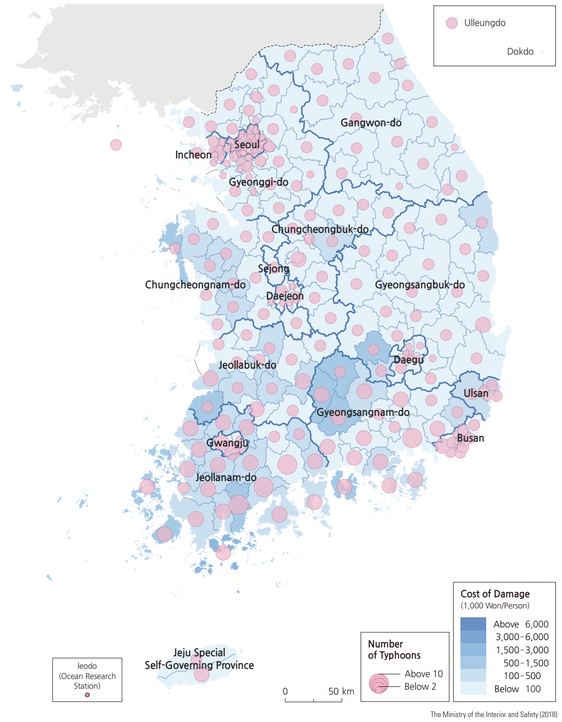
Typhoon Occurrences and Cost of Damage per Person

1999–2008



The Ministry of the Interior and Safety (2008)

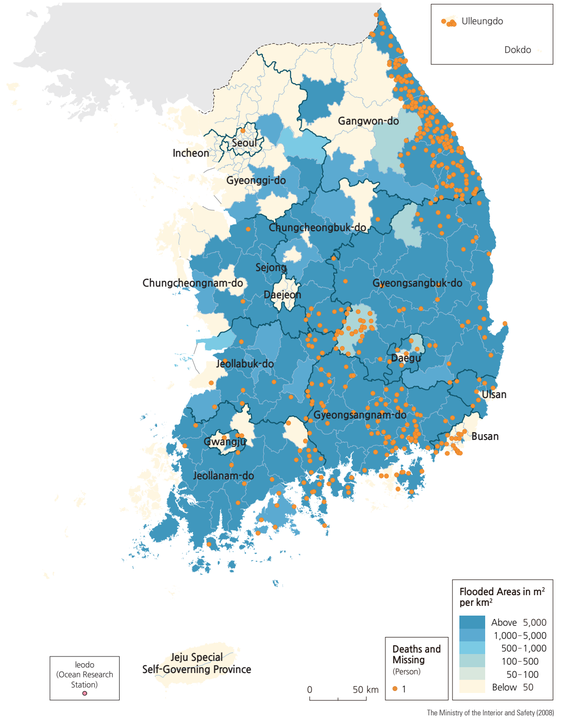
2009–2018



The Ministry of the Interior and Safety (2018)

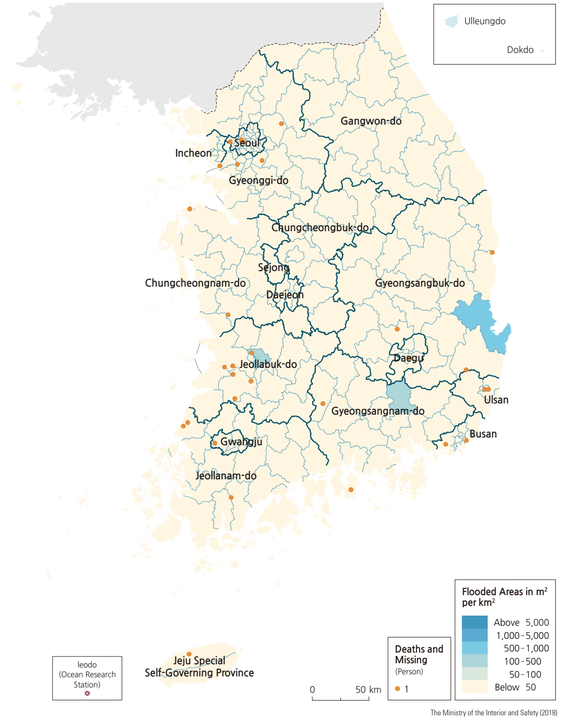
Casualties and Flooded Areas Caused by Typhoons

1999–2008



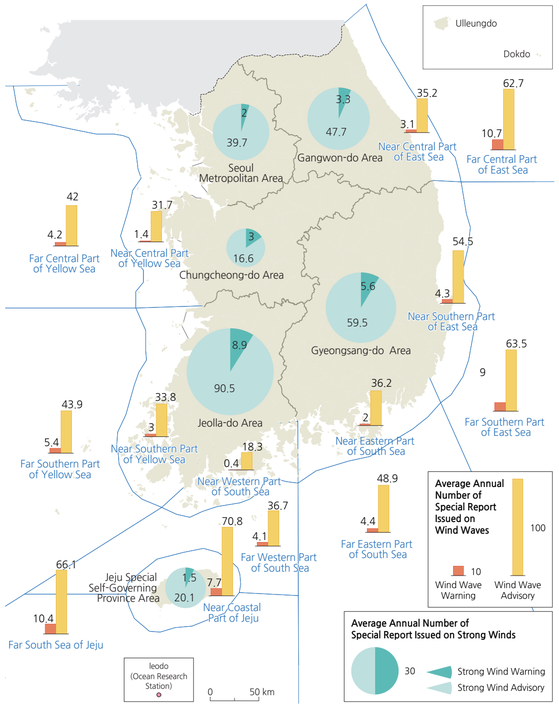
The Ministry of the Interior and Safety (2008)

2009–2018



The Ministry of the Interior and Safety (2018)

Average Annual Issuance on Special Report of Strong Winds and Wind Waves by Region (2010–2019)

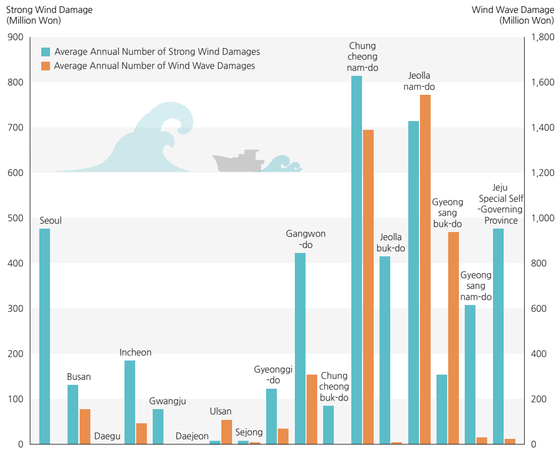


Korea Meteorological Administration (2019)

A wind disaster is caused by particularly strong winds that have reached critical wind speeds. Special weather reports differentiate between strong wind, which refers to wind on the land, and wind waves, which refers to wind and associated waves on the water. Special reports are issued for strong winds, and wind waves are categorized as advisories or warnings.

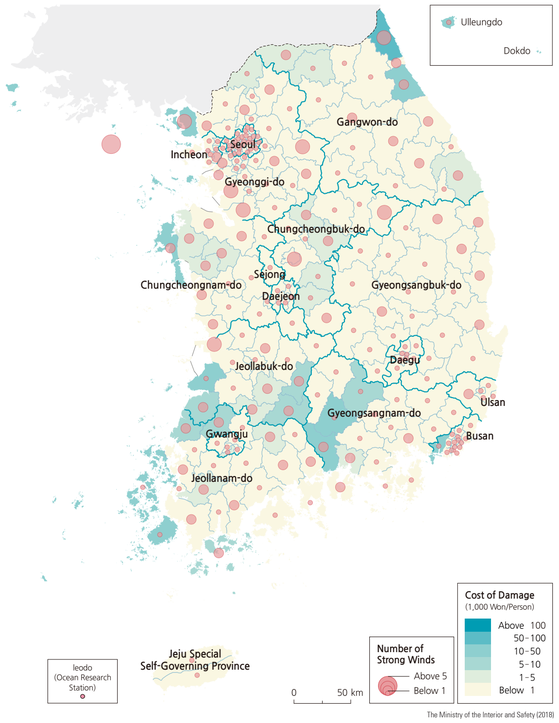
A strong wind advisory is issued when the wind speed exceeds 14 m/s or instantaneous wind speed reaches 20 m/s in lowland areas, and when wind speed exceeds 17 m/s or instantaneous wind speed reaches 25 m/s in mountainous areas. A strong wind warning is issued when the wind speed exceeds 21 m/s or instantaneous wind speed reaches 26 m/s in lowland areas, and when wind speed exceeds 24 m/s or instantaneous wind speed reaches 30 m/s in mountainous areas. A wind wave advisory is issued when a sustained wind speed of 14 m/s over the sea lasts more than three hours or wave height exceeds three meters. A wind wave warning is issued when a sustained wind speed of 21 m/s over the sea lasts more than three hours or a significant wave height exceeds five meters.

