Natural Hazards

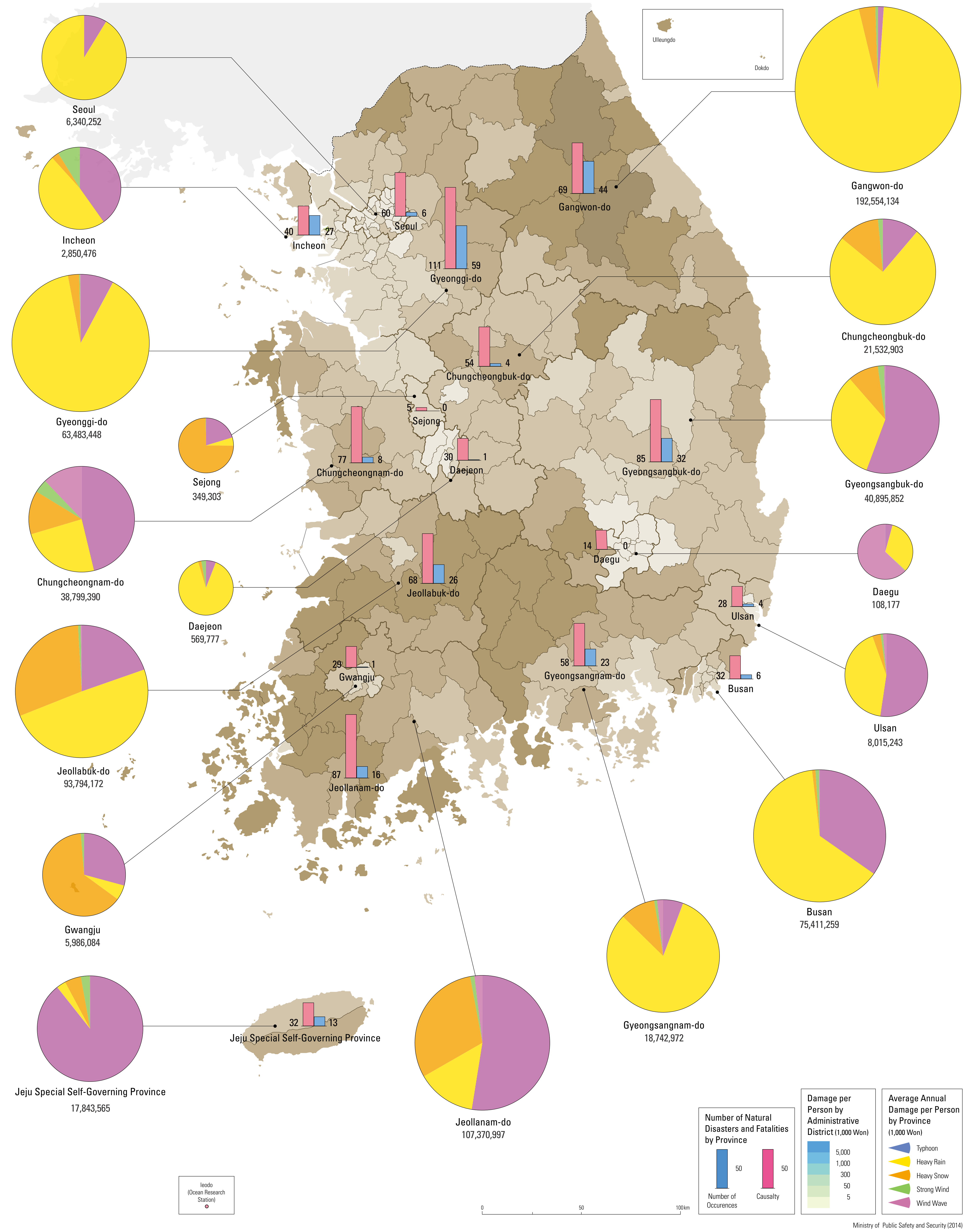
In recent days, natural disasters not only threaten human safety, but also their magnitude has caused unprecedented damages. The severity and frequency of natural disasters are increasing while the summer is getting warmer, and the winter is getting colder due to the effects of global warming. Korea is frequently hit by heat waves, heavy rains, and typhoons in the summer, whereas heavy snows are quite frequent in occurrence in the winter. They often bring detrimental effects to Korea. The most critical natural disasters in Korea are typhoons and heavy rains but damage from heavy snows has also risen because of the increasing frequency of heavy snows. An increase in the number of heavy rain and snow events has been observed since 1991, and this increase was particularly remarkable since the early 2000s.

In Korea, the scale of the damage caused by natural disasters varies and is much more ferocious for certain typhoons and heavy rains. More than 1,000 persons were killed or disappeared due to the typhoon Thelma in 1987. Because of Typhoon Yanni in 1998, and the flooding struck the Honam region in 1989, 384 people were killed, and 307 disappeared. A huge number of victims suffered from floods and typhoons from 1984 to 1990. There were over 360 thousand flood victims around Seoul and Gyeonggi-do area in 1984. The incredibly disastrous flood occurred in 1990 left more than 200 thousand victims and one trillion-won worth of damage. Over the past 30 years, the most adverse natural disaster that ever happened in Korea was Typhoon Rusa occured in 2002, whose damage costed the nation more than 8 trillion-won. In 2003, Typhoon Maemi caused a loss of more than 6 trillion-won. Typhoon Ewiniar inflicted more than 2 trillion-won in economic losses in 2006. Since then, natural disasters have inflicted less serious damage, causing 180 billion-won-worth property damage in 2014.

Damage caused by natural disasters has been slightly increasing since 2000. This is because 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 since 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 and mitigating the damages from natural disasters.

Natural Disasters

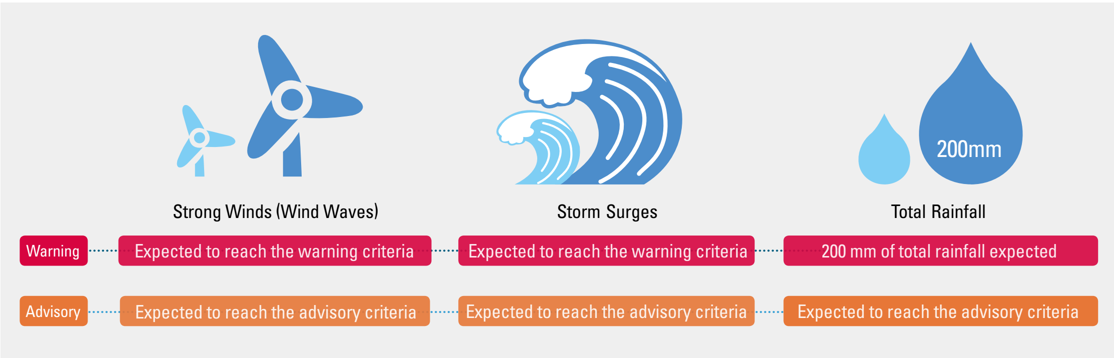
Damage Caused by Natural Disasters (2005 – 2014)



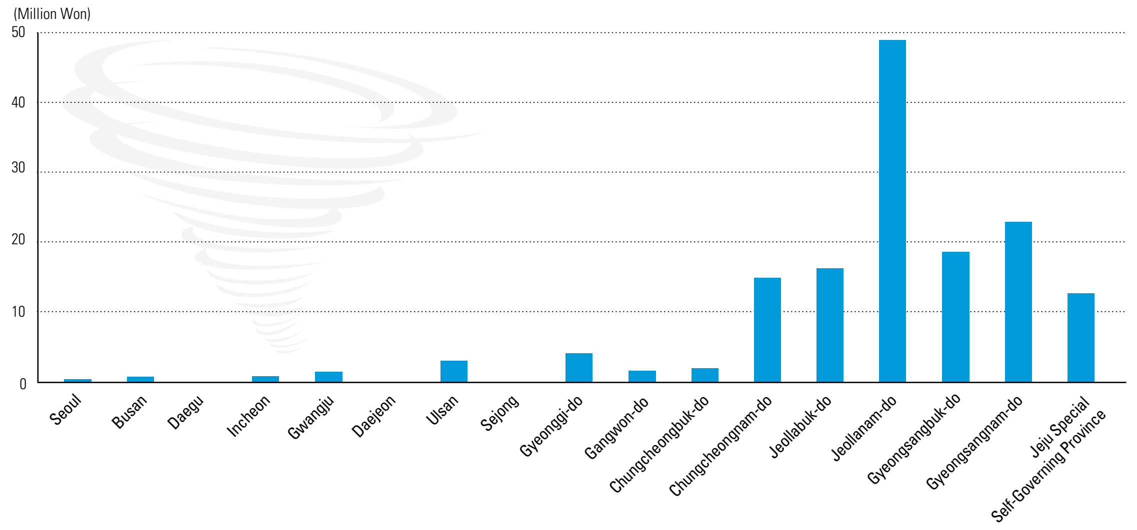
Storm and Flood

Storm Warnings

Type	Advisory	Warning
Typhoons	When strong winds, wind waves, heavy rains, and storm surges caused by typhoons are expected to reach advisory criteria.	When wind speed reaches the criteria for strong winds. When the total rainfall is expected to exceed 200 mm. When storm surge reaches the warning criteria.
Strong Winds	When the wind speed exceeds 14 m/s or instantaneous wind speed reaches 20 m/s in the low land areas. When wind speed is expected to be over 17 m/s or instantaneous wind speed reaches 25 m/s in the mountains	When the wind speed exceeds 21 m/s or instantaneous wind speed reaches 26 m/s in the low land areas. When wind speed is expected to be over 24 m/s or instantaneous wind speed reaches 30 m/s in the mountains.
Wind Waves	When the wind speed over the sea is sustained at 14 m/s for more than three hours or significant wave height is expected to exceed three meters.	When the wind speed over the sea is sustained at 21 m/s for more than three hours or significant wave height is expected to exceed five meters.
Heavy Rains	When rainfall is expected to reach more than 70 mm over a 6-hour period, or more than 110 mm over a 12-hour period.	When rainfall is expected to reach more than 110 mm over a 6-hour period, or more than 180 mm over a 12-hour period.
Storm Surges	When reporting criteria are expected to exceed sea level rise thresholds with complex effects such as astronomical tides, storms, and low pressure. The criteria are made according to regional reporting.	When reporting criteria are expected to exceed sea level rise thresholds with complex effects such as astronomical tide, storms, and low pressure. The criteria are made according to regional reporting.



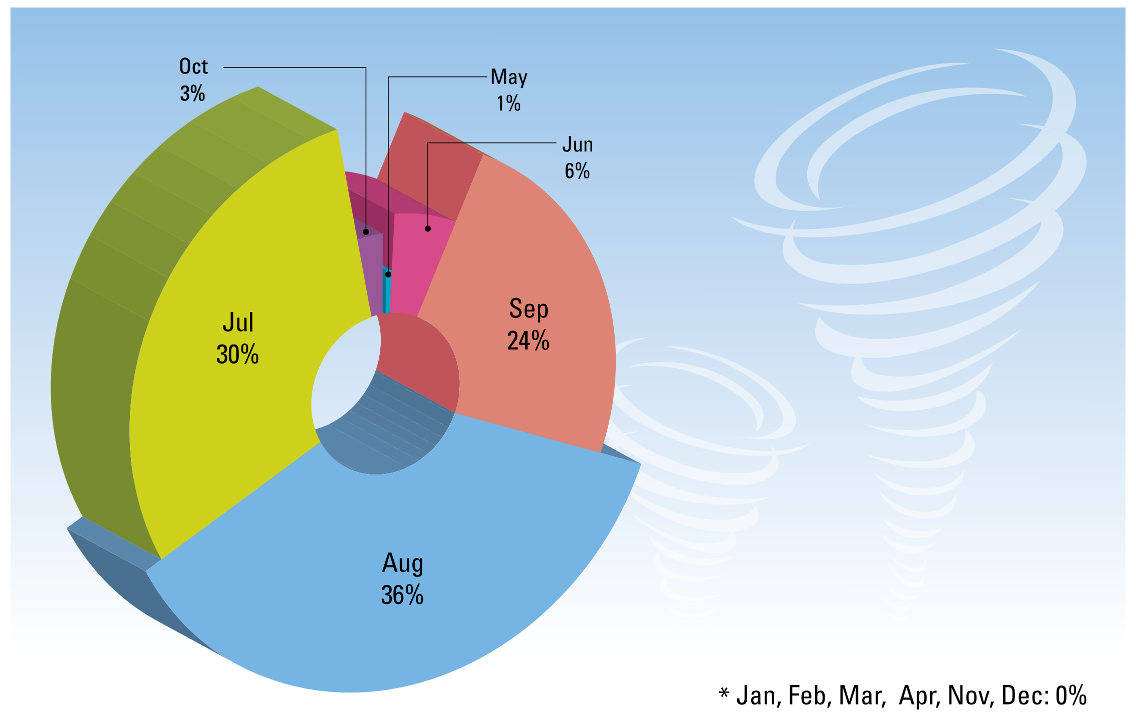
Average Annual Damage Caused by Typhoons (2005 – 2014)



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. Typhoon varies by size; small typhoons are measured as 200 km in diameter, large typhoons span over 1,500 km.

Since a Special Disaster Zone was declared after the Sampoong Department Store collapse in Seoul, Special Disaster Zones have been designated 14 times by 9 typhoons; Those 9 typhoons were Rusa (September 16, 2002), Maemi (September 22, 2003), Ewiniar (July 18 and October 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), and Sanba (September 26, 2012).

Monthly Occurrence of Typhoons in Korea (1904 – 2014)



* Jan, Feb, Mar, Apr, Nov, Dec: 0%

List of Typhoons by Casualty

Casualties			
Rank	Date (yyyy/mm/dd)	Typhoon	Deaths and Missing (Person)
1	1936/08/20 – 28	3693	1,232
2	1923/08/11 – 14	2353	1,157
3	1959/09/15 – 18	SARAH	849
4	1972/08/19 – 20	BETTY	550
5	1925/07/15 – 18	2560	516
6	1914/09/07 – 13	1428	432
7	1933/08/03 – 05	3383	415
8	1987/07/15 – 16	THELMA	345
9	1934/07/20 – 24	3486	265
10	2002/08/30 – 09/01	RUSA	246

* Damage cost is criterion of that year

List of Typhoons by Damage Cost

Property		
Date (yyyy/mm/dd)	Name of Typhoons	Damage Cost (100 Million Won)
2002/08/30 – 09/01	RUSA	51,479
2003/09/12 – 09/13	MAEMI	42,225
1990/07/23 – 08/04	OLGA	10,490
2012/08/25 – 08/30	BOLAVEN, TEMBIN	6,365
1995/08/19 – 08/30	JANIS	4,563
1987/07/15 – 07/16	THELMA	3,913
2012/09/15 – 09/17	SANBA	3,657
1998/09/29 – 10/01	YANNI	2,749
2000/08/23 – 09/01	PRAPIROON	2,520
2004/08/17 – 08/20	MEGI	2,508

National Emergency Management (Each Year)

Classification of Typhoons

The WMO (World Meteorological Organization) classifies typhoons into 4 classes. Once a storm reaches the status of tropical storm, a unique number and name are given. Each nation differs when it comes to classifying stages of typhoons. Korea and Japan classify tropical storms as typhoons once the maximum wind speed exceeds 17 m/s.

Maximum wind speed at storm center	WMO	Korea and Japan	
Below 17 m/s (< 34 knots)	TD: Tropical Depression		
18 – 24 m/s (34 – 47 knots)	TS: Tropical Storm	TS	Typhoon
25 – 32 m/s (48 – 63 knots)	STS: Severe Tropical Storm	STS	
Over 33 m/s (> 63 knots)	TY: Typhoon	TY	

* 1 m/s ≒ 1.94 knots

Comparing Typhoons and Other Natural Disasters

If a typhoon reaches land, buildings can collapse, electronic communication systems can be disrupted, and rivers can overflow. As seen in the table, a typhoon's energy is 10,000 times greater than the atomic bomb that was dropped on Nagasaki, Japan in 1945.

Criteria	Intensity
Global Heat Consumption in 1950	100
Typhoon	1
Volcanic Eruption in Krakatoa	1/10
Atomic Bomb in Nagasaki	1/10,000
Lightning	1/1,000,000,000
Wind Gust	1/10,000,000,000,000

Intensity of Typhoons

Typhoons can be classified according to intensity; the criterion for intensity is the maximum wind speed at the center of the typhoon.

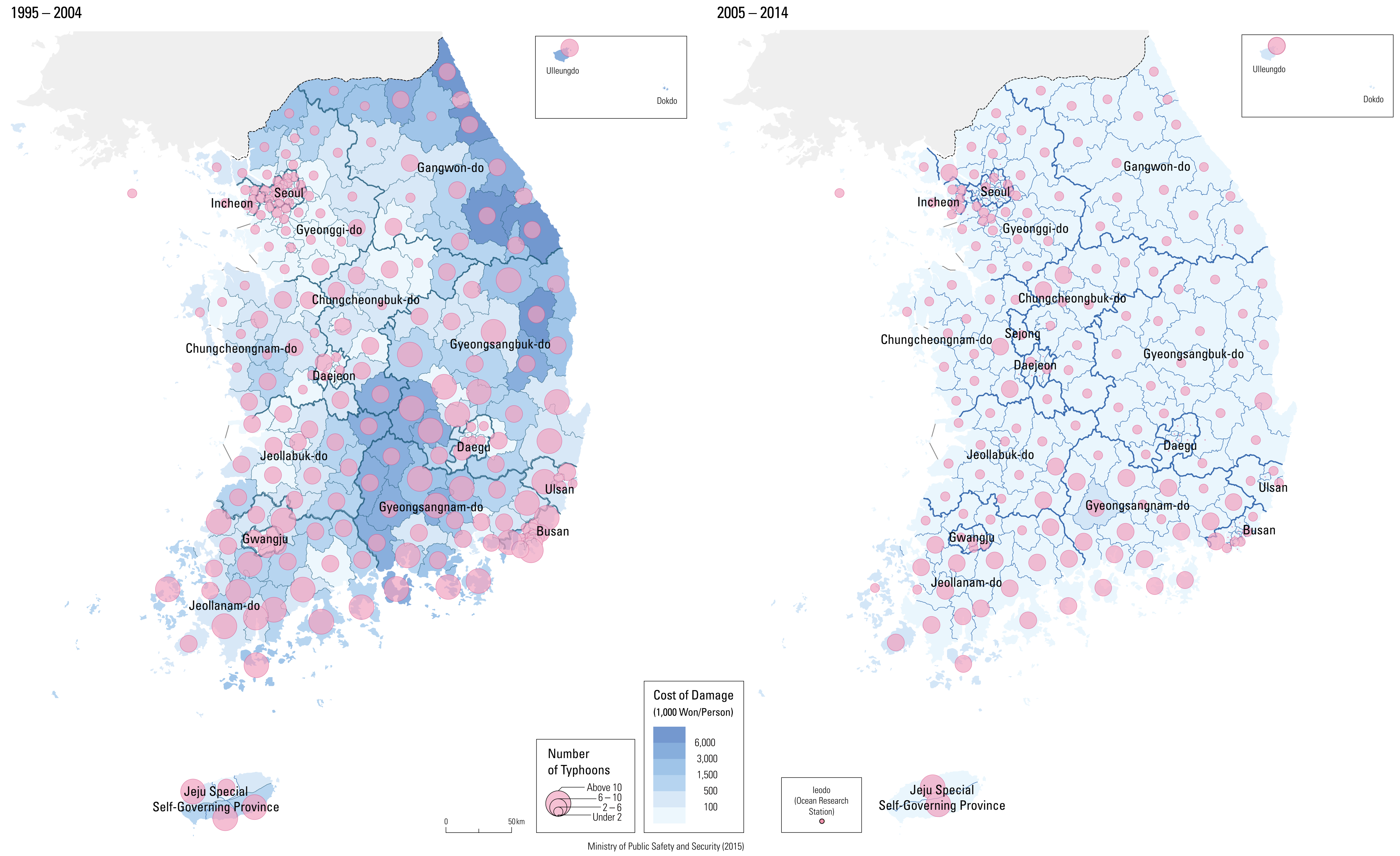
Class	Wind speed
Weak	17 – 25 m/s (34 – 47 knots)
Moderate	25 – 33 m/s (48 – 63 knots)
Strong	33 – 44 m/s (64 – 84 knots)
Very Strong	Over 44 m/s (> 84 knots)

Scale of Typhoons

Typhoons can be classified by the length of the radius along which the wind blows at 15 m/s or more from the center of the typhoon.

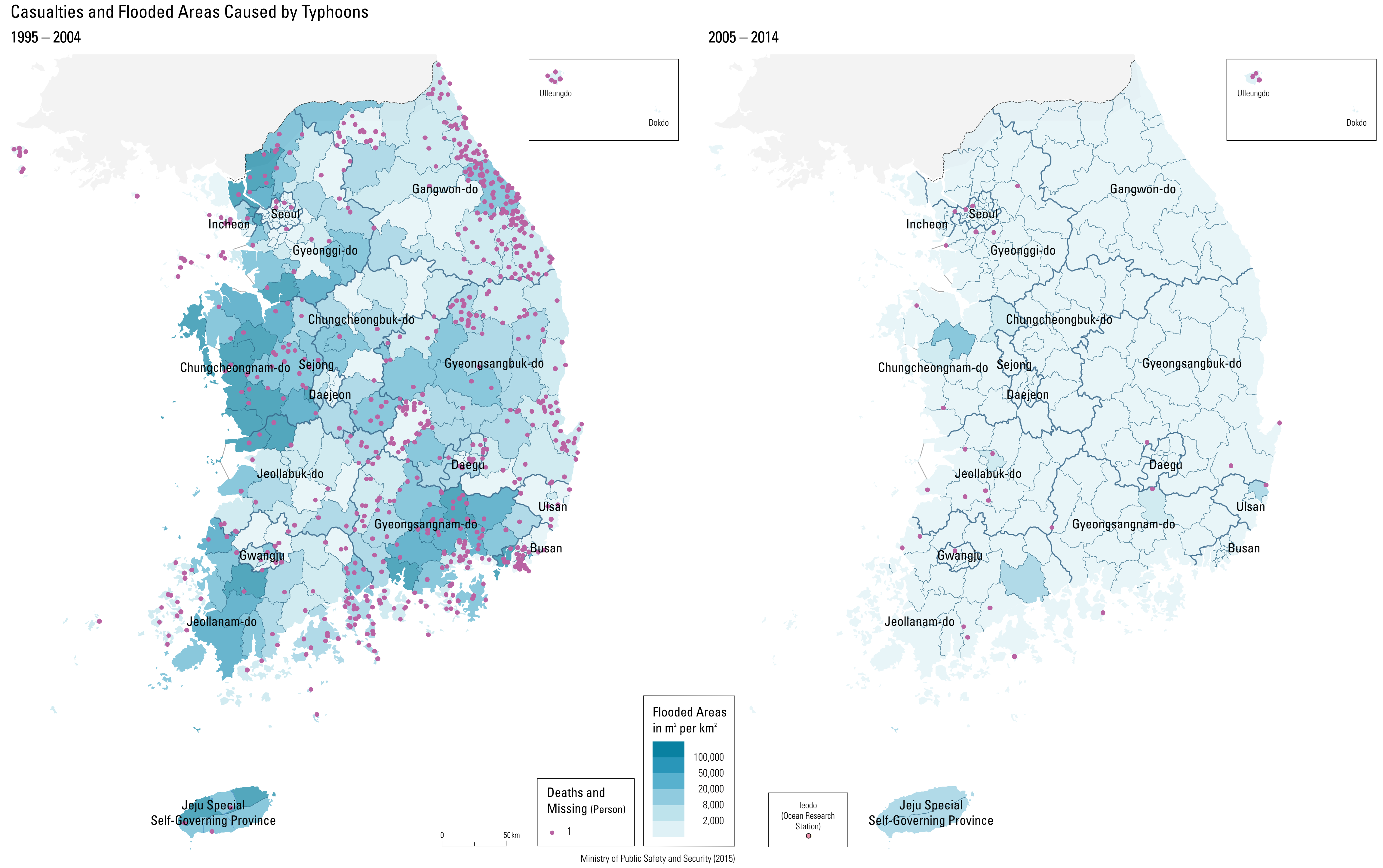
Class	Length of the radius along which the wind blows at 15 m/s or more from the center of the typhoon
Small	Below 300 km
Medium	300 – 500 km
Large	500 – 800 km
Mega	Over 800 km

Typhoon Occurrences and Damage



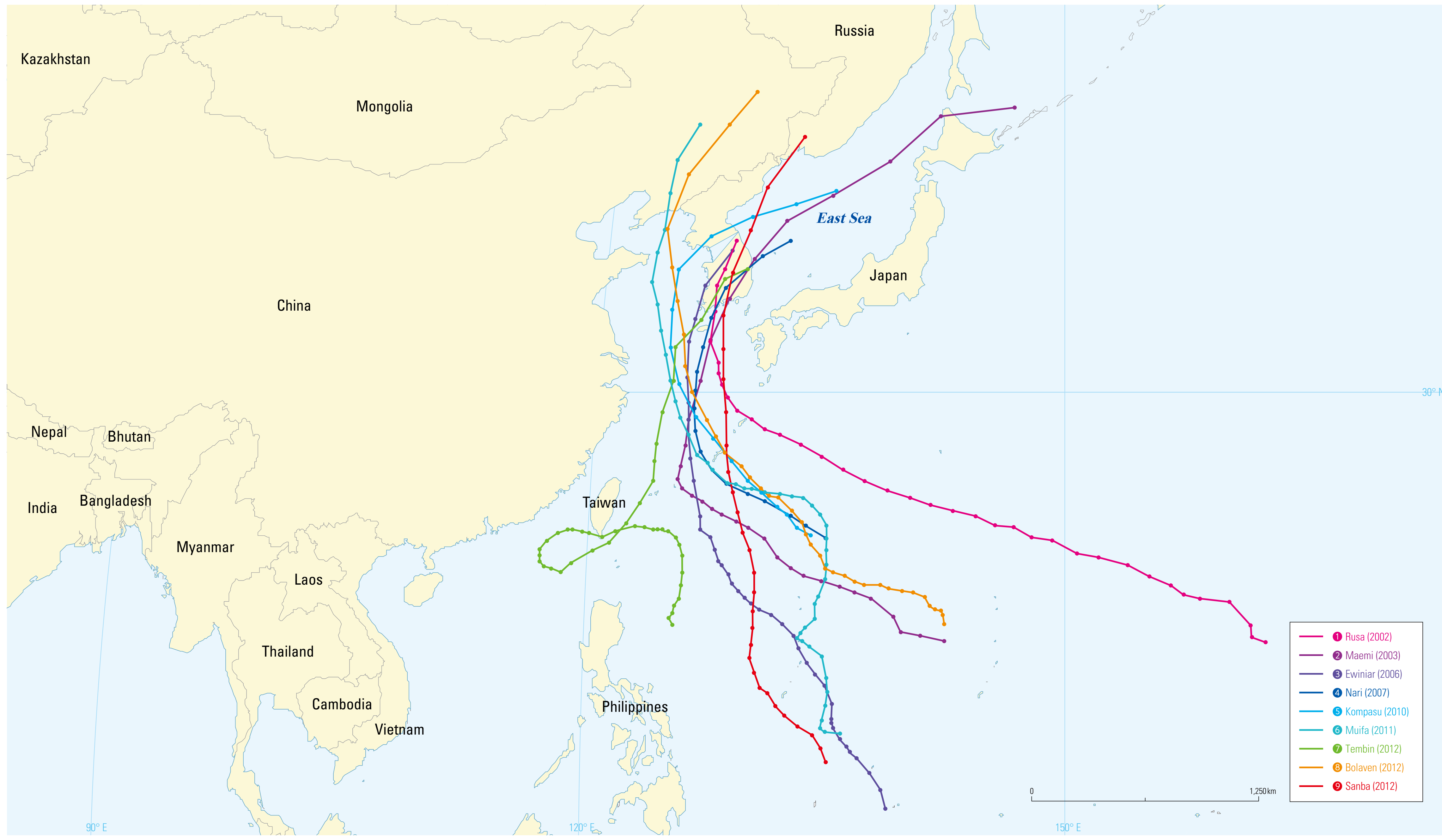
Ministry of Public Safety and Security (2015)

Casualties and Flooded Areas Caused by Typhoons



Ministry of Public Safety and Security (2015)

Routes of Typhoons (Special Disaster Zones Declared)



Damage Caused by Typhoons (Special Disaster Zones Declared)

Period of Occurrence, Fatalities, and Damaged Property by Rusa

RUSA	
Typhoon Number	2002 – 15
Period of Occurrence	2002/08/23 – 2002/09/01
Period of Damage	2002/08/30 – 2002/09/01
Victims	63,085
Deaths and Missing Persons	246
Converted Damages Based on 2014 (1,000 Won)	6,897,776,194
Damages Based on that Year (1,000 Won)	5,147,917,215

Period of Occurrence, Fatalities, and Damaged Property by Maemi

MAEMI	
Typhoon Number	2003 – 14
Period of Occurrence	2003/09/06 – 2003/09/14
Period of Damage	2003/09/12 – 2003/09/13
Victims	61,844
Deaths and Missing Persons	131
Converted Damages Based on 2014 (1,000 Won)	5,537,142,793
Damages Based on that Year (1,000 Won)	4,222,485,994

Period of Occurrence, Fatalities, and Damaged Property by Ewiniar

EWINIAR	
Typhoon Number	2006 – 03
Period of Occurrence	2006/07/01 – 2006/07/10
Period of Damage	2006/07/09 – 2006/07/29
Victims	2,790
Deaths and Missing Persons	652
Converted Damages Based on 2014 (1,000 Won)	2,200,602,331
Damages Based on that Year (1,000 Won)	1,834,428,129

Period of Occurrence, Fatalities, and Damaged Property by Nari

NARI	
Typhoon Number	2007 – 11
Period of Occurrence	2007/09/13 – 2007/09/17
Period of Damage	2007/09/13 – 2007/09/18
Victims	478
Deaths and Missing Persons	16
Converted Damages Based on 2014 (1,000 Won)	188,240,000
Damages Based on that Year (1,000 Won)	159,174,700

Period of Occurrence, Fatalities, and Damaged Property by Kompasu

KOMPASU	
Typhoon Number	2010 – 07
Period of Occurrence	2010/08/29 – 2010/09/03
Period of Damage	2010/09/01 – 2010/09/03
Victims	1,711
Deaths and Missing Persons	6
Converted Damages Based on 2014 (1,000 Won)	176,039,077
Damages Based on that Year (1,000 Won)	167,385,259

Period of Occurrence, Fatalities, and Damaged Property by Muifa

MUIFA	
Typhoon Number	2011 – 09
Period of Occurrence	2011/07/28 – 2011/08/09
Period of Damage	2011/08/06 – 2011/08/10
Victims	3,358
Deaths and Missing Persons	1
Converted Damages Based on 2014 (1,000 Won)	215,170,386
Damages Based on that Year (1,000 Won)	218,314,109