Average Annual Number of Damage Caused by Strong Winds and Wind Waves (2009–2018)

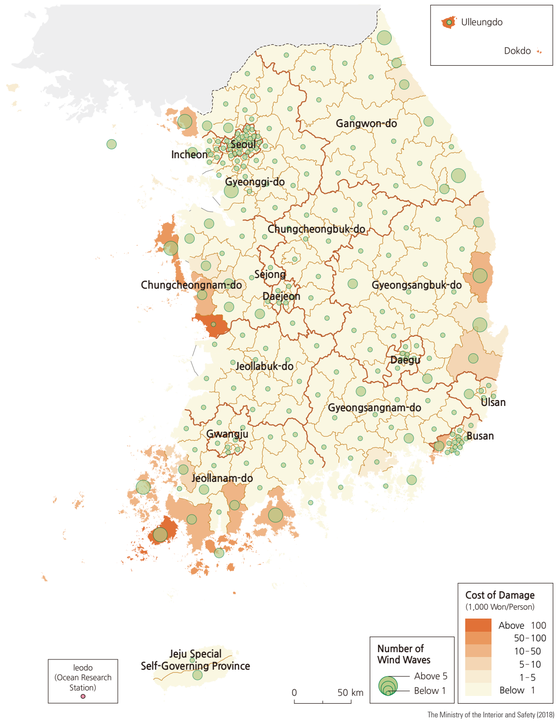


The Ministry of the Interior and Safety (2018)

Strong Wind Occurrences and Cost of Damage per Person (2009–2018)

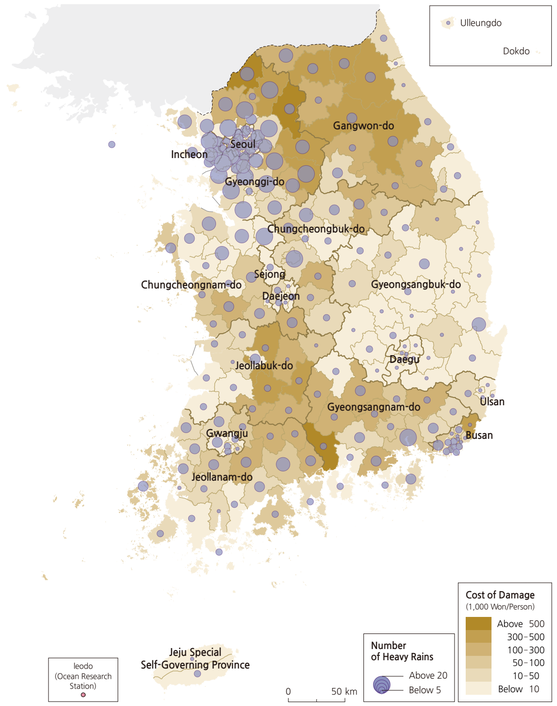


Wind Wave Occurrences and Cost of Damage per Person (2009–2018)



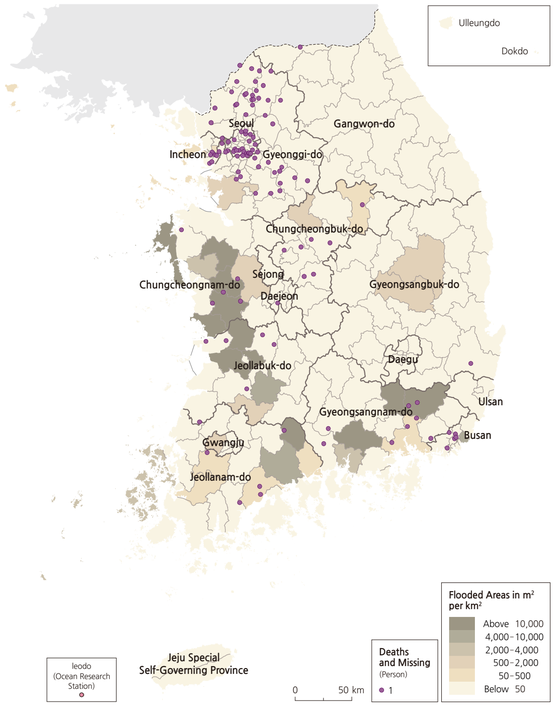
The Ministry of the Interior and Safety (2018)

Heavy Rain Occurrences and Cost of Damage per Person (2009–2018)



The Ministry of the Interior and Safety (2018)

Casualties and Flooded Areas Caused by Heavy Rains (2009–2018)



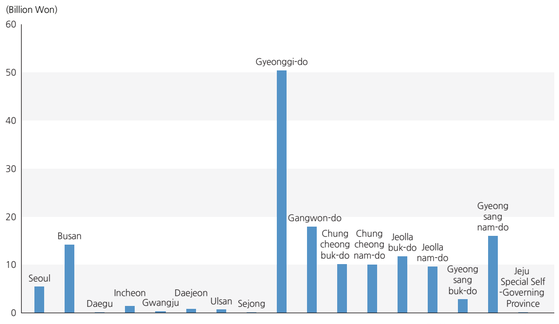
The Ministry of the Interior and Safety (2018)

History of Damage Caused by Heavy Rains

Rank		1	2	3	4	5	6	7	8	9	10
Date		2006/07/09 – 29	1998/07/31 – 08/18	1999/07/23 – 08/04	2002/08/04 – 08/11	1995/08/19 – 30	1987/7/21 – 23	1996/07/23 – 28	1989/07/25 – 27	2005/08/02 – 11	2011/7/26 – 7/29
Type of Heavy Rain		Heavy Rain and Typhoon (EWINIAR)	Heavy Rain	Heavy Rain and Typhoon (OLGA)	Heavy Rain	Heavy Rain and Typhoon (JANIS)	Heavy Rain	Heavy Rain	Heavy Rain	Heavy Rain	Heavy Rain
Deaths and Missing	Person	62	324	67	23	6	167	29	128	19	67
Damages (1,000 Won)	Converted Cost of Damage Based on 2018 Value of Won	2,248,309,598	1,694,401,285	1,454,633,742	1,256,889,468	744,936,676	682,155,779	676,157,939	584,645,877	410,065,771	379,408,881
	Cost of Damage Based on the Value of Won That Year	1,834,428,129	1,247,817,345	1,049,042,054	918,131,949	456,252,049	329,498,700	427,530,669	294,338,865	331,563,650	376,795,921

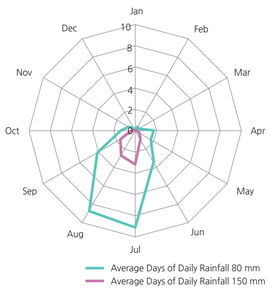
Korea Meteorological Administration (Each Year)

Average Annual Damage Caused by Heavy Rains (2009–2018)



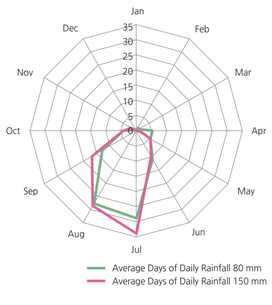
The Ministry of the Interior and Safety (2018)

Average Monthly Heavy Rain Days (2000–2019)



Korea Meteorological Administration (2019)

Ratio of Average Monthly Heavy Rain Days (2000–2019)



Korea Meteorological Administration (2019)

Floods are natural events that occur when a river or large body of water overflows its banks. Flooding has been the most common natural disaster in Korea over the past 10 years.

Special reports issued for heavy rains are categorized as advisory or warning. A heavy rain advisory is issued when rainfall is expected to exceed 60 mm over a three-hour period or to exceed 110 mm over a 12-hour period. A heavy rain warning is issued when rainfall is expected to exceed 90 mm over a three-hour period or to exceed 180 mm over a 12-hour period.

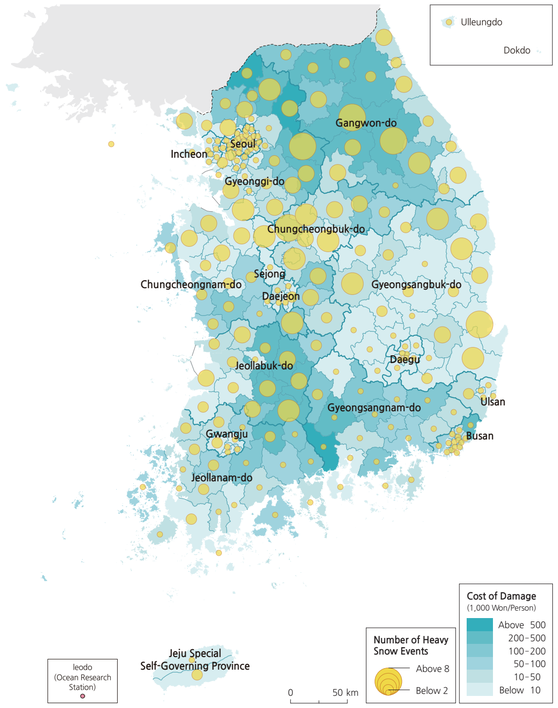
Special reports issued for flooding are categorized as advisory or warning. A flood advisory is issued when the water level is expected to exceed the advisory water level (water level in excess of 50% of the designed flood discharge capacity). A flood warning is issued when the water level is expected to exceed the warning water level (water level in excess of 70% of the designed flood discharge capacity).

Heavy Snow

Heavy snowfall is defined, based on spatial and temporal conditions, as an intense snow event with a large amount of snowfall. According to the Korean Meteorological Administration, a heavy snow advisory is issued when fresh snow cover is expected to accumulate to 5 cm within 24 hours. A heavy snow warning is issued when fresh snow cover is expected to accumulate to 20 cm within 24 hours. A warning is issued in the mountainous areas when snow accumulation is expected to be 30 cm or greater. If snow occurs along with a storm accompanied by a cold wave, or falls for a long time, it causes considerable damage to weaker structures such as agricultural farming facilities. In addition, it greatly affects the service sector, including transportation, distribution, tourism, insurance, and society as a whole.

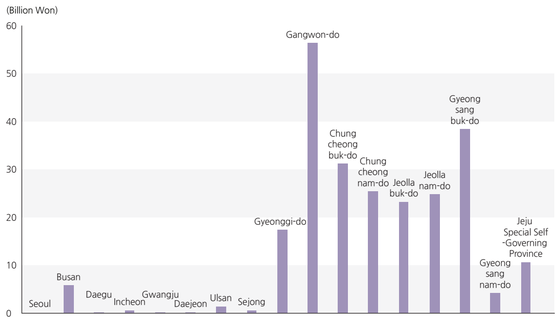
The distribution of atmospheric pressures across Korea and surrounding areas determine the spatial patterns of heavy snowfalls. When isobars run north to south, and a northwest monsoon wind is strong due to a high pressure system in the west with low pressure in the east of the Korean Peninsula, heavy snowfalls often occur in the coastal regions of Chungcheongnam-do, Jeollanam-do, and Jeollabuk-do, and in the mountain regions of Jejudo and Ulleungdo. Heavy snowfalls often occur on the east coast of the Korean Peninsula when isobars run east to west, and a northeasterly is dominant due to a high pressure system in the north, with low pressure in the south of the Korean Peninsula. If troughs form in a north-south direction and cyclones move through slowly, snow can occasionally fall in the central regions of Korea. In this case, if the temperature is quite low, snow can fall in the southern part of Korea. According to records of snowy days between 1974 and 2001, the yearly average number of heavy snowfalls is 2–3 times in the coastal regions of Gangwon-do and 7–8 times in the mountainous regions of Gangwon-do. Heavy snowfalls exceeding 50 cm occur about once a year. More than half of these heavy snowfalls were recorded in mountainous areas such as Daegwallyeong.