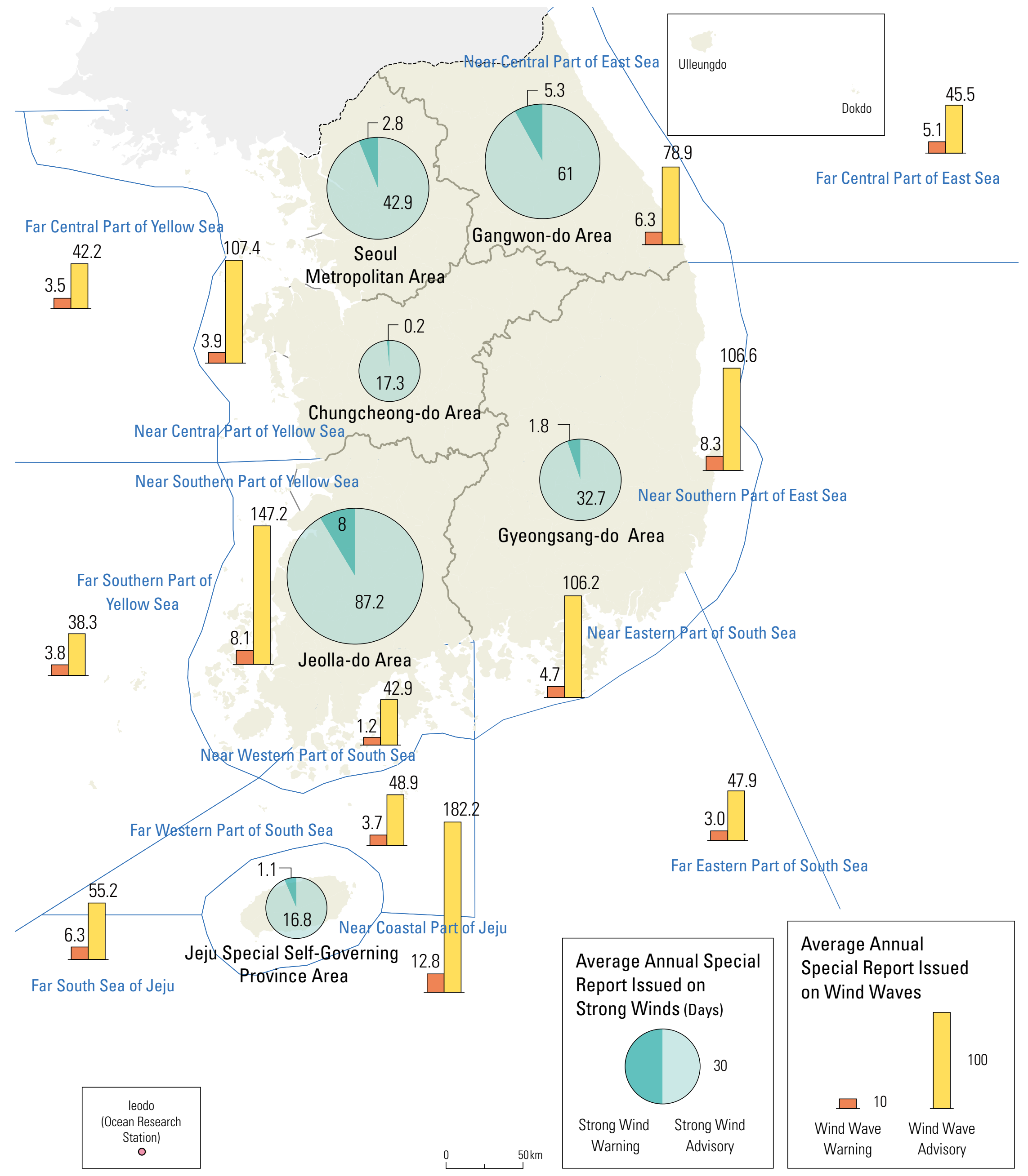
Period of Occurrence, Fatalities, and Damaged Property by Tembin and Bolaven

TEMBIN/BOLAVEN	
Typhoon Number	2012 – 14,15
Period of Occurrence	2012/08/19 – 2012/08/31 2012/08/20 – 2012/08/29
Period of Damage	2012/08/25 – 2012/08/30
Victims	3,830
Deaths and Missing Persons	11
Converted Damages Based on 2014 (1,000 Won)	622,965,826
Damages Based on that Year (1,000 Won)	636,471,218

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 2014 (1,000 Won)	357,955,776
Damages Based on that Year (1,000 Won)	365,715,966

Average Annual Issuance on Special Report of Strong Winds and Wind Waves by Region (2005 – 2014)

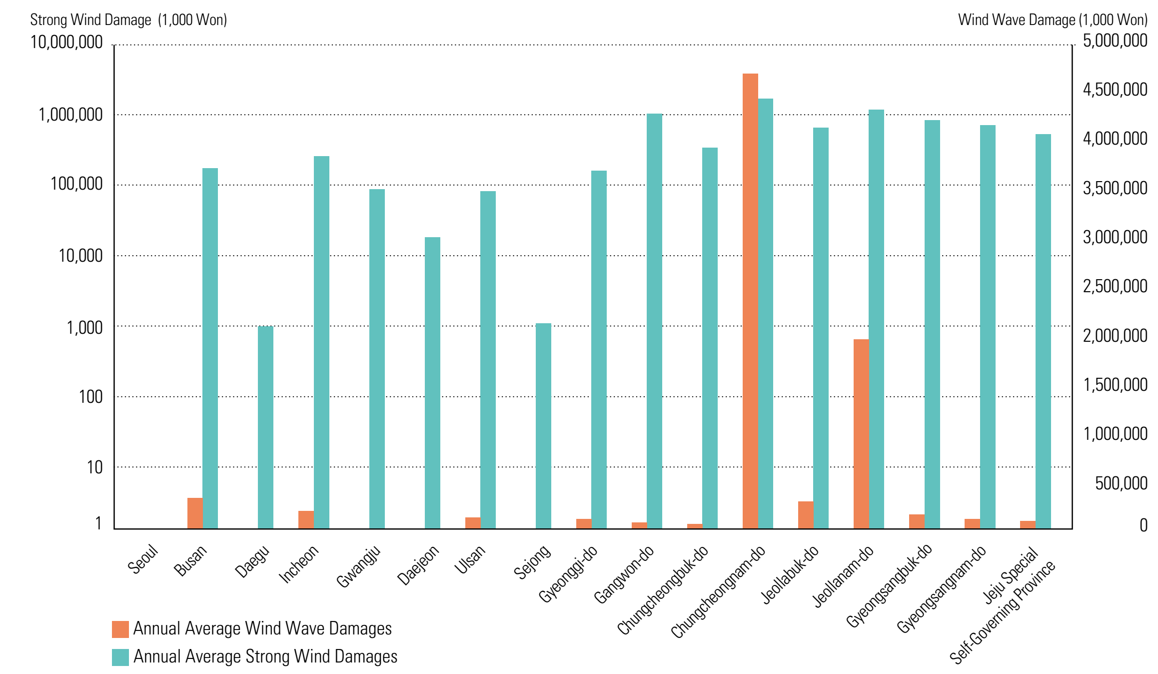


Korea Meteorological Administration (2015)

A wind disaster is a disaster caused by wind, particularly strong winds that have critical wind speeds. In terms of special weather report, a strong wind refers to wind on land, while wind waves refer to wind and associated waves on the water. Special reports are issued for strong winds, and wind waves are categorized as advisories or warnings.

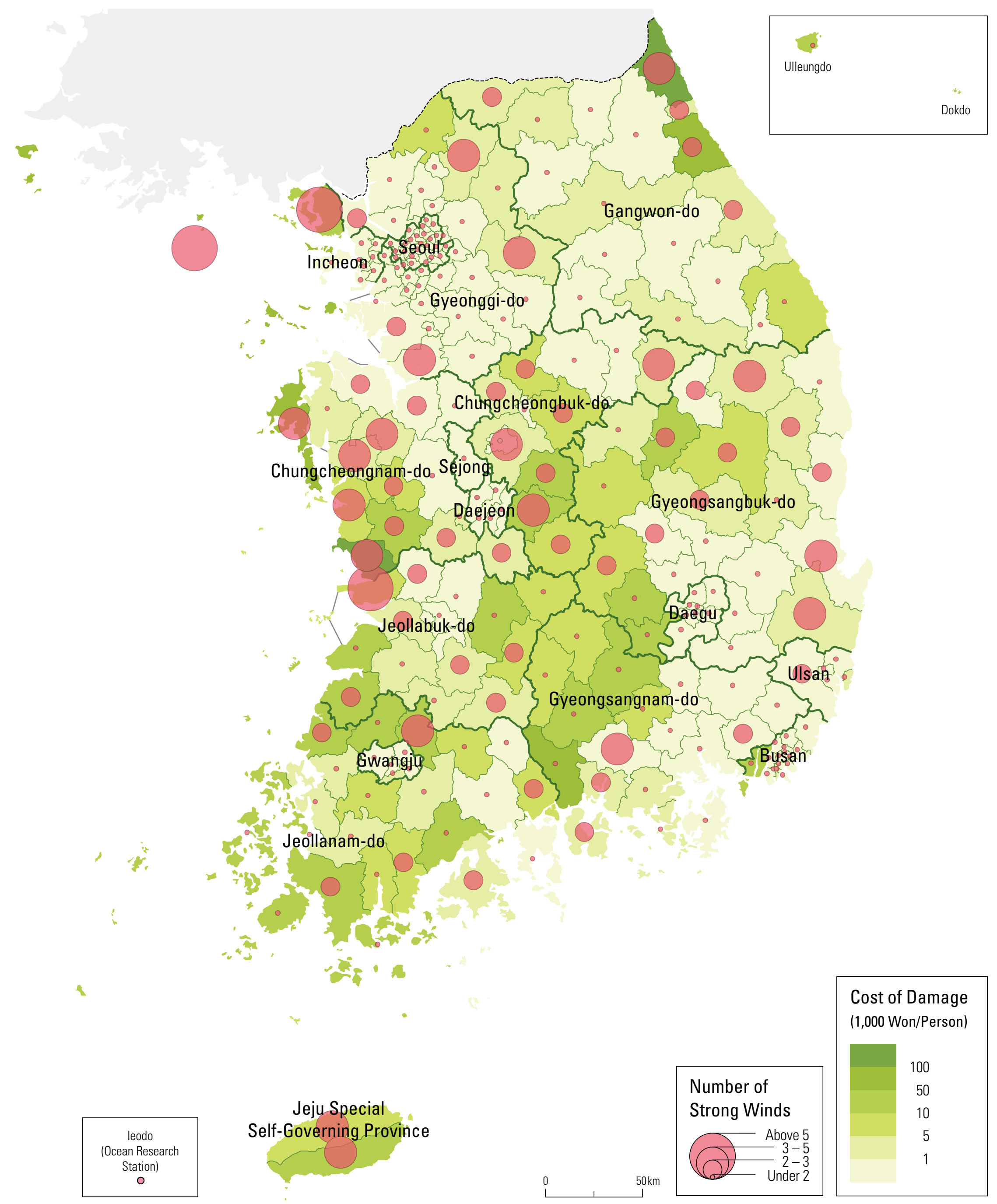
A strong wind advisory is issued when the wind speed exceeds 14 m/s or instantaneous wind speed reaches 20 m/s in lowland areas, and when wind speed exceeds 17 m/s or instantaneous wind speed reaches 25 m/s in mountainous areas. A strong wind warning is issued when the wind speed exceeds 21 m/s or instantaneous 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 significant wave height exceeds five meters.

Average Annual Damage Caused by Strong Winds and Wind Waves (2005 – 2014)



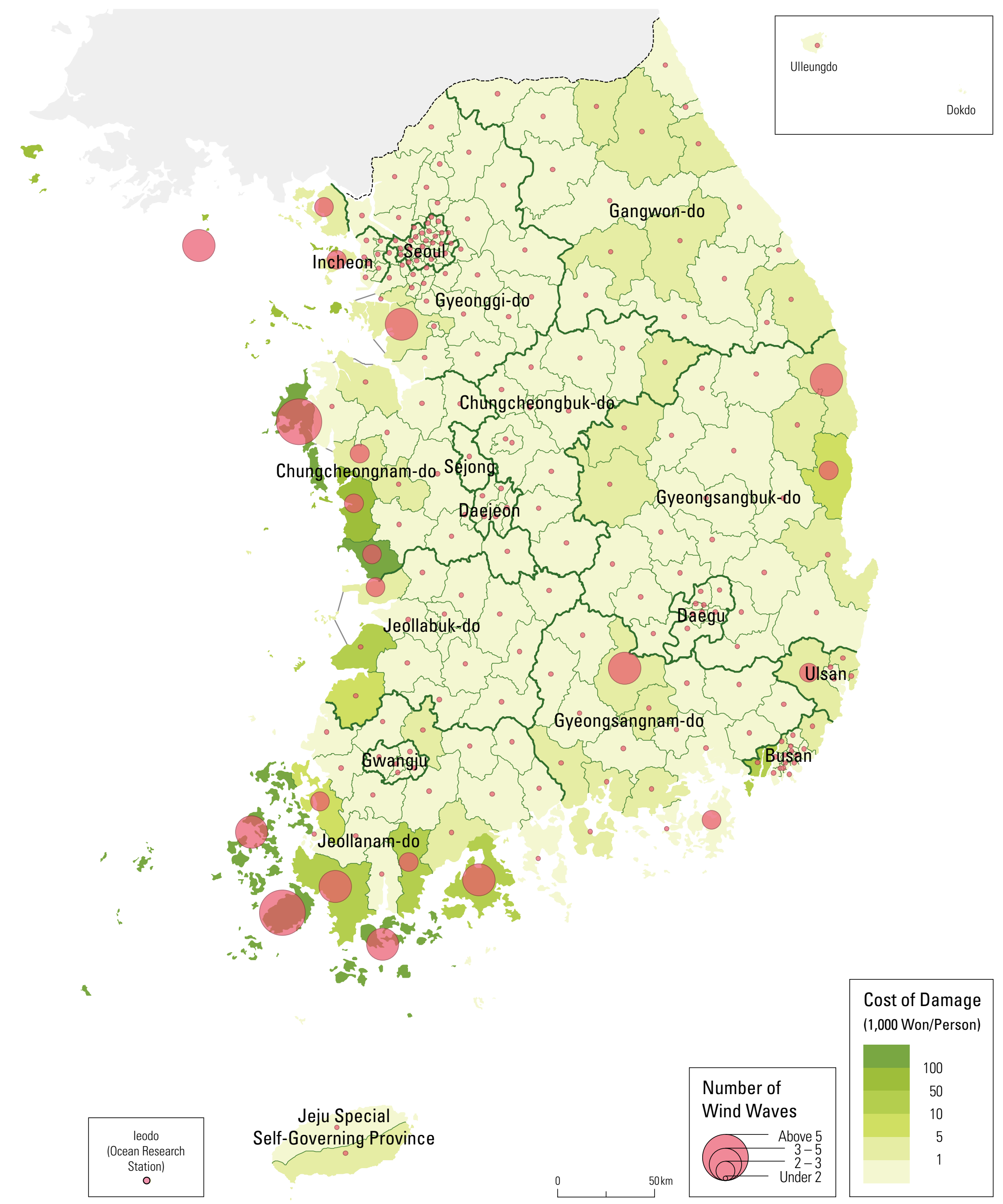
Ministry of Public Safety and Security (2015)

Strong Wind Occurrences and Cost of Damage per Person (2005 – 2014)



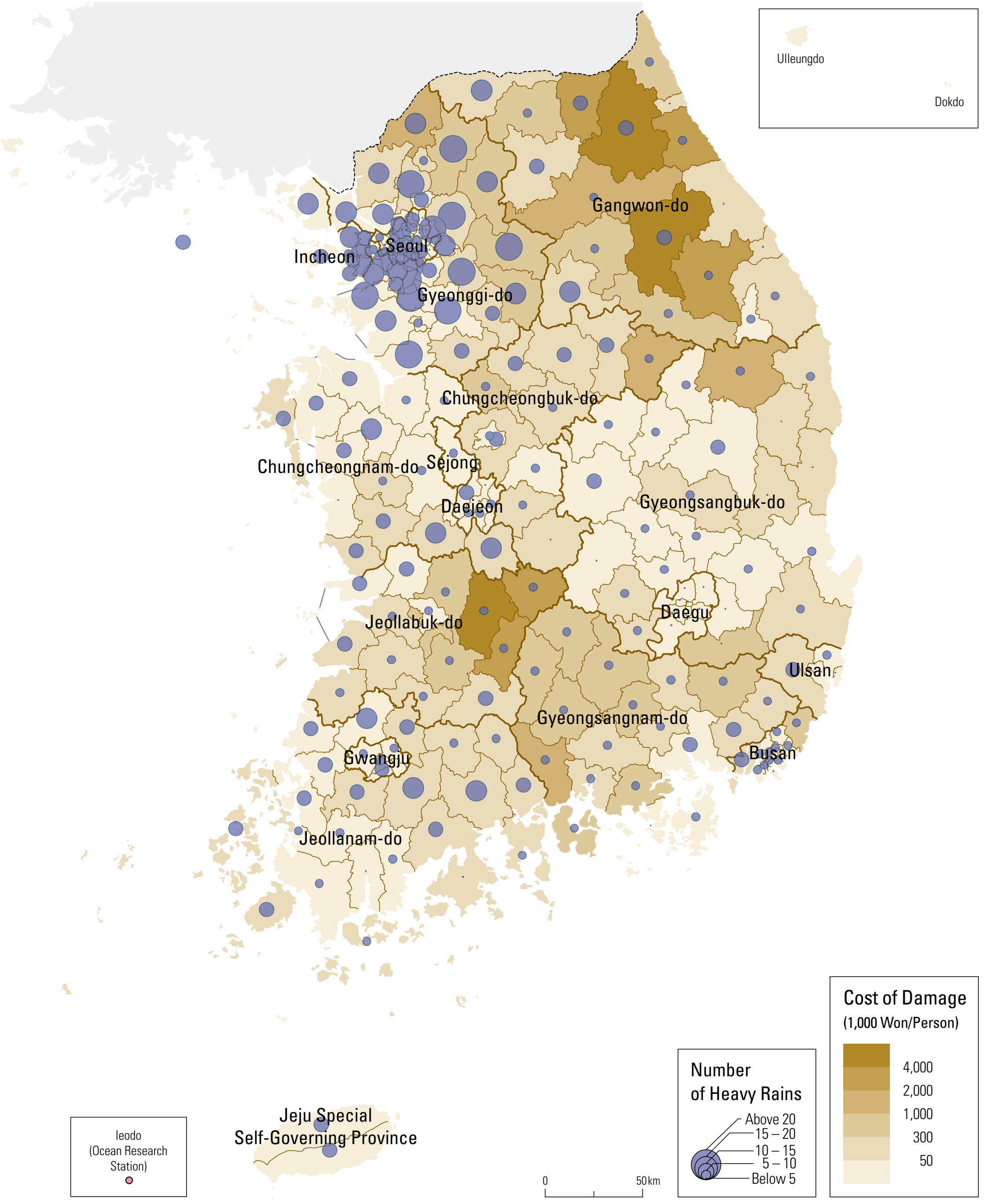
Ministry of Public Safety and Security (2015)