Heavy Snow Occurrences and Cost of Damage per Person (2009–2018)



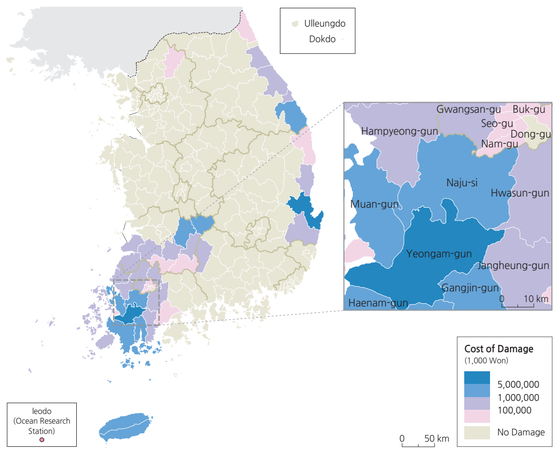
The Ministry of the Interior and Safety (2018)

Average Annual Cost of Damage Caused by Heavy Snows (2009–2018)

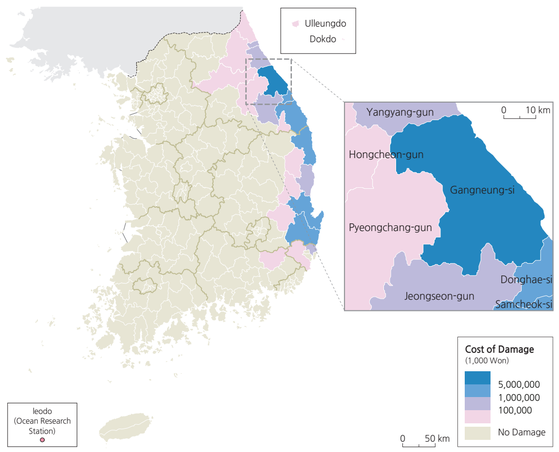


The Ministry of the Interior and Safety (2018)

Cost of Damage from Heavy Snows in December 2010 and January 2011



Cost of Damage from Heavy Snows in February 2011



• Statistics of Jeju Special Self-Governing Province shows the sum of damages of all -si and -gun districts in the Province.

From December 29, 2010, to January 1, 2011, cyclone paths shifted toward Korea from the East-Asian continent, forming snow clouds over Korea, leading to heavy snowfall on the west coast and central region. The continuous, strong, heavy snow greatly damaged greenhouses and ginseng farms. During January 3–4, 2011, cold air with a temperature around -30°C flowed into the East Sea along with northeasterly winds and met relatively warm air over the East Sea. This atmospheric condition turned a large amount of water vapor into snow. The government declared Special Disaster Zones for Yeongam-gun, Jeollanam-do, which had been damaged by the heavy snow from December 29, 2010, to January 4, 2011.

Damage by Heavy Snow (Dec 29, 2010–Jan 04, 2011)

Total Cost of Damage (1,000 Won)	Victims (Persons)	Deaths and Missing Persons
38,261,083	9	0

The Ministry of the Interior and Safety (2015)

From February 11–14, 2011, due to a trough created by cyclones coming from the southeastern sea of the Korean Peninsula, both the northern region and Yeongdong region of Korea experienced heavy snowfall. Many facilities such as farm facilities and military bases were damagedin Gangwon-do and the eastern coastal region of Gyeongsangbuk-do (the maximum snowfall was 133 cm). The government declared Special Disaster Zones for Gangneung-si and Samcheok-si of Gangwon-do and Uljin-gun of Gyeongsangbuk-do, which had been damaged by the heavy snow between February 11–14, 2011.

Damage by Heavy Snow (Feb 11–14, 2011)

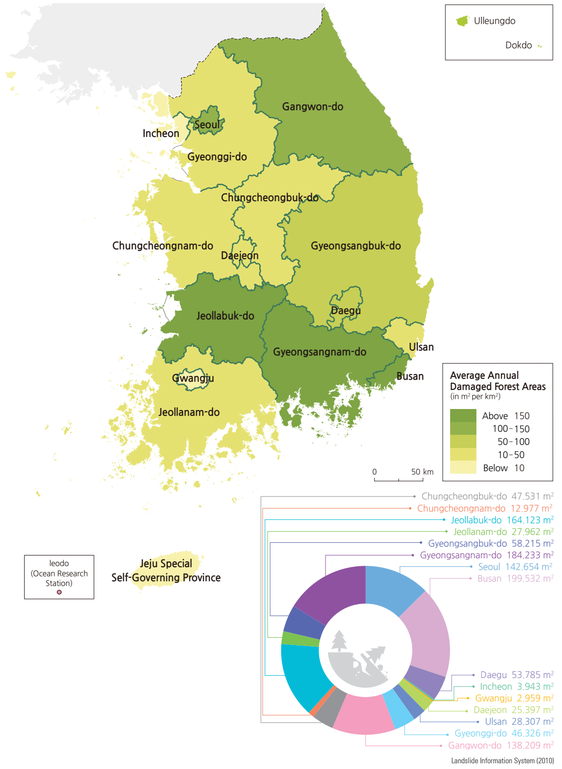
Total Cost of Damage (1,000 Won)	Victims (Persons)	Deaths and Missing Persons
35,982,165	64	0

The Ministry of the Interior and Safety (2015)

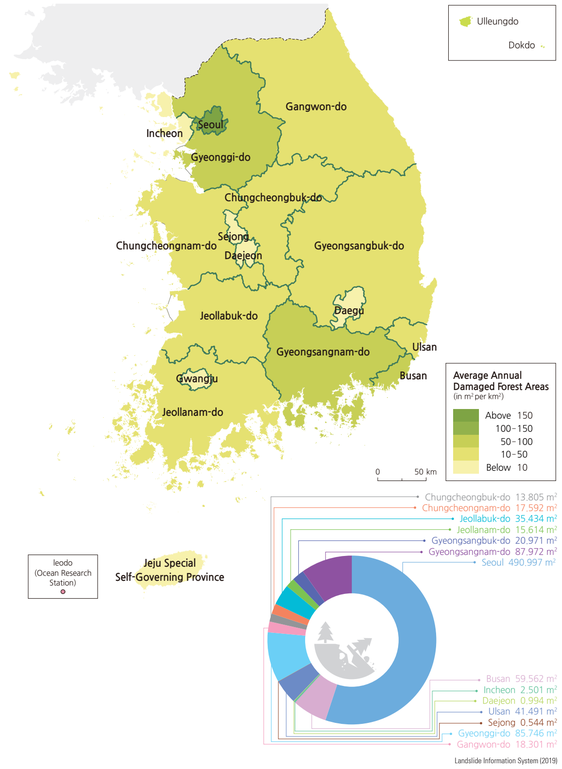
Landslide

Average Annual Damaged Areas Caused by Landslide by Province

2001–2010



2011–2019

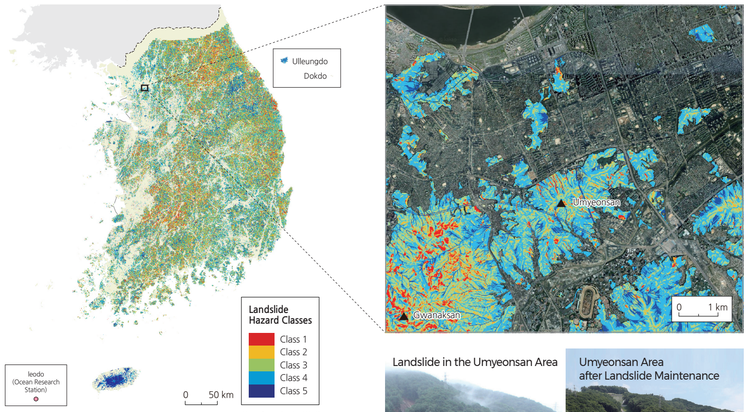


The landslide hazard map shows the landslide risk for all mountains in Korea. The map classifies the risk into five groups with regard to both internal and external triggering mechanisms for landslides. The maps include the landslide hazard map for Korea and the magnified Umyeonsan area in Seoul. The images on the right show a landslide that caused 67 casualties in the Umyeonsan area on July 25, 2011. The image on the right shows the Umyeonsan area when the maintenance work had been finished after the disastrous landslide.

Most landslides are caused by heavy rains or earthquakes, thunder, or volcanic eruptions. Landslides can happen in any place with a slope angle over 30°, and areas with groundwater flowing are susceptible. Landslides can occur where the slope of the stratum is similar to the land surface and when the land surface changes from concave to convex in shoulder zones.

It is difficult to predict landslides because they occur sporadically when heavy rains fall over a short period. Landslides can cause more casualties. When a landslide occurs, a great amount of water and debris mix together, becoming a debris flow that can lead to destructive erosion in valleys. Huge amounts of earth material deposited downstream can lead to secondary damage such as stream flooding due to raised river beds.