Wind Wave Occurrences and Cost of Damage per Person (2005 – 2014)



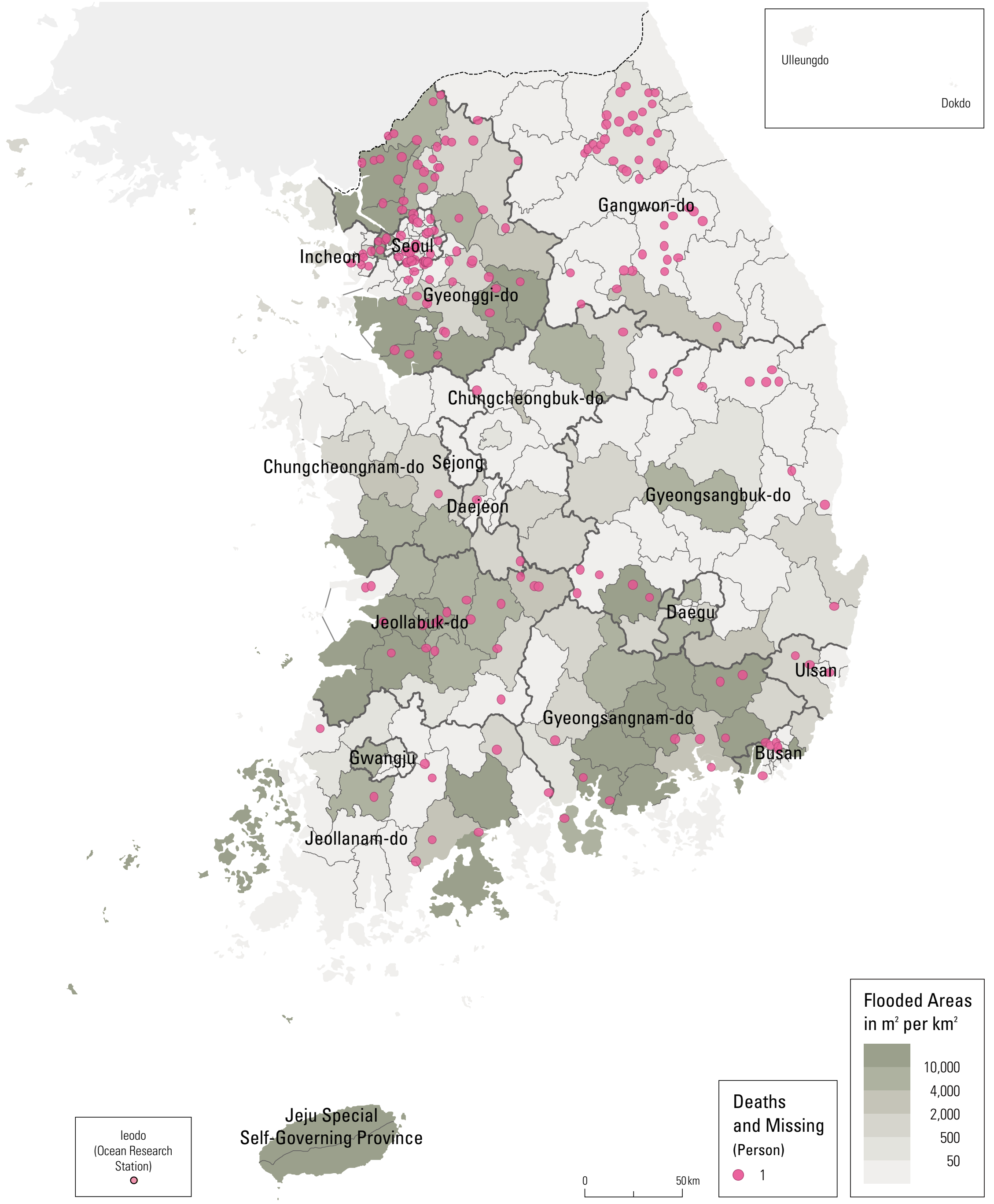
Ministry of Public Safety and Security (2015)

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



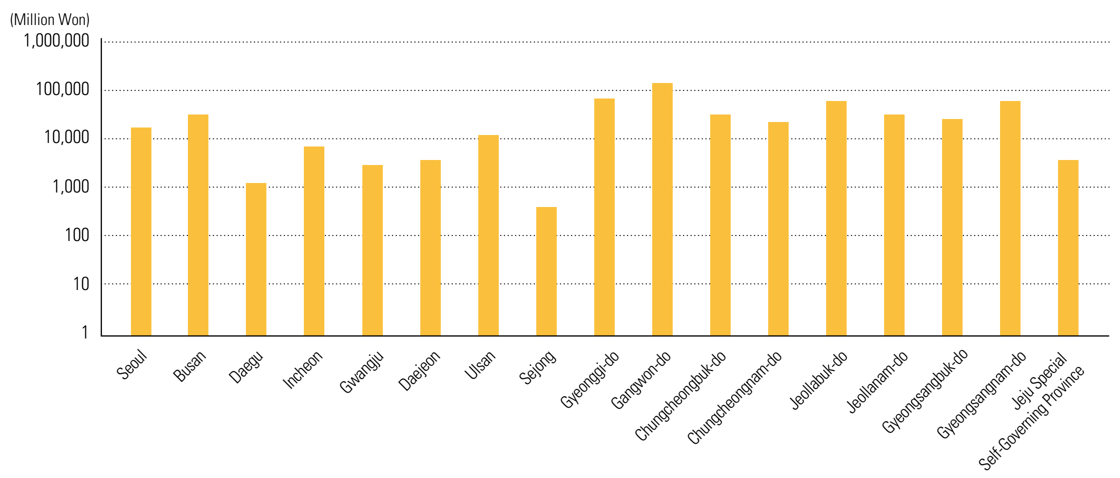
Ministry of Public Safety and Security (2015)

Casualties and Flooded Areas Caused by Heavy Rains (2005 – 2014)



Ministry of Public Safety and Security (2015)

Average Annual Damage Caused by Heavy Rains (2005 – 2014)



Ministry of Public Safety and Security (2015)

Representative Picture of Flood

Representative Picture of Heavy Rain

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	1990/09/09 – 09/12	1995/08/19 – 30	1997/07/21 – 23	1996/07/26 – 28	1989/07/25 – 27	2005/08/02 – 11
Type of Heavy Rain		Heavy Rain and Typhoon (EWINIAR)	Heavy Rain	Heavy Rain and Typhoon (OLGA)	Heavy Rain	Heavy Rain	Heavy Rain and Typhoon (JANIS)	Heavy Rain	Heavy Rain	Heavy Rain	Heavy Rain
Deaths and Missing	Person	62	324	67	23	163	65	167	29	128	19
Damages (1,000 Won)	Converted Cost of Damage Based on 2014 Value of Won	2,200,602,331	1,658,447,494	1,423,767,619	1,230,219,609	1,025,510,273	729,129,737	667,680,999	661,810,428	572,240,176	401,364,515
	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	520,312,144	456,252,049	329,498,700	427,530,669	294,338,865	331,563,650

Ministry of Public Safety and Security (Each Year)

During the rainy season, especially in the summer, Korea experiences heavy rains over a short period of time. The amount of rainfall often exceeds 300 mm a day and in some cases, it exceeds 100 mm per hour. Floods are natural events that occur when a river or large body of water overflows into the land. Flooding is a common natural disaster which has occurred most frequently 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 70 mm over a six-hour period or to exceed 110 mm over a 12-hour period. A heavy rain warning is issued when rainfall is expected to exceed 110 mm over a six-hour period or exceeds 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 an advisory water level (the water level that is in excess of 50% of the designed flood discharge capacity). A flood warning is issued when the water level is expected to exceed a warning water level (the water level that is in excess of 70% of the designed flood discharge capacity).

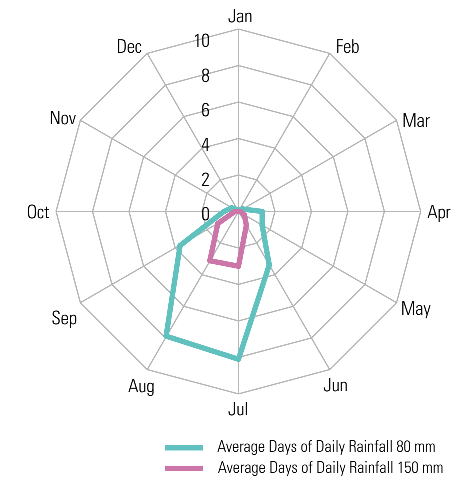
ANTHROPOSPHERE

Natural Hazards
Storm and Flood

According to the control records of rainy days of daily precipitation exceeding 80 mm or 150 mm over the last 30 years, it can be summarized as follows: first, the yearly average number of rainy days exceeding 80 mm of precipitation is 27. In 1998, there were 44 days for which daily precipitation exceeded 80 mm. Second, the yearly average number of rainy days exceeding 150 mm of precipitation is 9. In 1999, there were 17 days for which daily precipitation exceeded 150 mm. Third, roughly 84% of annual precipitation occurs from June to September, especially in July and August. In particular, heavy rain events are more concentrated in July and August when Korea falls in the path of typhoons and Jangma (East Asian monsoon) fronts.

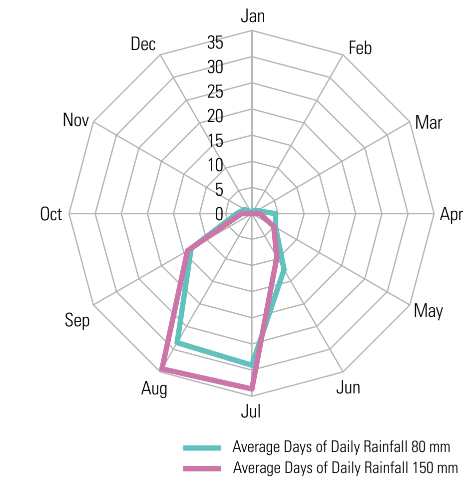
South Korea experiences more days of heavy rain in a year than North Korea, as total precipitation for South Korea is higher than for North Korea. Two geographical belts with higher frequency of heavy rain days lie east to west in the south coastal region including inland of Gyeongsangnam-do and in the central region of South Korea including Seoul. This reflects the fact that both the rainy season and local severe rainstorms move between east-west. In addition, Jeju experiences many heavy rainy days annually because it is in the path of the Jangma front and typhoons.

Average Monthly Heavy Rain Days (1981 – 2010)



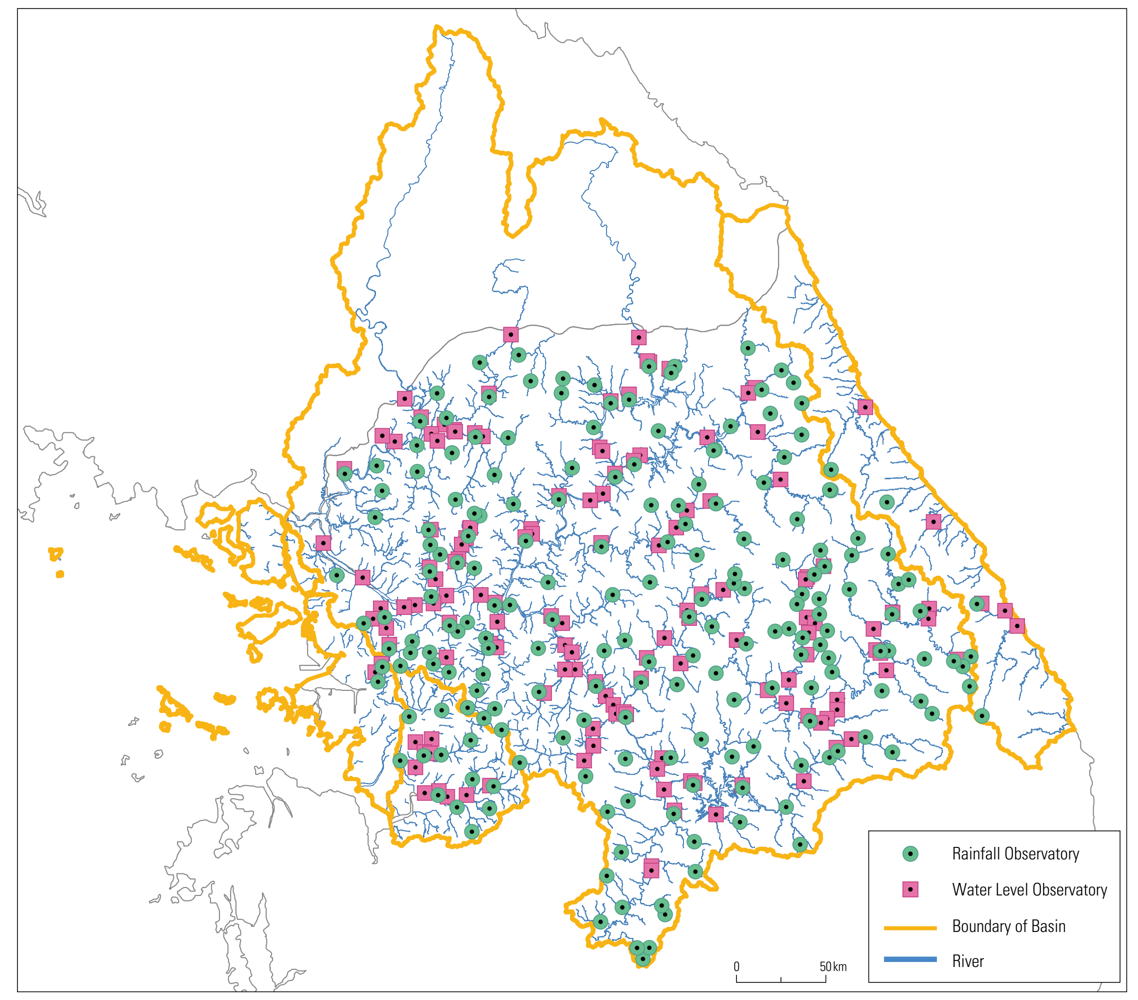
Korea Meteorological Administration (2011)

Ratio of Average Monthly Heavy Rain Days (1981 – 2010)