Landslide Hazard Map

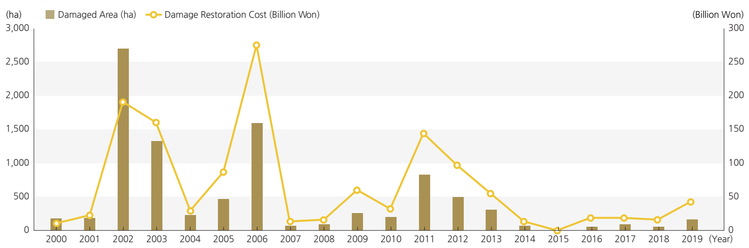


Korea Forest Service (2019)

Landslide in the Umyeonsan Area

Umyeonsan Area after Landslide Maintenance

Damaged Areas and Restoration Cost by Year

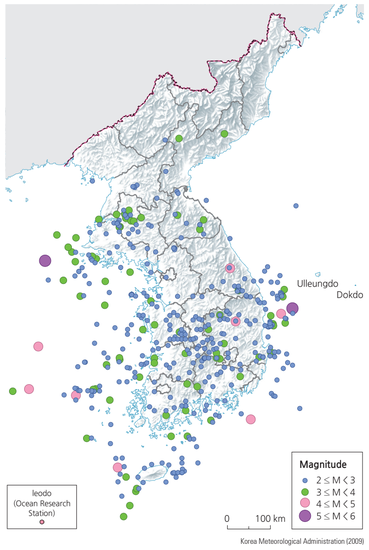


Landslide Information System (2019)

Earthquake and Tsunami

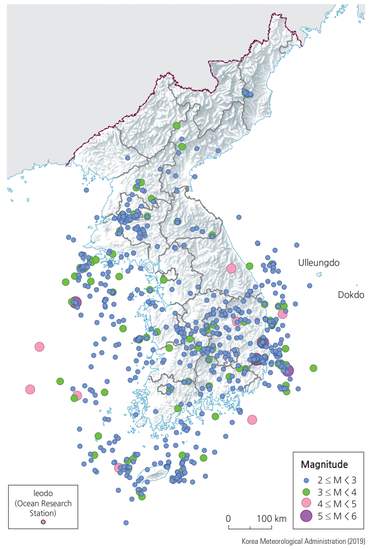
Distribution of Epicenters

2000–2009



Korea Meteorological Administration (2009)

2010–2019



Korea Meteorological Administration (2019)

Since 1999, earthquakes have been measured using the current digital method. The annual average frequency of earthquakes with a magnitude of over 2.0 from 1999 to 2018 is 69.9. In 2019, there were 88 earthquakes, which is higher than the 20-year average. There were 14 earthquakes with a magnitude of over 3.0 in 2014, which is above the annual average frequency of earthquakes (10.9 earthquakes) for the same period. Sixteen earthquake events were felt, which is 0.7 fewer than the annual average (16.7 events). The yearly record for earthquakes increased after the mid-1990s; the increased number of earthquakes reflects the expansion of earthquake observations due to improved observation techniques. Excluding 2016 and 2018, when the Gyeongju-Pohang earthquake occurred, there is no clear change in the frequency of earthquakes over 3.0 magnitude and earthquakes that are felt. Seismic sea waves or tsunamis occur when the seafloor uplifts and sinks due to earthquakes, creating huge waves that spread in all directions, potentially devasting coastal regions. In 1983 and 1993, the east coast of Korea was damaged due to tsunamis that had originated from Japan.

Distribution of Earthquake Observatories (2019)

Korea Meteorological Administration, Korea Institute of Nuclear Safety (2019)

Rank of Earthquakes by Magnitude

Rank	Magnitude	Date (yyyy/mm/dd)	Epicenter		
			Latitude	Longitude	Location
1	5.8	2016. 9. 12.	35.76	129.19	8.7 km SSW of Gyeongju-si, Gyeongsangbuk-do
2	5.4	2017. 11. 15.	36.11	129.37	8 km North of Pohang-si, Gyeongsangbuk-do
3	5.3	1980. 1. 8.	40.20	125.00	20 km SSW of Sakju, Pyeonganbuk-do
4	5.2	2004. 5. 29.	36.80	130.20	74 km ESE of Uljin, Gyeongsangbuk-do
5	5.2	1978. 9. 16.	36.60	127.90	32 km Northwest of Sangju, Gyeongsangbuk-do
6	5.1	2016. 9. 12.	35.77	129.19	8.2 km SSW of Gyeongju-si, Gyeongsangbuk-do
7	5.1	2014. 4. 1.	36.95	124.50	100 km WNW of Taean-gun, Chungcheongnam-do
8	5.0	2016. 7. 5.	35.51	129.99	52 km East of Dong-gu, Ulsan
9	5.0	2003. 3. 30.	37.80	123.70	88 km WSW of Baengnyeongdo, Incheon
10	5.0	1978. 10. 7.	36.60	126.70	3 km East of Hongseong-gun, Chungcheongnam-do
11	4.9	2013. 5. 18.	37.68	124.63	31 km South of Baengnyeongdo, Incheon
12	4.9	2013. 4. 21.	35.16	124.56	101 km Northwest of Sinan-gun, Jeollanam-do
13	4.9	2003. 3. 23.	35.00	124.60	88 km WNW of Sinan-gun, Jeollanam-do
14	4.9	1994. 7. 26.	34.90	124.10	128 km WNW of Sinan-gun, Jeollanam-do

Korea Meteorological Administration (2019)

Major Earthquakes and Tsunamis Occurred

Date		May 26, 1983	July 12, 1993
Earthquake	Date	1983. 5. 26. AM 11:59	1993. 7. 12. PM 22:17
	Magnitude	7.7	7.8
	Epicenter	West sea of Akita Honshu, Japan	Northwest sea of Hokkaido, Japan
Tsunamis	Damage	• Victims: Death 1, Missing 2, Injured 2 • Damaged Buildings: 42	• Victims: None • Damaged Ships: 32 • Damaged Fishing Nets: 3,000
	Total Cost of Damages based on that Year	370 Million Won	400 Million Won

Korea Meteorological Administration (2019)

Number of Earthquakes by Year (1999–2018)

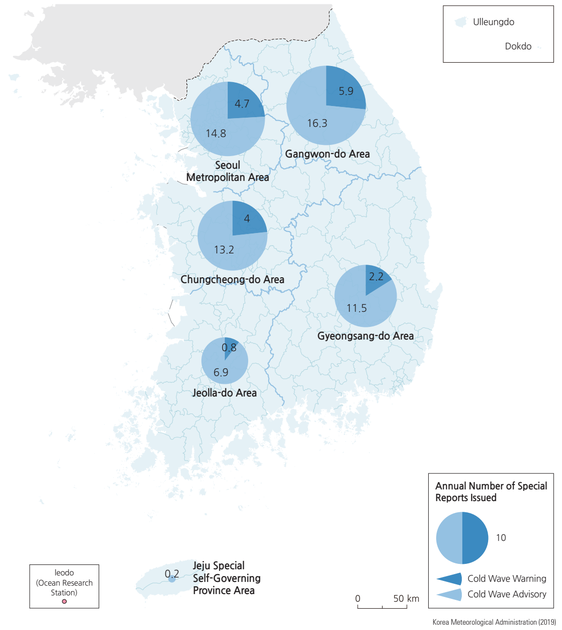
Korea Meteorological Administration (2018)

Average Annual Earthquakes by Region (1978–2018) and Number of Earthquakes in 2019

Korea Meteorological Administration (2019)

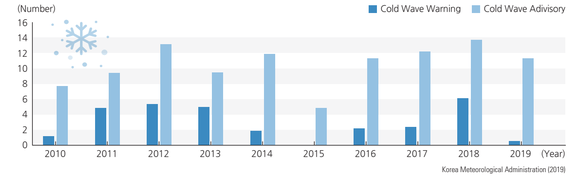
Cold Waves and Heat Waves

Average Annual Number of Special Reports of Cold Waves Issued by Region (2010–2019)



Korea Meteorological Administration (2019)

Number of Special Reports Issued on Cold Waves by Year (2010–2019)



Korea Meteorological Administration (2019)

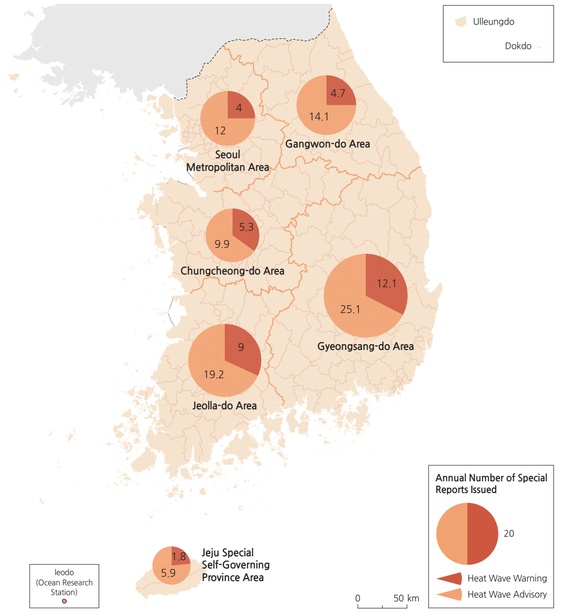
Cold waves are distinguished by a sudden drop in temperature over the Korean Peninsula when the cold, dry Siberian anticyclone expands into southern China, and the northerly winds are strengthened. During the Northwest monsoon season, the anticyclone expansion and northerly winds cause cold waves that reach Korea when a high pressure system resides in the west of the Korean Peninsula, and low pressure resides in the east. Cold waves are often detrimental to peoples' lives and health and cause serious damage.

Cold wave special reports are classified as advisories and warnings. A cold wave advisory is issued in three situations. First, it is issued when the minimum temperature in the morning is expected to drop below 3˚C from October to April, decreases more than 10˚C compared to the previous day, and when the temperature drops 3˚C below the annual average. Second, it is issued when the minimum temperature in the morning is expected -12˚C or below for more than 2 days. Third, it is issued when the minimum temperature in the morning is so low that damage is expected. Cold wave warnings are issued in three situations. First, when the minimum temperature in the morning is expected to reach lower than 3˚C from October to April, by 15˚C below than the previous day, and it is expected to be 3˚C lower than the annual average. Second, when the minimum temperature is -15˚C in the morning for 2 days or more. Third, when the temperature is cold enough to cause critical damage over a wide area.