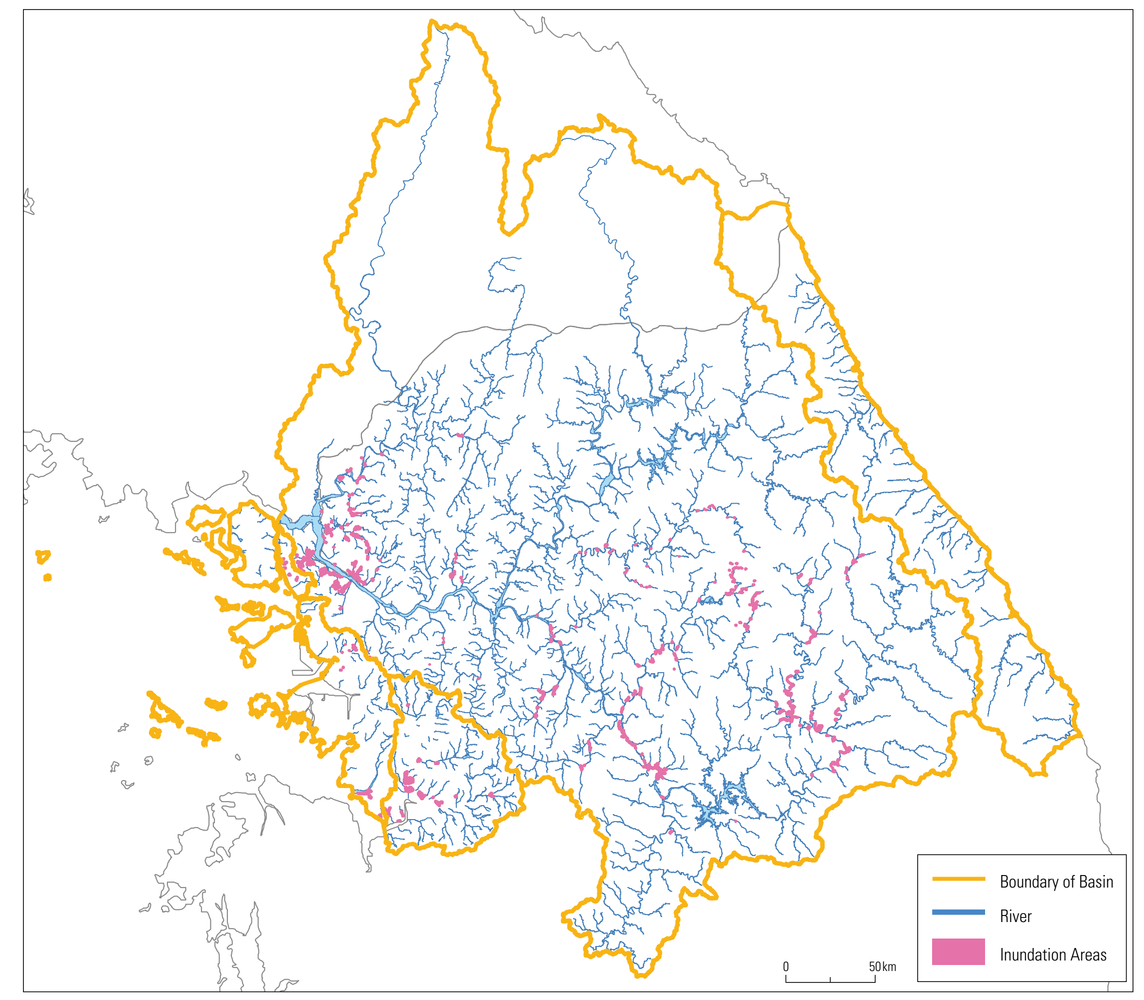
Korea Meteorological Administration (2011)

Hydrologic Network Map of Hangang Basin



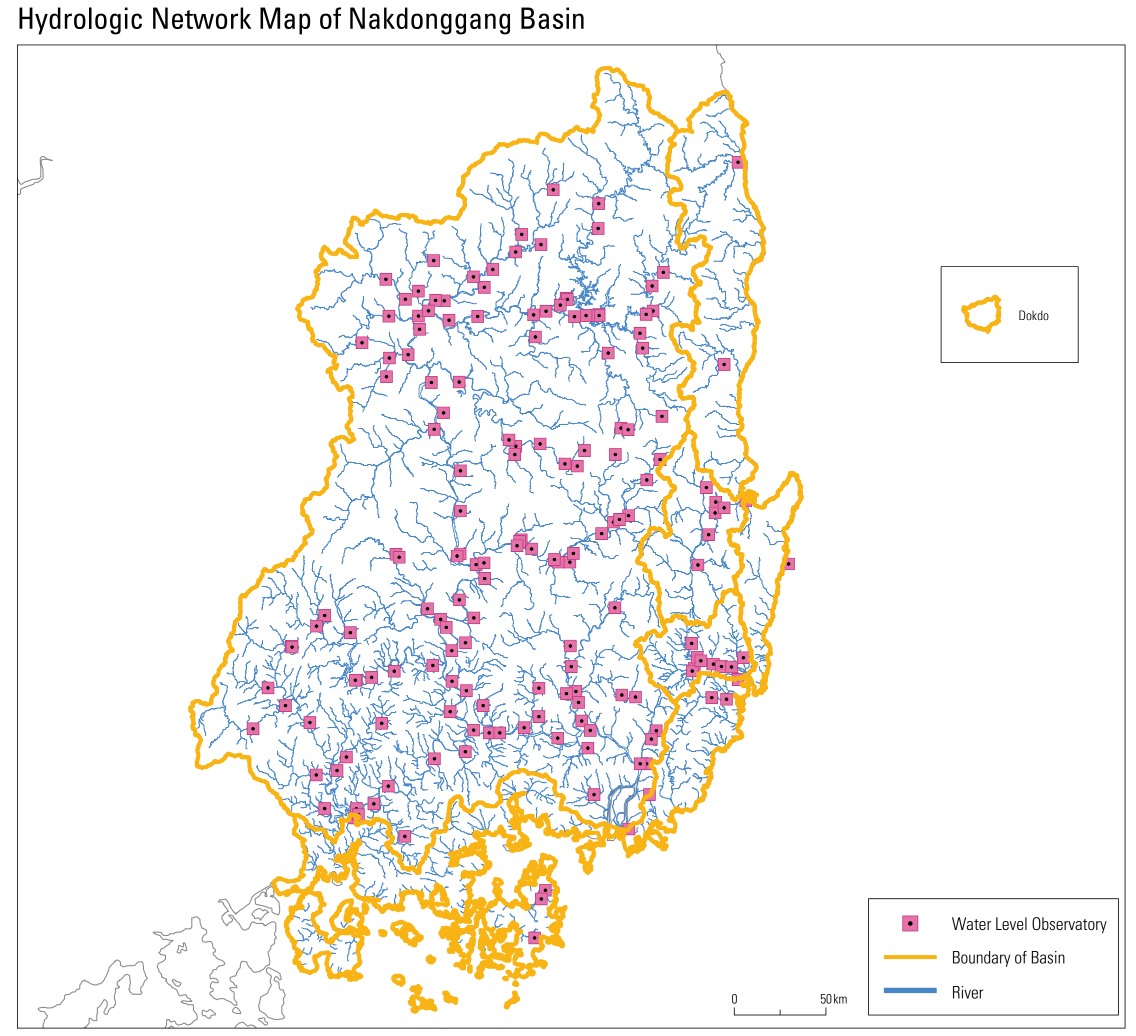
Water Resources Management Information System (2015)

Flood Hazard Map of Hangang Basin (2006 – 2009)



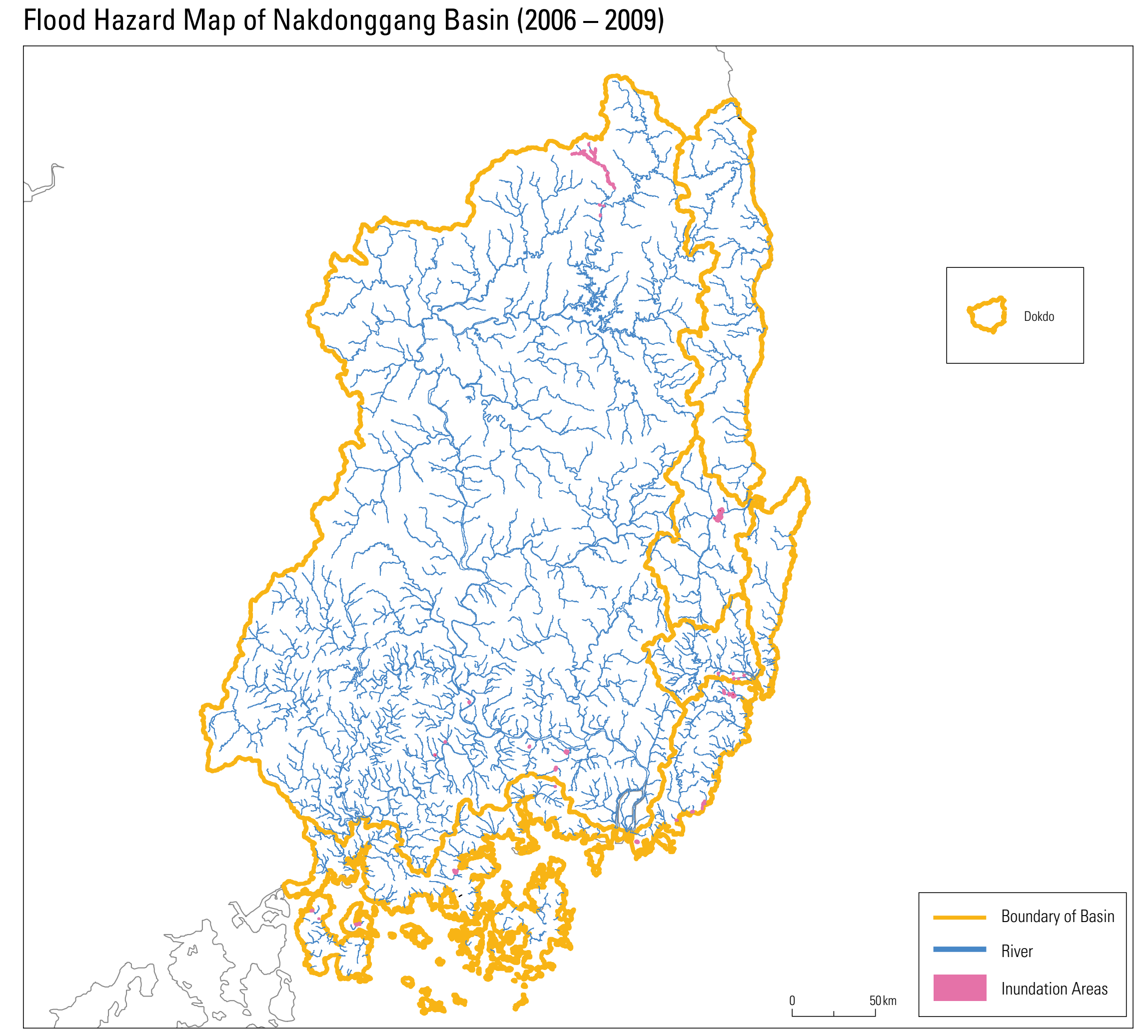
Water Resources Management Information System (2015)

Hydrologic Network Map of Nakdonggang Basin



Water Resources Management Information System (2015)

Flood Hazard Map of Nakdonggang Basin (2006 – 2009)

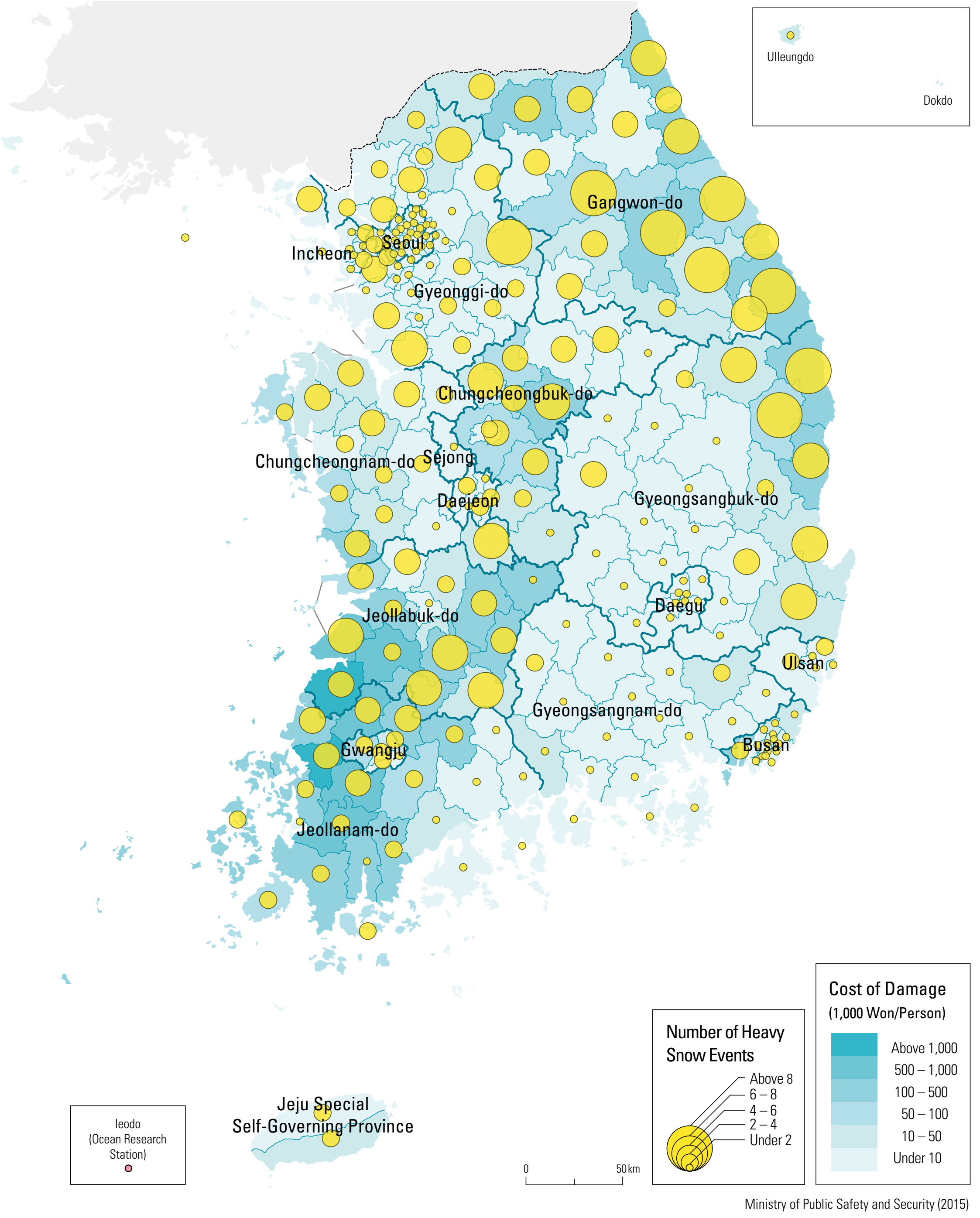


Water Resources Management Information System (2015)

The flood hazard map illustrates general conditions and damage conditions for regions that have been flooded. Locations, river codes, related rivers, times of occurrences, types of rainfall, and land uses are recorded as general conditions. Flooded area, flood duration, type of inundation, and cause of flood are recorded as damage conditions. The hydrologic network maps show the distribution of rainfall observatories and water level observatories. The rainfall and water level observatories are operated by the Ministry of Land, Infrastructure and Transport, Korea Rural Community Corporation, and other government organizations.