A heat wave occurs when the temperature and heat index exceed a certain threshold over a period of days. Heat wave special reports are classified as advisories and warnings. A heat wave advisory is issued when the temperature is expected to reach a maximum of 33˚C for more than 2 days. A heat wave warning is issued when the temperature is expected to reach a maximum of 35˚C for more than 2 days.

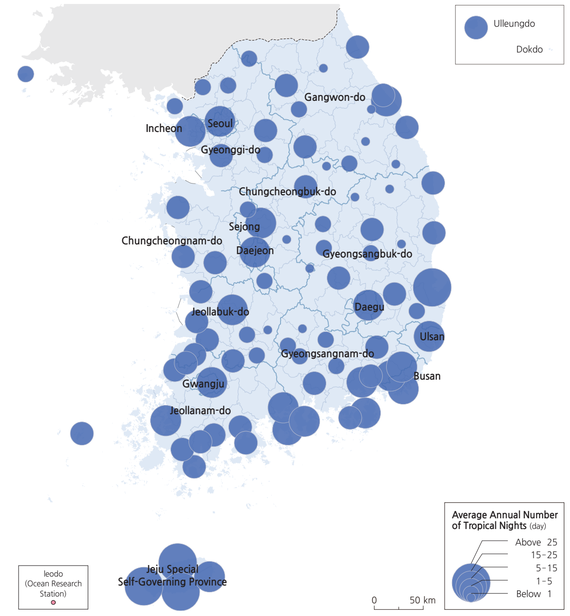
A tropical night occurs when the temperature does not drop below 25˚C from sunset to sunrise. Tropical nights occur for 13–22 days of the year in southern coastal regions (e.g., Busan), and 9–22 days of the year in inland regions (e.g., Seoul).

Average Annual Number of Special Reports of Heat Waves Issued by Region (2010–2019)



Korea Meteorological Administration (2019)

Average Annual Number of Tropical Nights per Observatory (2010–2019)



Korea Meteorological Administration (2019)

Number of Special Reports Issued on Heat Waves by Year (2010–2019)

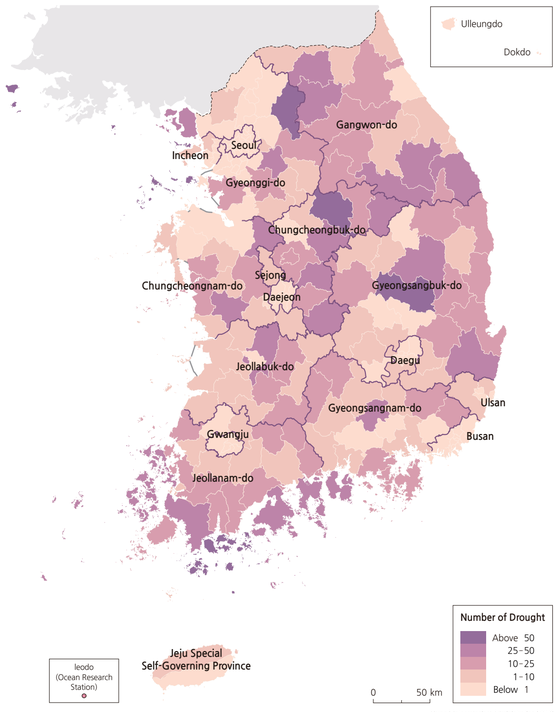
Korea Meteorological Administration (2019)

Average Annual Number of Tropical Nights by Year (2000–2019)

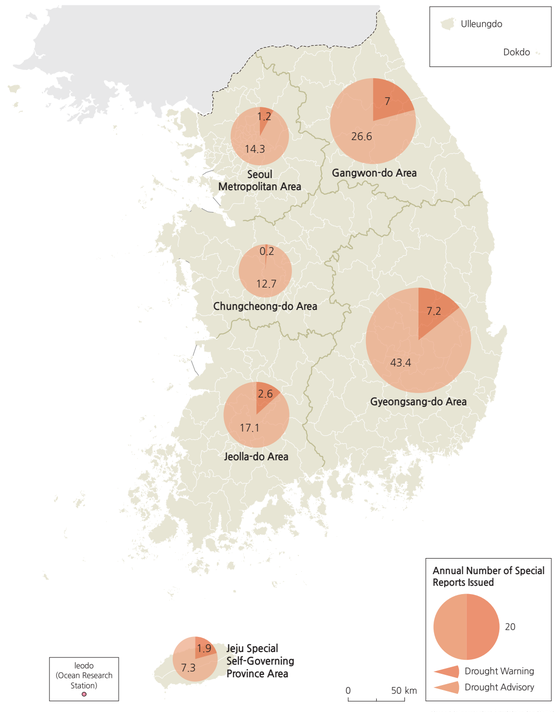
Korea Meteorological Administration (2019)

Drought

Drought by Si·Gun·Gu (1990–2019)



Annual Number of Droughts (2000–2019)



Drought refers to water scarcity and reduction of streamflow, reduction in lake or reservoir storage, and lowering groundwater levels due to a lack of rainfall and intense sunshine. In the past, drought intensity was evaluated based on the number of consecutive drought days. These days, it is determined by the duration of water scarcity and the extent of the regions affected.

Drought damage includes industrial damage, human injury, and loss of life due to water scarcity. Water scarcity means not only a huge decrease in water volume, groundwater, and soil moisture, but also reduced productivity due to industrial water shortages. In Korea, droughts often occur when a Jangma (East Asian monsoon) front is moving north due to high pressure in the North Pacific High during the summer, which prevents and restricts precipitation.

Soyanggang Area taken by the Arirang-2 Satellite in April 2012 (Usual day)

Soyanggang Area taken by the Arirang-3 Satellite in March 2015 (Drought)

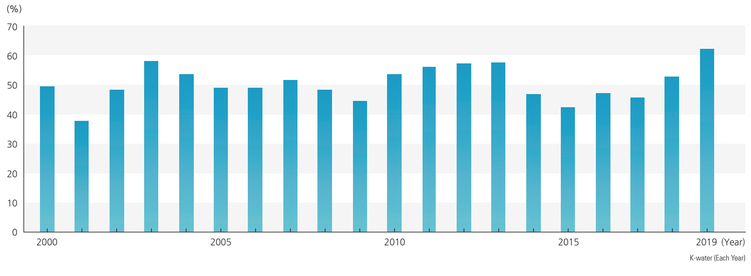
Population Affected by Restricted Water Supply (1994–2009)

(1,000 Persons)

Year of Droughts	Metropolitan Cities	Gyeonggi-do	Gangwon-do	Chung cheong buk-do	Chung cheong nam-do	Jeollabuk-do	Jeollanam-do	Gyeong sang buk-do	Gyeong sang nam-do	Sum
1994 – 1995	17.7	8.4	299.6	36.9	36.6	237.9	147.9	482.8	954.6	2,222.4
2001 – 2002	0.0	19.7	69.0	8.1	0.0	4.9	48.3	95.0	59.9	304.9
2008 – 2009	0.7	0.8	75.5	2.5	7.0	14.2	48.4	65.9	65.1	280.1

Ministry of Land, Infrastructure, and Transport, K-water (2015)

Average Water Storage Rates by Year (2000–2019)



K-water (Each Year)

Precipitation and Average Water Storage Rates by Year (2000–2019)

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Precipitation (mm)*	1,378	962	1,610	1,829	1,495	1,285	1,454	1,464	906	1,172	1,449	1,598	1,506	1,169	1,192	925	1,265	877	1,438	1,076
Amount of Inflow (Million m^3)	14,608	7,289	18,091	29,928	20,197	16,254	22,191	20,969	9,254	12,854	19,495	25,979	19,178	14,458	11,379	7,831	12,580	9,768	16,925	11,263
Amount of Discharge (Million m^3)	16,807	8,631	15,854	29,299	21,150	16,923	22,398	19,083	11,706	12,140	17,533	25,711	18,640	15,985	11,634	7,374	11,275	10,093	13,680	14,740
Average Amount of Storage (Million m^3)**	6,205	4,739	6,084	7,310	6,748	6,139	6,170	6,463	6,069	5,602	6,469	7,296	6,469	7,229	5,897	5,026	6,172	6,398	7,147	7,734
Average Storage Rate (%)***	49.3	37.7	48.4	58.1	53.6	48.8	49	51.4	48.2	44.5	53.6	56	57.2	57.5	46.7	42.3	47.2	45.7	52.8	62.3

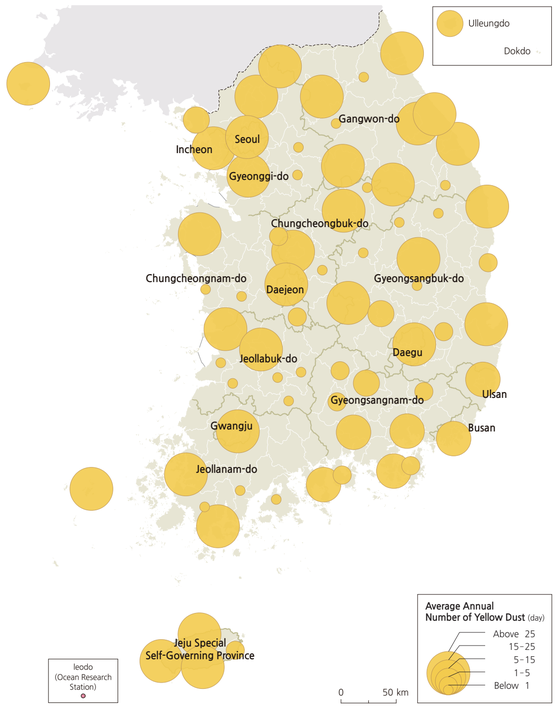
• Precipitation: Precipitation of the Multipurpose Dams' Drainage Areas (22% of Total Area of South Korea) •• Average Amount of Storage: Sum of Average Annual Amount of Storage of All Dams ••• Average Storage Rates: Average Amount of Storage / Sum of Storage of All Dams