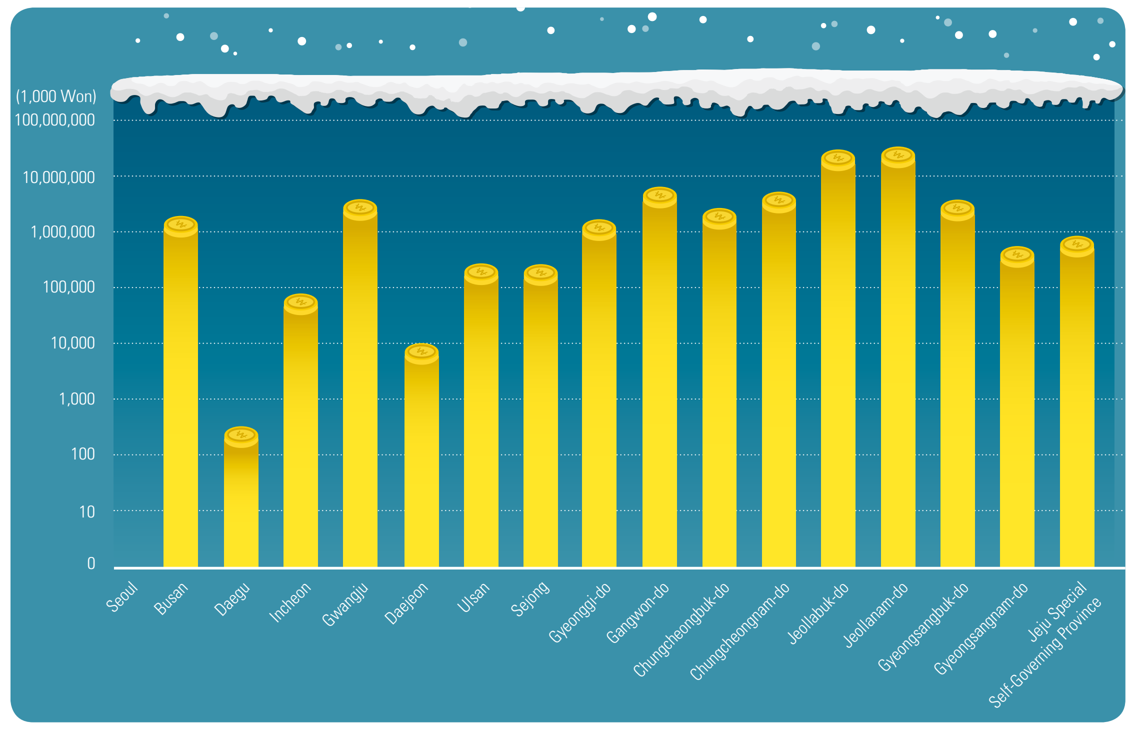
Heavy Snow

Heavy Snow Occurrences and Cost of Damage per Person (2005 – 2014)



Ministry of Public Safety and Security (2015)

Average Annual Cost of Damage Caused by Heavy Snows (2005 – 2014)



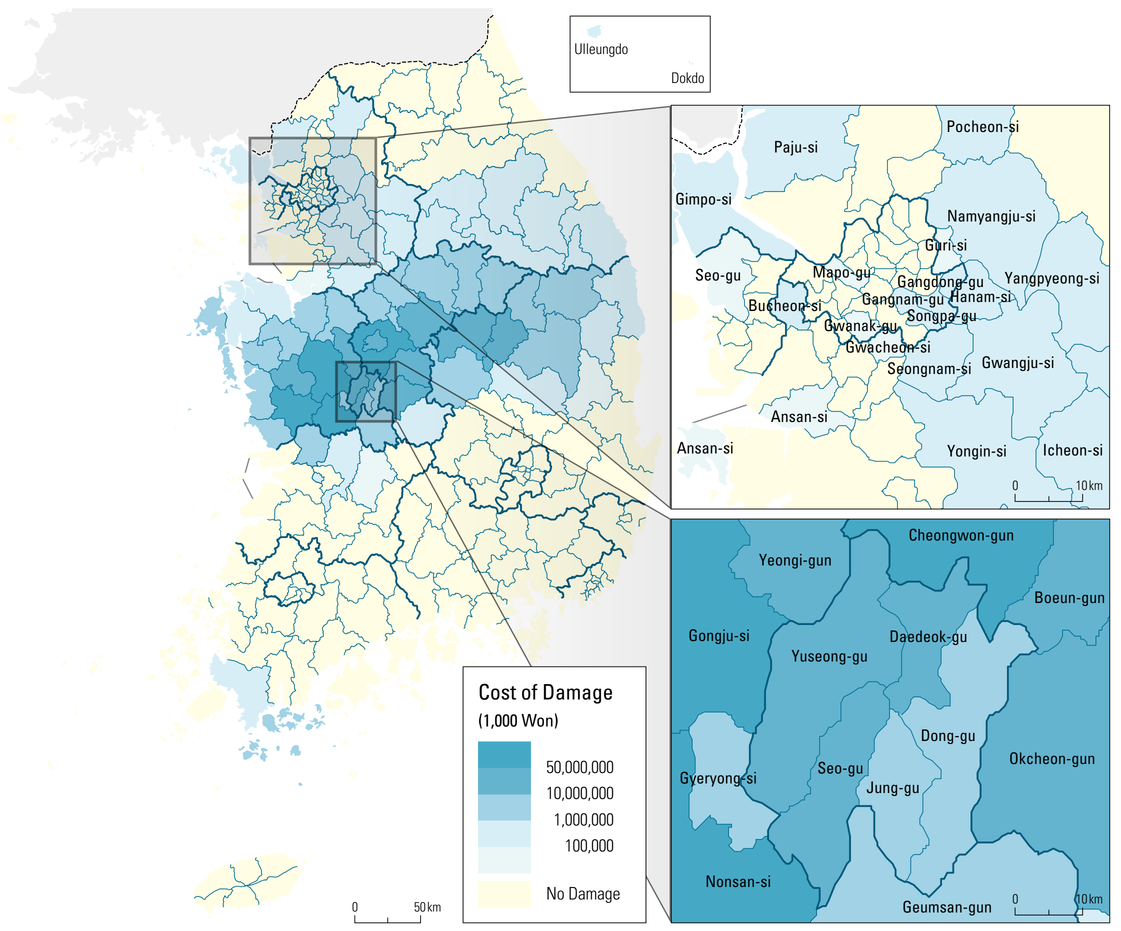
Ministry of Public Safety and Security (2015)

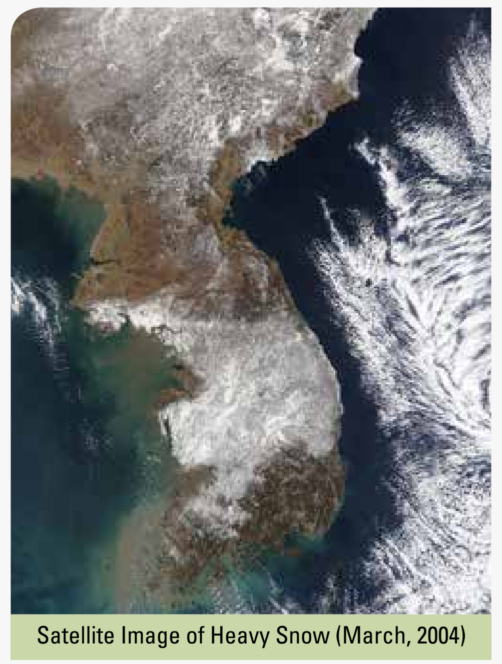
Street Scene with Heavy Snow that Can Cause Damage

Heavy snowfall is defined, based on spatial and temporal conditions, as an intense snow event in which a large amount of snow falls. According to the Korea 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. In the mountainous areas, a warning is issued when snow accumulation is expected to be 30 cm or greater. According to records of snowy days over the period of 1974 – 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 the mountainous areas such as Daegwallyeong.

The distribution of atmospheric pressures across Korea and surrounding areas determines the spatial patterns of heavy snowfalls. When isobars run north to south, and a northwest monsoon wind is strong as a high pressure system resides in the west, and low pressure resides 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 as a high pressure system resides in the north, and low pressure resides 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 temperature is quite low, snow can fall in the southern part of Korea.

Cost of Damage from Heavy Snow in March 2004





Satellite Image of Heavy Snow (March, 2004)

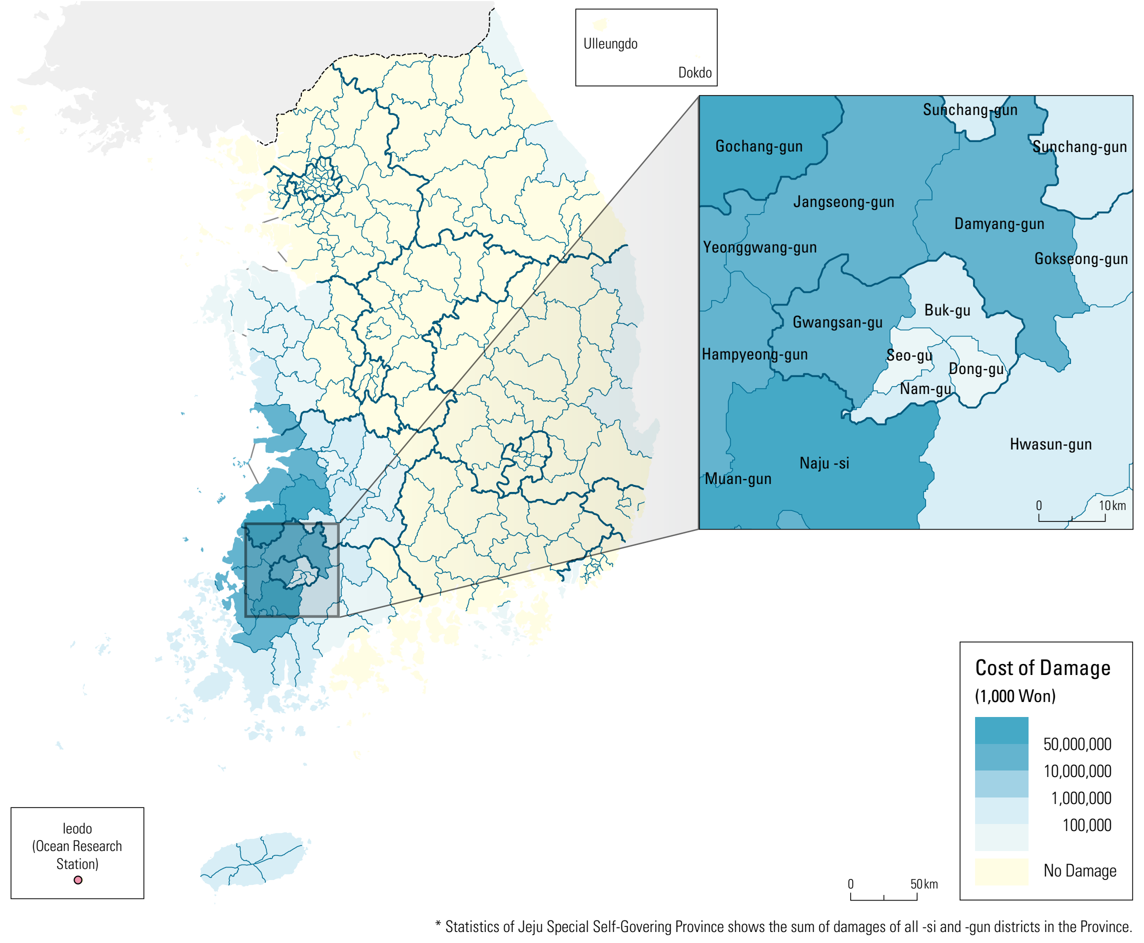
Damage by Heavy Snow (2004/Mar/04 – 05)

Total Cost of Damage (1,000 Won)	Victims (Persons)	Deaths and Missing Persons
673,423,501	25,145	0

Ministry of Public Safety and Security (2015)

On March 4 and 5, 2004, a heavy snowfall was accompanied by thunder and lightning. A warm, and humid air mass driven by cyclones in the Yellow Sea flowed into Korea so that the air above Korea was unstable because of a temperature difference. As a result, a lot of snow fell on March 4th: regional snowfall was 18.5 cm (Seoul), 12.7 cm (Incheon), 16.0 cm (Wonju-si), 19.2 cm (Dongducheon-si), and 23.0 cm (Munsan-eup). The snow was centered on Seoul and the Gyeonggi-do area. On the 5th, regional snowfall in Chungcheongnam-do and Chungcheongbuk-do was 20.5 cm (Yeongwol-gun), 39.9 cm (Boeun-gun), 32.0 cm (Cheongju-si), 49.0 cm (Daejeon), 49.0 cm (Mungyeong-si), 35.8 cm (Yeongju-si), 16.7 cm (Jecheon-si), and 29.8 cm (Buyeo-gun). The government declared a Special Disaster Zone for 10 metropolitan areas and -do, 82 -si, -gun, and -gu, and 647 -eup, -myeon, and -dong, which were damaged by the heavy snow during this period.

Cost of Damage from Heavy Snows in December 2005



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

Satellite Image of Heavy Snow (December, 2005)

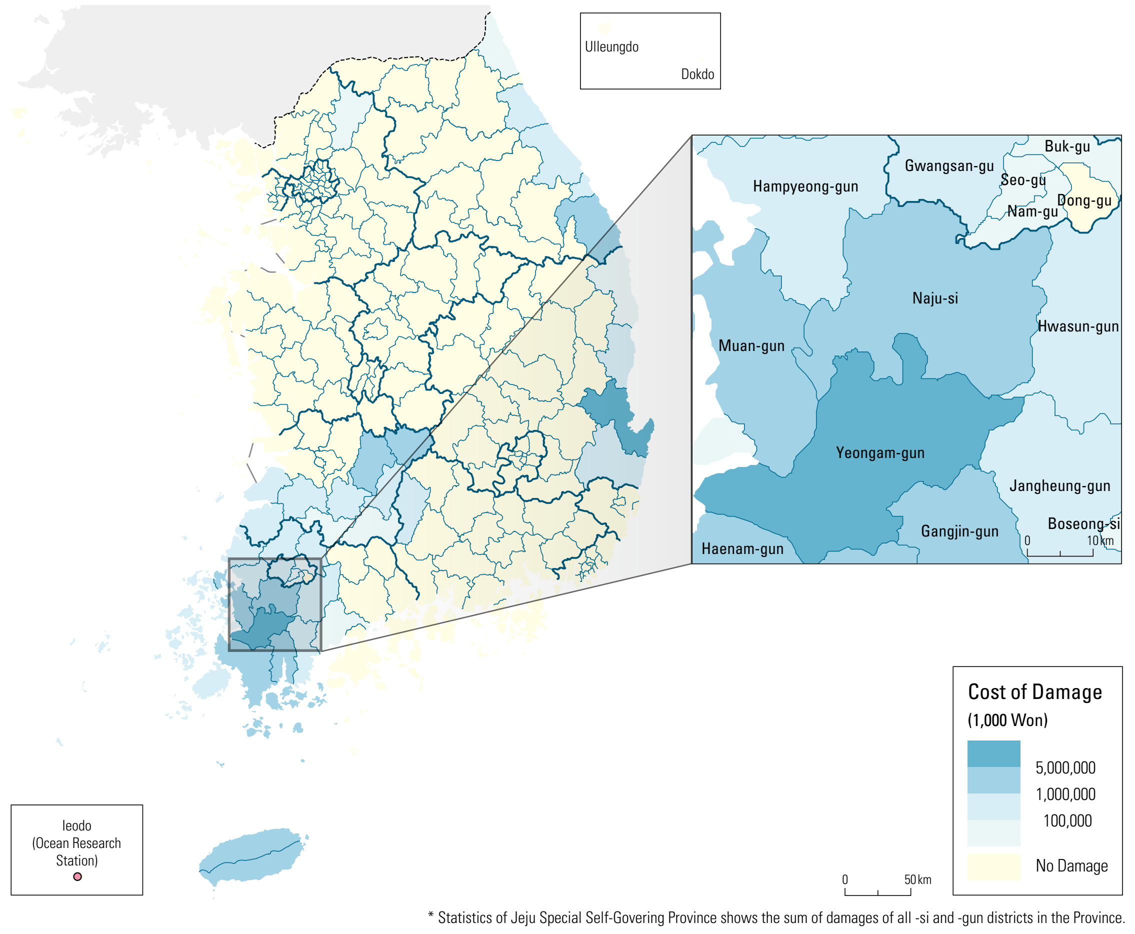
Cold air driven by a cold continental anticyclone, and warm and humid air from the Yellow Sea met, causing a temperature difference that led to the formation of a big snow cloud with snowfall on December 3 – 5, 2005. Another heavy snowfall accompanied by strong winds and cold snaps occurred on December 9-10, 2005. The regional maximum daily snowfall during this period was recorded as follows: 59.3 cm (Jeongeup-si), 47.1 cm (Buan-gun), 40.5 cm (Gwangju), 38.5 cm (Haenam-gun), and 37.3 cm (Suncheon-si). The government declared Special Disaster Zones for 9 metropolitan areas and -do, and 57 -si, -gun, and -gu, which were damaged by the heavy snows, strong winds, and wind waves during December 3 – 24, 2005.