K-water (2019)

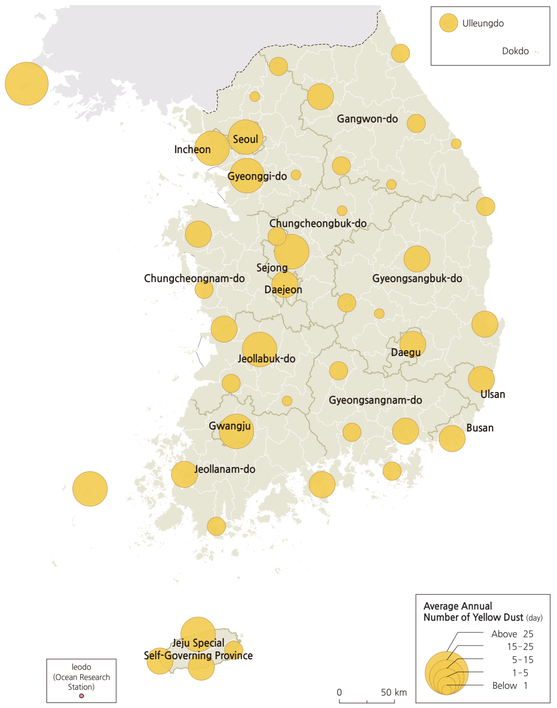
Yellow Dust

Average Annual Number of Yellow Dust Days

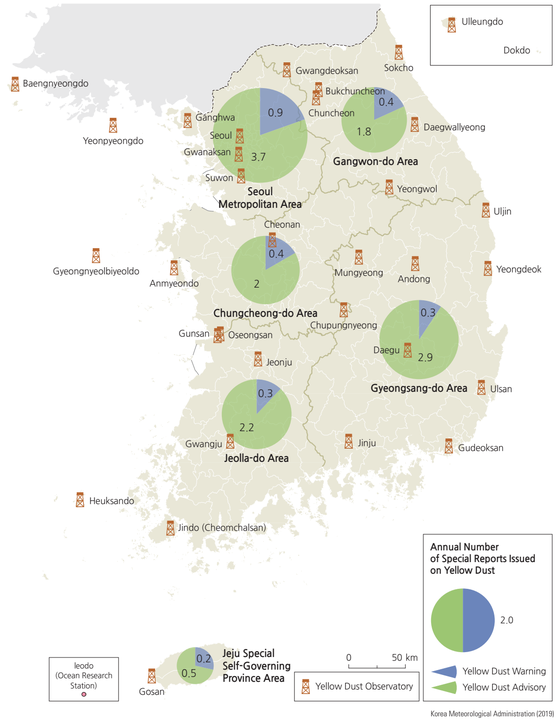
2000–2009



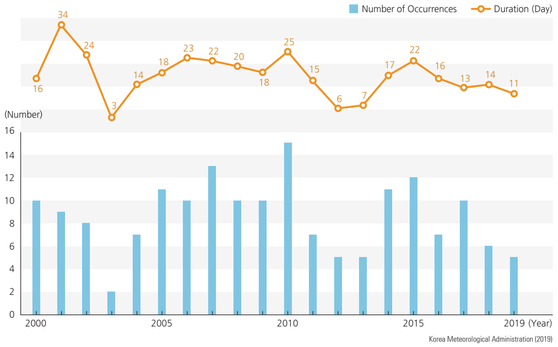
2010–2019



Distribution of Yellow Dust Observatories and Average Annual Number of Special Reports Issued on Yellow Dust by Region (2010–2019)



Annual Frequency of Yellow Dust Occurrences (2000–2019)



Korea Meteorological Administration (2019)

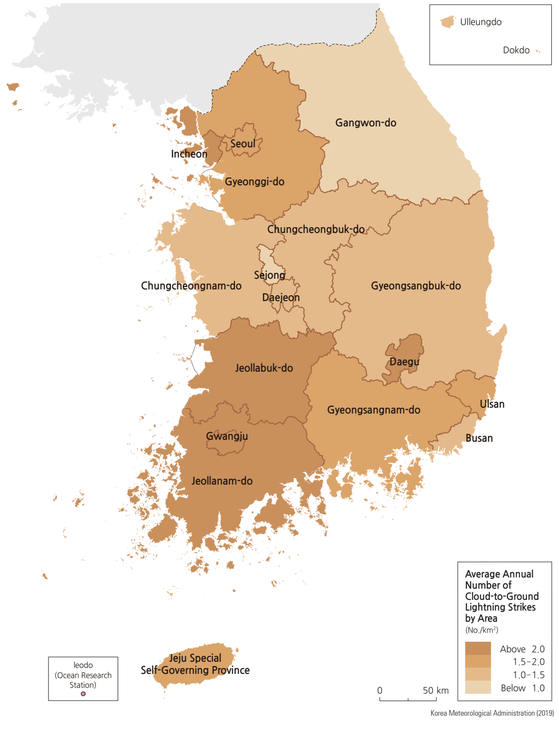
Yellow dust occurs when fine sand dust is blown by the wind from the northern part of China and dry/red clay zones of Mongolia and spreads, covering the sky and blanketing certain regions. Yellow dust generally occurs from March to May when cyclones are active. Sometimes, the dust reaches North America via strong upper-level west winds that pass over Korea, Japan, and the Pacific Ocean. When yellow dust occurs, sunlight is blocked by airborne particulates, and the sky appears yellowish-brown. Yellow-brown dust also covers the land.

The dust causes various problems in human health, agriculture, industry, transportation, and the oceans. Although Korea and Japan are far from the main dust sources, they are directly impacted by the dust. The intensity and number of yellow dust days have been rapidly increasing since the 1990s. The number of yellow dust days in Seoul has increased as follows: 28 days (1971–1980), 39 days (1981–1990), 77 days (1991–2000), and 122 days (2001–2010). The number of events in the 2000s is four times greater than that of the 1970s.

The yellow dust special weather reports issued by the Korea Meteorological Administration are classified as yellow dust advisories and yellow dust warnings. The fine dust warning replaced the yellow dust warning in 2017. The fine dust advisory is issued when an hourly average particulate matter (PM_{10}) density of 300 μg/m^3 is expected to last for more than two hours. A yellow dust warning is issued when an hourly average particulate matter (PM_{10}) density of 800 μg/m^3 is expected to last for more than two hours.

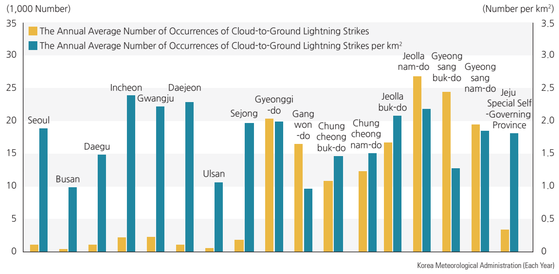
Cloud-to-Ground Lightning

Average Annual Number of Cloud-to-Ground Lightning Strikes by Province (2015–2019)



Korea Meteorological Administration (2019)

Number of Cloud-to-Ground Lightning Strikes by Province (2015–2019)



Korea Meteorological Administration (Each Year)

Number of Cloud-to-Ground Lightning Strikes per Season (2015–2019)

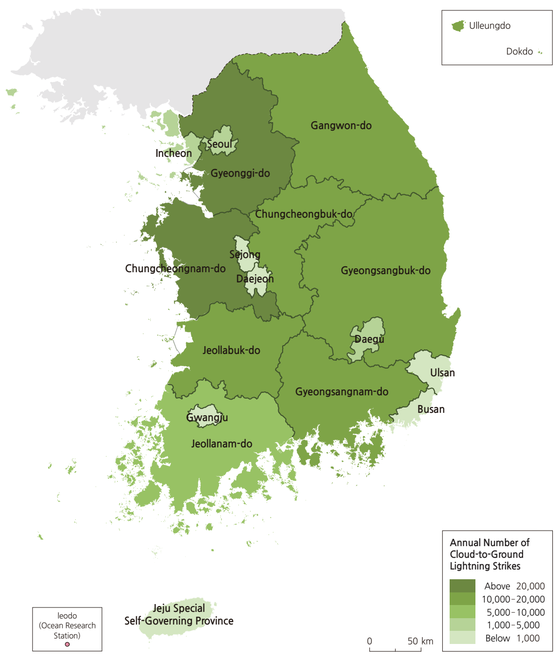
Province	Spring	Summer	Fall	Winter	Total
Seoul	1,343	3,814	491	30	5,678
Busan	278	5,136	299	123	5,836
Daegu	538	9,095	1,196	40	10,869
Incheon	2,785	7,135	1,464	136	11,520
Gwangju	412	5,157	149	6	5,724
Daejeon	293	2,371	376	62	3,102
Ulsan	455	8,834	226	64	9,579
Sejong	103	1,857	389	52	2,401
Gyeonggi-do	22,505	64,640	13,678	653	101,476
Gangwon-do	13,224	61,565	6,948	265	82,002
Chungcheongbuk-do	6,040	42,386	5,354	170	53,950
Chungcheongnam-do	4,988	46,082	9,212	1,291	61,573
Jeollabuk-do	10,334	68,271	3,717	1,082	83,404
Jeollanam-do	22,483	103,909	7,241	437	134,070
Gyeongsangbuk-do	6,779	105,502	9,122	419	121,822
Gyeongsangnam-do	5,097	85,392	6,529	426	97,444
Jeju Special Self-Governing Province	1,170	13,532	1,660	361	16,723

Korea Meteorological Administration (2019)

Cases of cloud-to-ground lightning are classified according to loss of life and property damage. Casualties caused by cloud-to-ground lightning can be subdivided into deaths and injuries. Direct, primary damages from lightning include house and forest fires and facility/building collapses, along with loss of lives. Secondary damages include blackouts, disconnections, traffic accidents, and cessation of operations caused by lightning that strikes plants, communication facilities, traffic facilities, and factories. Cloud-to-ground lightning normally occurs in the summer.