Damage by Heavy Snow (2005/Dec/03 – 24)

Total Cost of Damage (1,000 Won)	Victims (Persons)	Deaths and Missing Persons
520,614,626	6,511	14

Ministry of Public Safety and Security (2015)

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



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

Satellite Image of Heavy Snow (January, 2011)

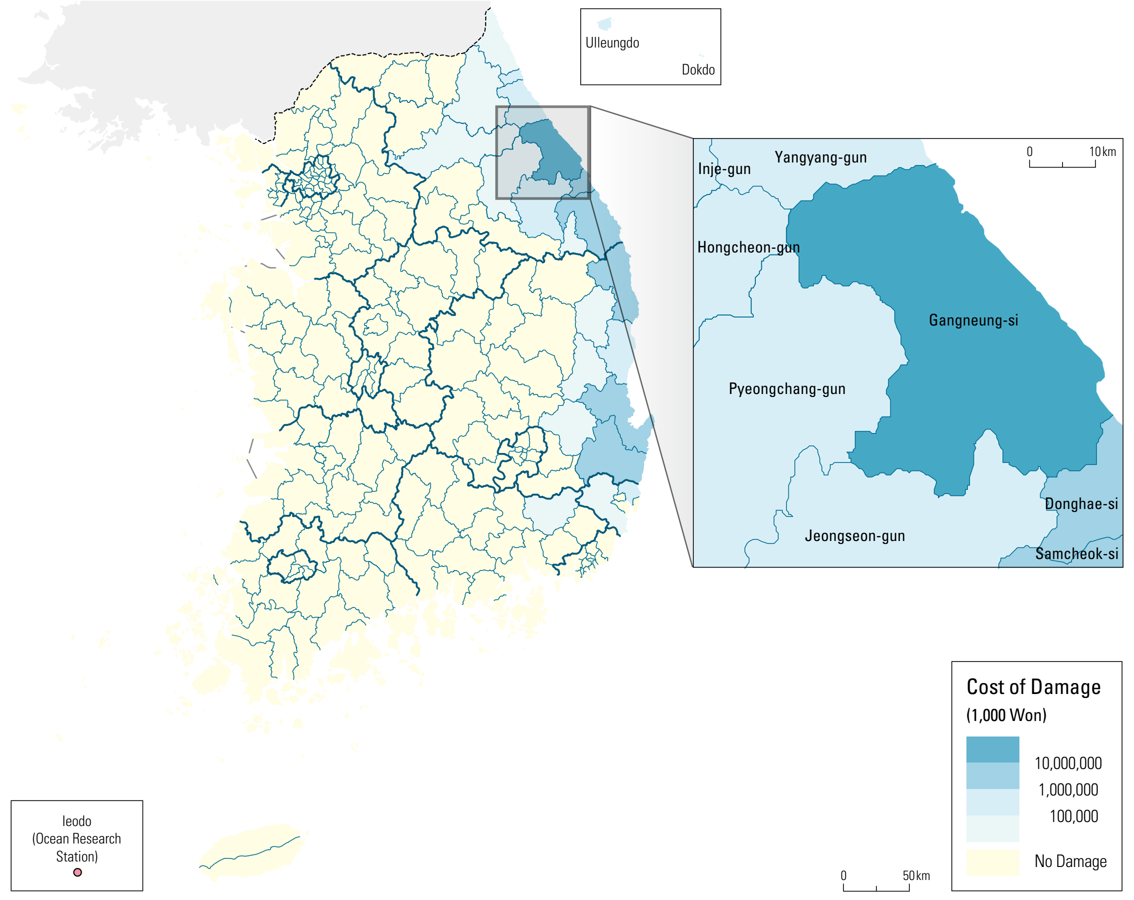
From December 29, 2010 to January 1, 2011, cyclone paths shifted toward Korea from the East-Asian continent, so snow clouds formed over Korea, leading to heavy snowfall on the west coast and central region of Korea. With continuous, strong, heavy snow, greenhouses and ginseng farms were greatly damaged. During January 3 – 4, 2011, air temperature around -30°C flowed into the East Sea along with northeasterly winds, and met relatively warm air over the East Sea. This created a large amount of water vapor that turned 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 (2010/Dec/29 – 2011/Jan/04)

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

Ministry of Public Safety and Security (2015)

Cost of Damage from Heavy Snows in February 2011



Satellite Image of Heavy Snow (February, 2011)

From February 11 to 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 a large amount of snow. A lot of facilities such as greenhouses and military bases were damaged by this heavy snow (the maximum snowfall was 133 cm) in Gangwon-do and the eastern coastal region of Gyeongsangbuk-do. 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 and 14, 2011.

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

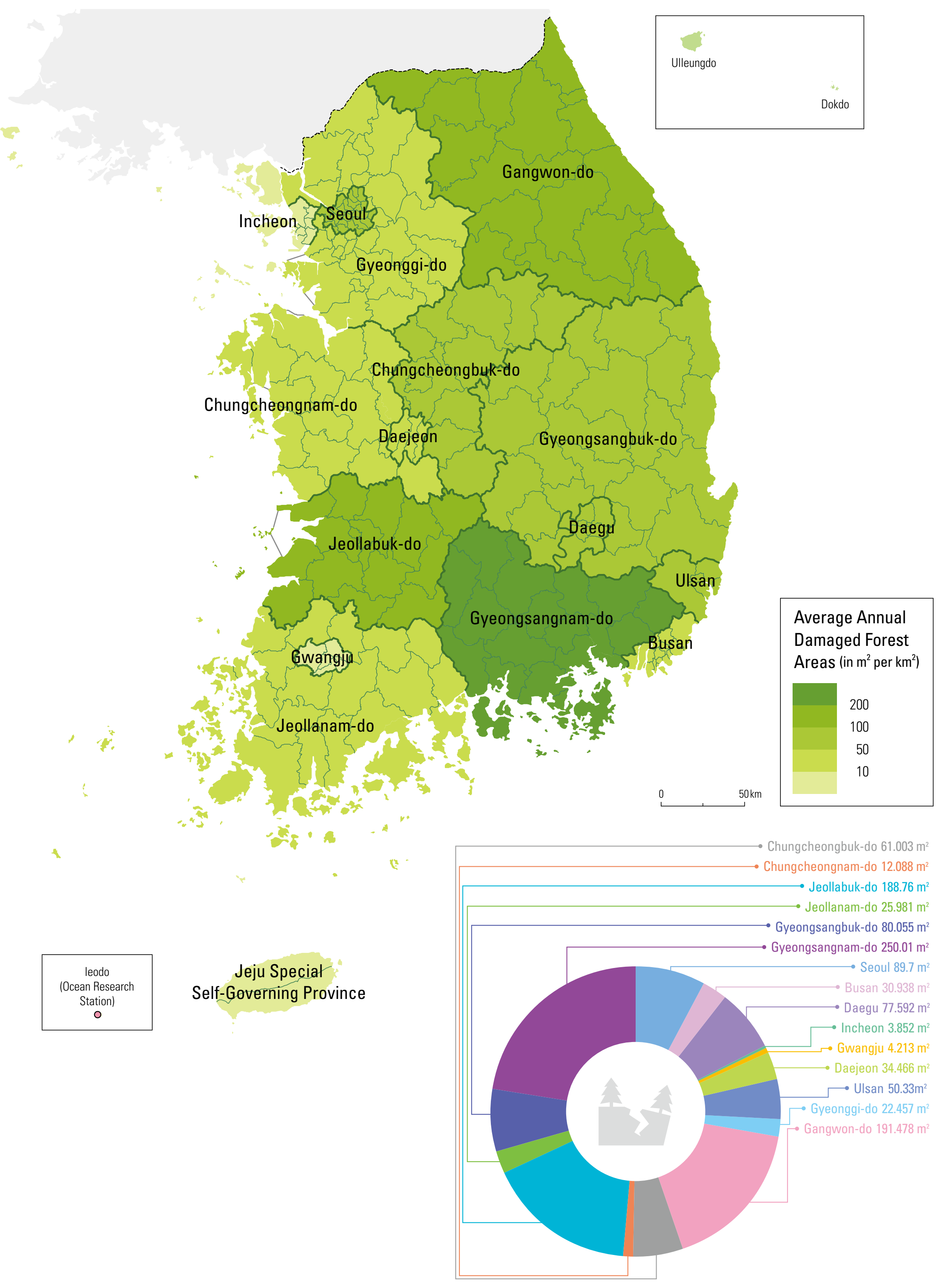
Total Cost of Damage (1,000 Won)	Victims (Persons)	Deaths and Missing Persons
35,982,165	64	0

Ministry of Public Safety and Security (2015)

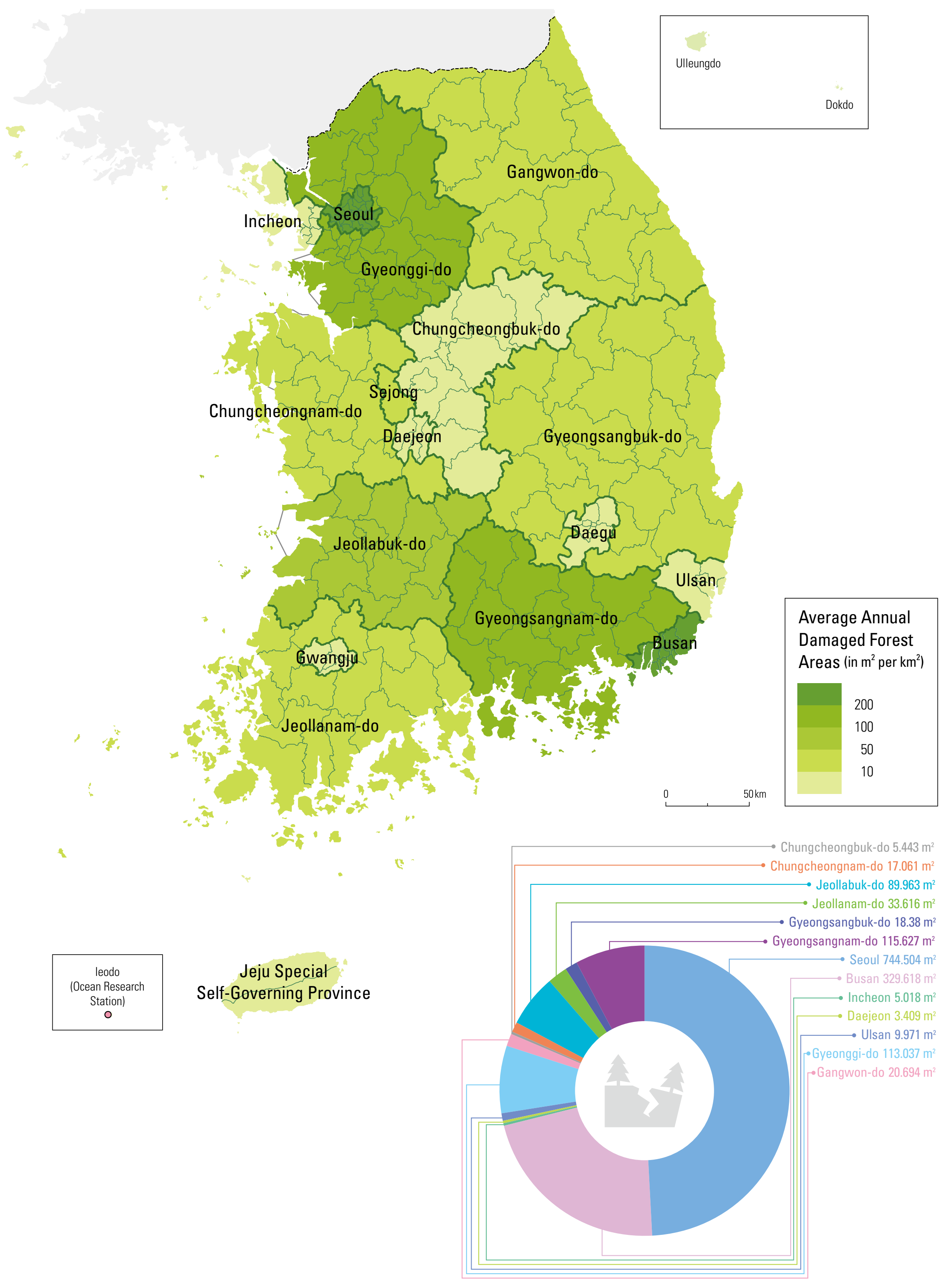
Landslide

Average Annual Damaged Areas Caused by Landslide by Province

2001 – 2007

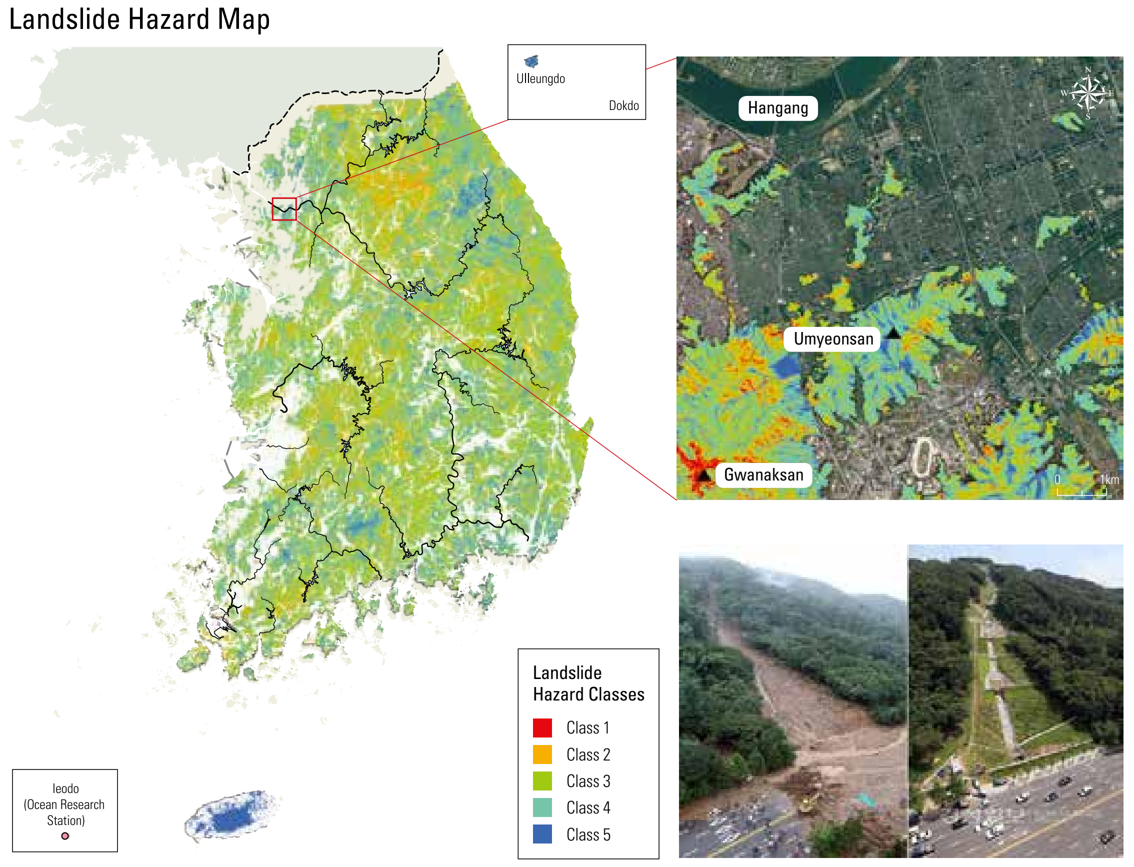


2008 – 2014



Landslide Information System (2015)

Landslide Hazard Map



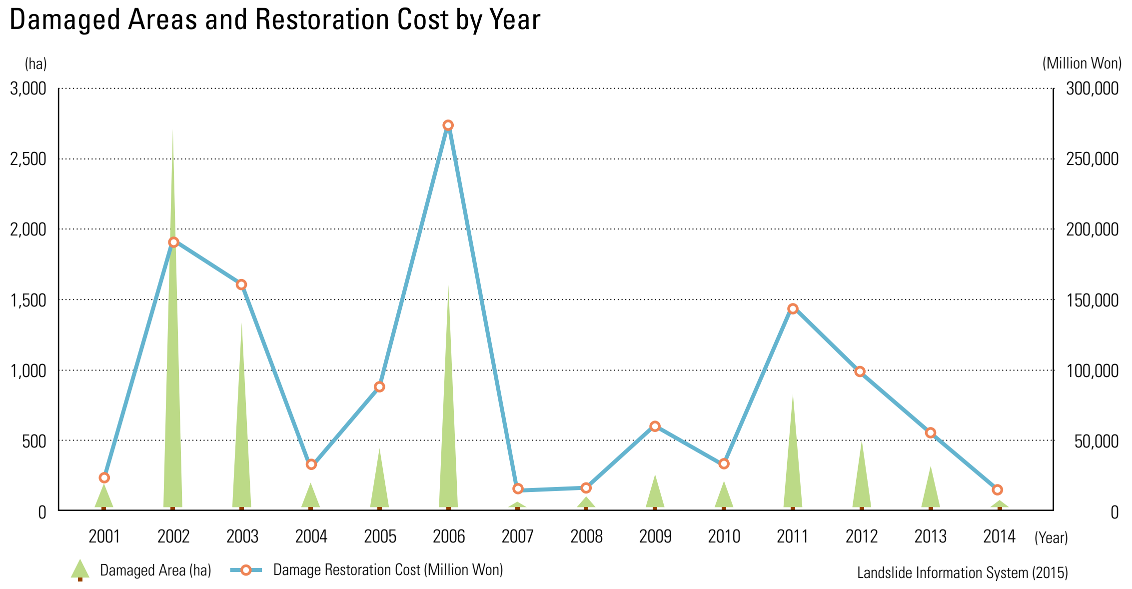
Landslide Information System (2015)

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 above maps include the landslide hazard map for Korea and the magnified Umyeonsan area in Seoul. Above images show a landslide which caused 67 casualties in the Umyeonsan area on the 25th of July, 2011. The right one shows the Umyeonsan area when the maintenance work had been finished after the disastrous landslide.