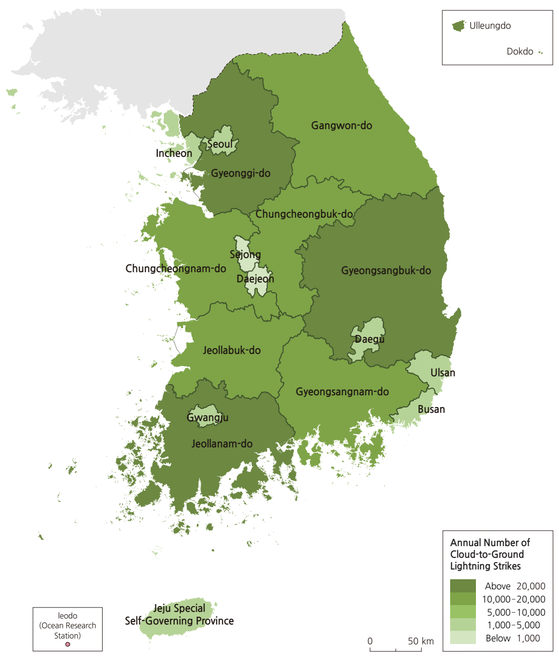
Cloud-to-Ground Lightning Strikes by Si·Do

2000–2014



Korea Meteorological Administration (2015)

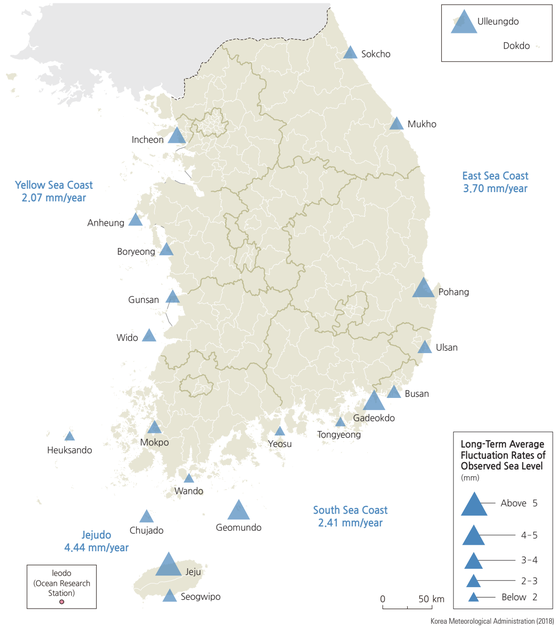
2015–2019



Korea Meteorological Administration (2020)

Sea Level Rise

Long-Term Average Fluctuation Rates of Observed Sea Level (2018)



Korea Meteorological Administration (2018)

The sea level surrounding the Korean Peninsula has risen. The rate of sea level rise in the East Sea is relatively higher than that in the South and Yellow seas, and the rates of sea level rise for the South and Yellow seas are similar.

Observed mean sea level fluctuations around the Korean Peninsula are 2.07 mm/yr, 2.41 mm/yr, and 3.70 mm/yr in the Yellow, South, and East seas, respectively. Mean sea level fluctuation in Jejudo is the highest at 4.44 mm/yr. Jeju recorded the highest sea level fluctuation among all the sea regions at 5.43 mm/yr, followed by Ulleungdo (5.13 mm/yr), Pohang (4.55 mm/yr), and Geomundo (0.41 cm/yr).

Compared to the other seas, the sea level rise in the East Sea is remarkable. It is due to an increase in the heat transport of the Kuroshio warm current and a rise in the temperature of warm current through the East Sea as a result of global warming. If global warming is accelerated, the coastal areas are expected to suffer great damage from coastal flooding due to sea level rise.

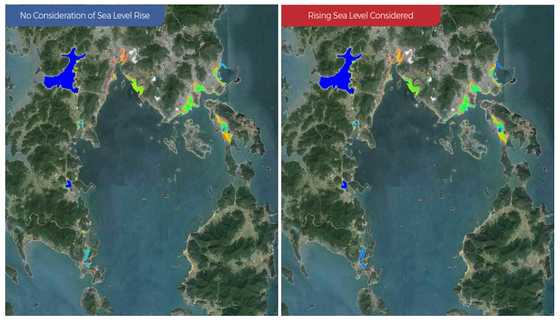
According to the Representative Concentration Pathway (RCP) 4.5 (8.5) scenario, the sea level around Korea will rise by 53 cm (65 cm) in both the South Sea and the Yellow Sea, and 74 cm (99 cm) in the East Sea within the second half of the twenty-first century (2071–2100). Meanwhile, the global average sea level is expected to rise by 70.6 cm (88.5 cm) for the same period. According to the RCP 4.5 (8.5) scenario, the sea level will rapidly increase by 2100, and the sea level around the Korean Peninsula will continue to rise by more than 65 cm (85 cm) in both the South Sea and the Yellow Sea, and 90 cm (130 cm) in the East Sea. According to the RCP 8.5 scenario, the high risk of flooding due to rising sea levels can be seen in coastal lowlands.

*** RCP (Representative Concentration Pathways)**

RCPs are a series of climate change scenarios used to determine greenhouse gas reduction policies per socioeconomic setting. There are four trajectories that are calculated by different levels of carbon dioxide concentration. RCP 2.6 (420 ppm of CO_2) projects that the Earth will be able to recover from the negative consequences of human activity by itself, though this is not seen as a feasible plan. RCP 4.5 (540 ppm) is a scenario in which greenhouse gas reduction policies are carried aggressively, while RCP 6.0 (670 ppm) is a scenario in which the policies are carried out to some degree. In an RCP 8.5 (940 ppm) scenario, greenhouse gases will continue to be emitted at the current rate without any reductions.

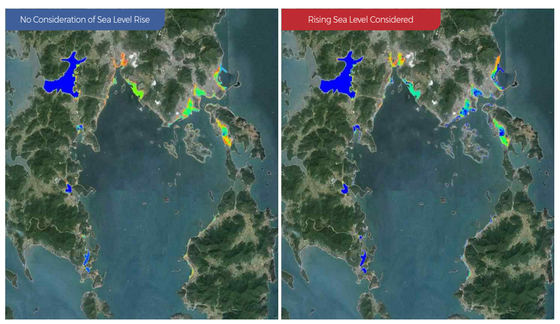
Inundation Range According to Sea Level Rise Scenarios

Middle of the 21st Century (2041–2050, Yeosu-si)



Middle of the 21st Century (2041–2050, Gijang-gun)

Late 21st Century (2091–2099, Yeosu-si)



Late 21st Century (2091–2099, Gijang-gun)

Korea Hydrographic and Oceanographic Administration (2014)

Changes in Inundation Area Caused by Sea Level Rise in Yeosu-si

Classification	50-Year Return Period			100-Year Return Period		
	No Consideration	Considering Rise	Fluctuation Rate	No Consideration	Considering Rise	Fluctuation Rate
Average Inundation Depth (cm)	149.1	162.3	13.2	157.6	207.7	50.1
Inundation Area (km^2)	8.3	8.7	0.4 (4.8%)	8.5	9.7	1.2 (14.1%)

Changes in Inundation Area Caused by Sea Level Rise in Gijang-gun

Classification	50-Year Return Period			100-Year Return Period		
	No Consideration	Considering Rise	Fluctuation Rate	No Consideration	Considering Rise	Fluctuation Rate
Average Inundation Depth (cm)	77.90	82.50	4.60	82.70	100.60	17.90
Inundation Area (km^2)	0.49	0.58	0.09 (17.7%)	0.56	1.37	0.81 (145.1%)

Prevention and Response to Natural Disasters

Efforts to Prevent Natural Disasters

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.

Dondae (Pisudae: Shelter Zone for Flooding)
These zones are artificially built in places where floods happen frequently. Some houses are built on the Dondae in Goyang-si, Gyeonggi-do, downstream of the Hangang.

Teododum House
Lowlands with lots of rainfall such as large river floodplains are often flooded. In order to avoid damage, people build up the land surrounding sites for houses then construct their houses above these sites.

Windbreak Forest of Mulgeon-ri, Namhae-gun
The Natural Monument No. 150 is Bangjo eoburim located at Mulgeon-ri, Namhae-gun. Eoburim means a fish shelter forest, but this forest has played a more important role in protecting villages and crops from strong winds than in luring fish.

Daraengyi Village of Namhae-gun
Daraengyi means a stair-shaped, terraced paddy field. The paddy fields of a Daraengyi village were made by following the contours of the mountains in order to get enough space for agriculture. These terraced paddy fields also prevent land erosion.

Traditional Houses of Jejudo
The roof angle of Jejudo's traditional houses is gentle since winds are very strong in Jejudo, and the region receives the highest precipitation in Korea. This roof is made of grass and straw.

Udegi and Jjukdam of Ulleungdo
Udegi is an outer wall with thin pillars standing together, woven with string like blinds. Jjukdam is a hallway that surrounds the living area between Udegi and the walls of the house. This double-envelope system provides a thermal buffer between the living space and the harsh weather.

Korea invented the world's first rainfall gauge and has a long history of recording weather events and natural disasters. According to historical records, natural disasters occurred 40,000 times in Korea from the Three Kingdoms period to the Joseon dynasty. Some natural disasters were inevitable. However, people have tried to manage these kinds of disasters by strengthening prediction, prevention, and preparedness strategies.

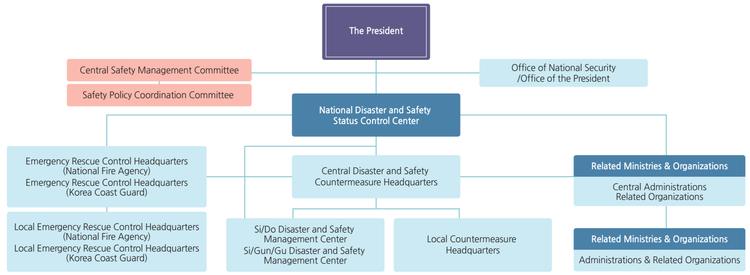
In ancient times, Koreans conducted irrigation projects and used charms or incantations to overcome nature's challenges, reduce damage from droughts and floods, and bring good harvests. Since the Agricultural Age, agricultural productivity has been constantly influenced by droughts and floods. When floods occurred during the Three Kingdoms period, they were described in detail by recording Daesu (big water) and Daewu (big rainfall). There were about 40 events, including DaeSu, Daewu, and rainfalls causing water-related damages, according to *Samgug sagi* (the History of the Three Kingdoms). Records of natural disasters from the Three Kingdoms history focused on the capital. Even though the historical disaster records from the Goryeo dynasty focused on the capital as well, there were more records about natural disasters than from the Three Kingdoms period. Thus, the central government implemented strong policies to mitigate the damage caused by natural disasters during the Goryeo dynasty.

During the Joseon dynasty, both the *Seungjeongwon ilgi* (the Diaries of the Royal Secretariat) and the *Joseon wangjo silrok* (the Annals of the Joseon Dynasty) recorded floods that occurred in Seoul for 450 years. Water levels of the Hangang and streams in Seoul also appear in the documents recording ritual ceremonies for rain and sun held during the Joseon dynasty. According to these documents, there were 176 floods around Seoul in this period.

Most natural disasters in recent years were caused by localized heavy rains, typhoons, and tsunamis. However, the type and extent of damage caused by natural disasters have diversified and are increasing. Expanding cities, industrial areas, and decreasing reservoirs have caused a significant increase in the amount of runoff, resulting in greater damages. The central government conducts various nation-wide prevention measures to mitigate damage from natural disasters, such as by applying earthquake resistant design codes to new buildings and by building erosion control dams.

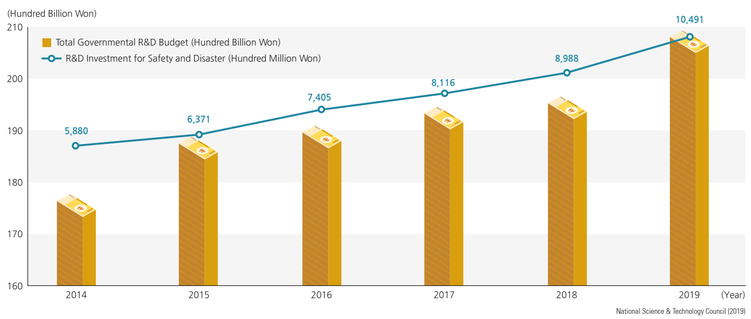
The Ministry of Public Safety and Security, which was launched by integrating disaster prevention and response functions, was incorporated into the Ministry of Interior and Safety in July 2017. The Ministry of Interior and Safety is responsible for overseeing and coordinating disaster and safety management tasks conducted by the state and local governments.

Reformed Disaster Safety Management Systems



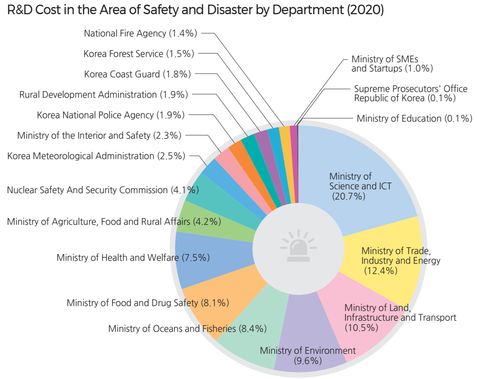
The Ministry of the Interior and Safety (2019)

Total Government R&D Budget and the Amount of R&D Budget Spent on Human Safety and Human Disaster Management (2014–2019)



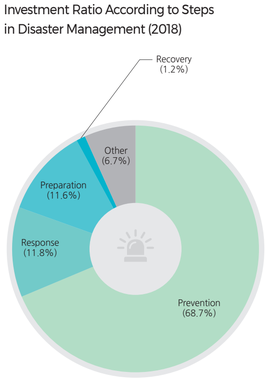
National Science & Technology Council (2019)

R&D Cost in the Area of Safety and Disaster by Department (2020)



KISTEP (2020)

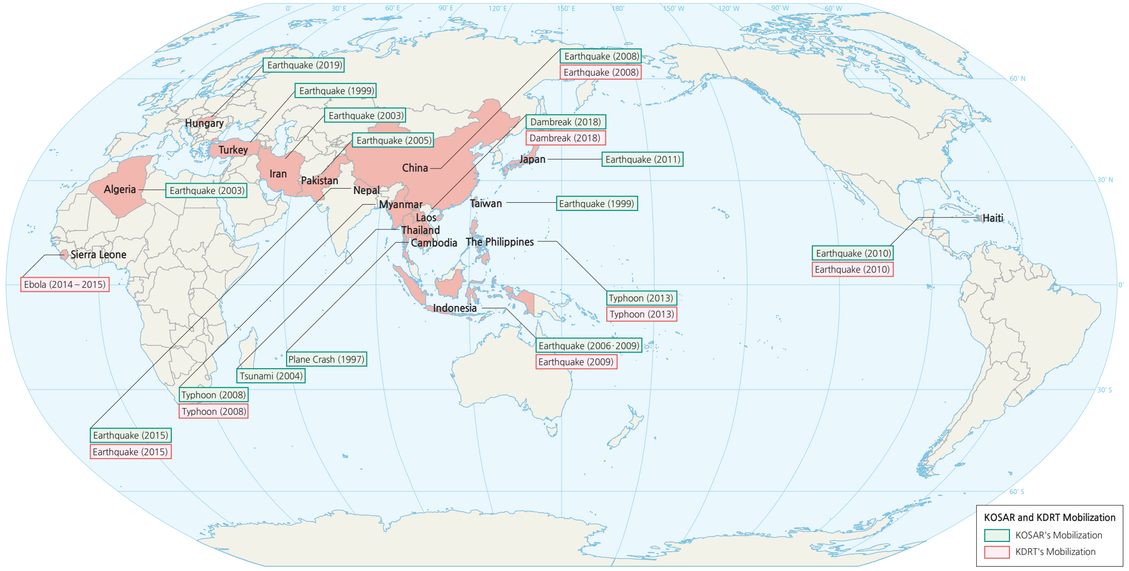
Investment Ratio According to Steps in Disaster Management (2018)



KISTEP (2018)

International Cooperation

Mobilization of Korea's 119 Search and Rescue Team (KOSAR) and Korea's Disaster Relief Team (KDRT)



National 119 Rescue Headquarters, KOICA (2020)

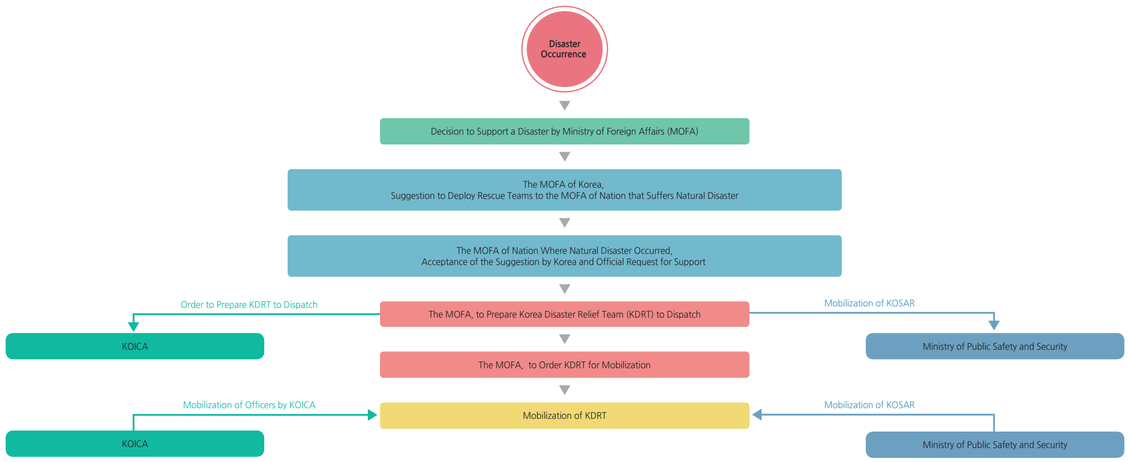
Activity of KDRT (Earthquake, Haiti)

Activity of KOSAR (Earthquake, Tohoku, Japan)

Activity of KDRT (Typhoons, The Philippines)

Activity of KDRT (Earthquake, Nepal)

Organization and Mobilization of Korea's 119 Search and Rescue Team (KOSAT)



National 119 Rescue Headquarters (2020)

Korea has made various efforts to prevent and overcome natural disasters and hazards. Korea has cooperated internationally with other countries in disaster fields and supported humanitarian aid to many countries suffering from natural disasters, conflicts, and complex catastrophes.

Korea has provided foreign aid requested by international organizations. The Korea 119 Search and Rescue Team (KOSAR) and the Korea Disaster Relief Team (KDRT) are rescue teams regulated under Article 9, "Organization and Operation of Korea 119 Search and Rescue Team" of the Act on 119 Rescue and Emergency Medical Services. They are also an international USAR team consisting of firefighters. When a major disaster occurs overseas, they play a greater role in preventing further damage and protecting people who suffer. The National 119 Rescue Headquarters is in charge of the organization and operation of the Korea 119 Search and Rescue Team. After the Korean Airline plane crash at Guam on August 6, 1997, the Korean government established the Korea 119 Search and Rescue Team for massive disasters such as flight and boating accidents. It was launched with 31 people in 3 teams on August 22, 1997.

In times of disaster occurrences overseas, the Korea 119 Search and Rescue Team is sent with the Korea Disaster Relief Team. The minister of the Ministry of Foreign Affairs decides whether or not to dispatch the Korea 119 Search and Rescue Team to assist with international disaster relief. The decision is made according to the Government-Civilian Overseas Emergency Relief Council established by the Overseas Emergency Relief Act.