Most landslides are caused by heavy rains, along with vibrations from earthquakes, thunder, and volcanic eruptions. Even though the number of landslides caused by earthquakes, and volcanic eruptions is small, the magnitude of the damage inflicted is great. Landslides can happen in any place that has a slope angle over 30˚ and, areas with groundwater flowing are more susceptible to landslides. In addition, 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 the shoulder zones.

It is very hard to predict landslides because they occur sporadically when heavy rains fall over a short period of time. Landslides are relatively smaller than floods and forest fires in terms of their scale, but 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. As a result, huge amounts of earth material are flushed and become deposited into downstream, leading to secondary damage such as stream flooding due to raised river beds.

Damaged Areas and Restoration Cost by Year



Landslide Information System (2015)

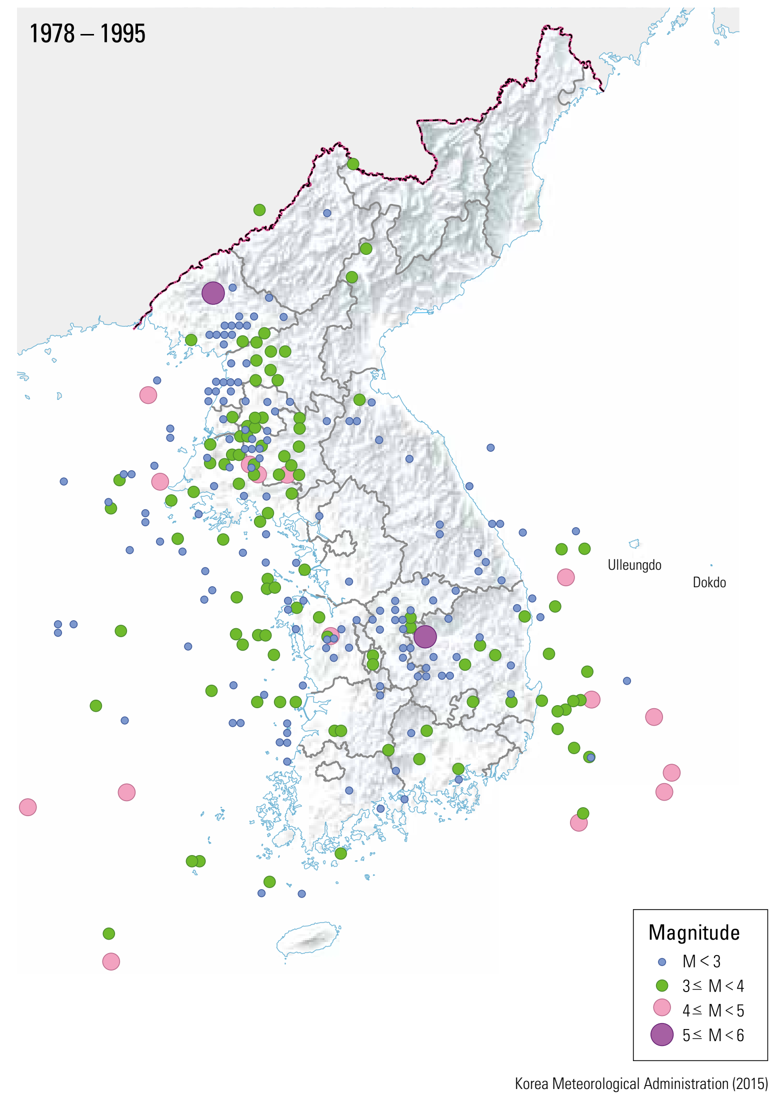
ANTHROPOSPHERE

Natural Hazards

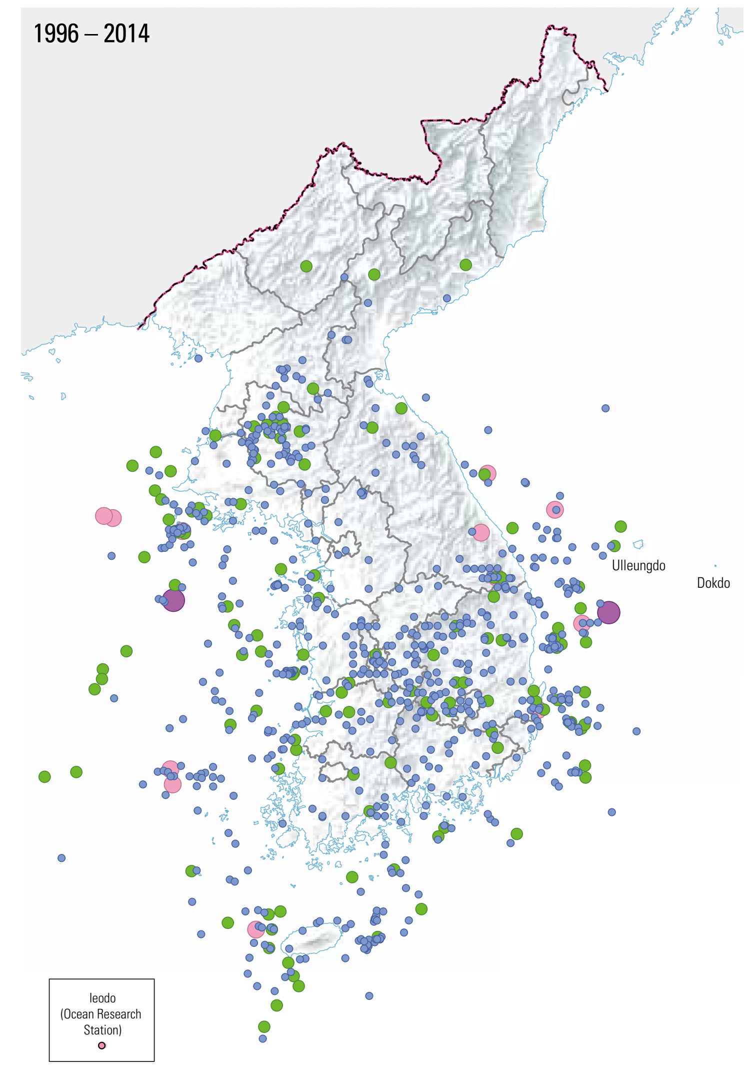
Earthquake and Tsunami

Distribution of Epicenters

1978 – 1995

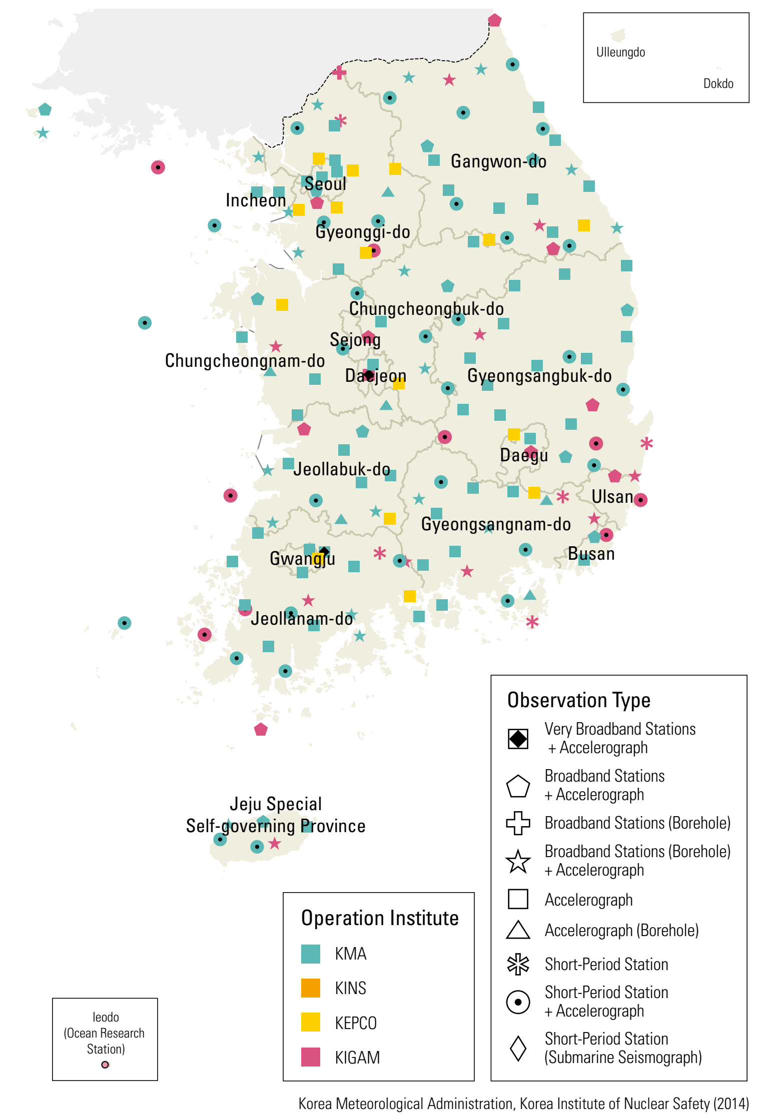


1996 – 2014



Korea Meteorological Administration (2015)

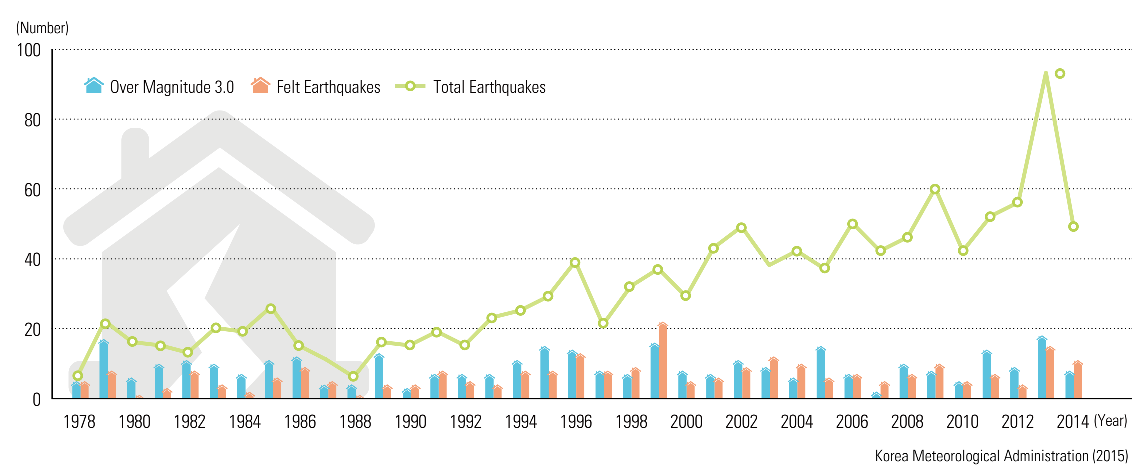
Distribution Map of Earthquake Observatories (2014)



Korea Meteorological Administration, Korea Institute of Nuclear Safety (2014)

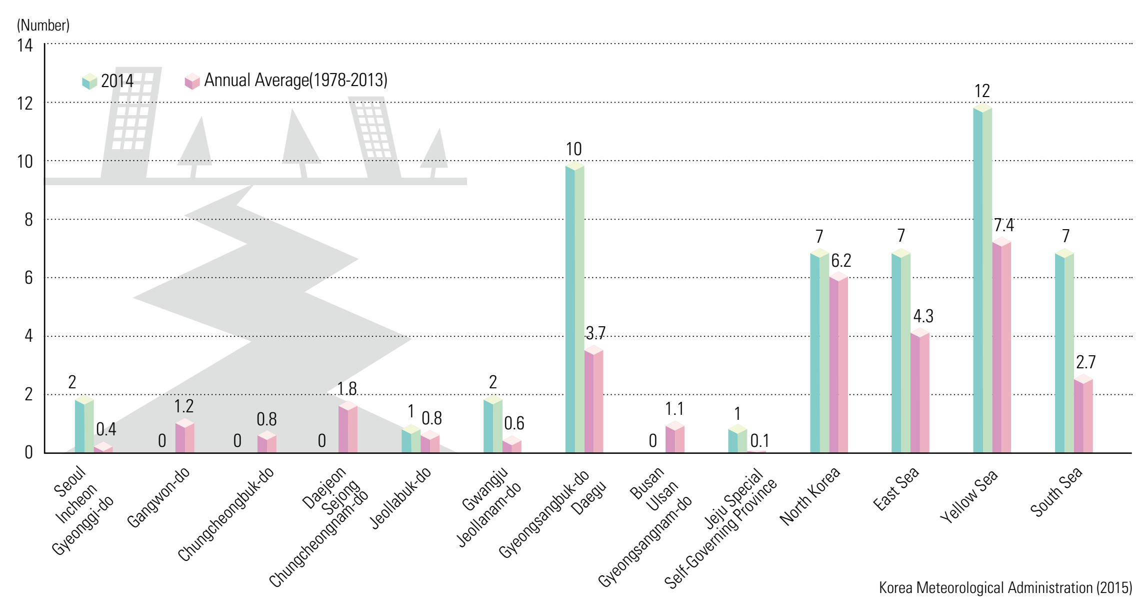
In 2014, there were 49 earthquakes with a magnitude over 2.0, which was similar to the annual average number of earthquakes (47.7 earthquakes) during the period from 1999 when digital surveying began and had been conducted 2013. There were 8 earthquakes with a magnitude over 3.0 in 2014, which was below the annual average number of earthquakes (9.8 earthquakes) for the same period. Earthquakes were felt 11 times, which was more than the annual average (8.7 events). The yearly record for earthquakes increased after the mid-1990s; the increased number of earthquakes reflects the expansion on earthquake observations due to improved observation techniques. There is no clear change in frequency of occurrences of earthquakes over 3.0 magnitude and earthquakes that are felt. Seismic sea waves or tsunamis occur when the sea floor is uplifted and sunk by earthquakes; huge waves are created that spread in all directions, reaching coastal regions. When a tsunami occurs, huge waves can reach the coastal regions, causing much damage. In 1983 and 1993, the east coast of Korea was damaged due to tsunamis that had originated from Japan.

Number of Earthquakes by Year



Korea Meteorological Administration (2015)

Average Annual Earthquakes by Region (1978 – 2013) and Number of Earthquakes in 2014



Korea Meteorological Administration (2015)

Major Earthquakes and Tsunamis Occurred in the Korean Peninsula and Surroundings

Name of Earthquake or Tsunami	Date (yyyy/mm/dd)	Magnitude	Damage
Nigata Tsunami	1964/06/16	7.5	• No property damage • Tsunami recorded 32 cm in Busan and 39 cm in Ulsan
Songnisan Earthquake	1978/09/16	5.2	• No property damage • Vibrations felt all over Korea
Hongseong Earthquake	1978/10/07	5.0	• 300 million won of property damage • Approximately 100 buildings collapsed and approximately 1,000 buildings suffered cracks around the Hongseong City Hall • Damaged fortress: Historical Landmark No. 231 Hongju Fortress collapsed • Other damage included broken windows, blackouts, and telecom disconnections
Tsunami Caused by Earthquake in the Central East Sea	1983/05/26	7.7	• Around 370 million won of property damage (Wondeok port 243 million, Samcheok port 93 million, Ulleungdo 21 million, Uljin 6 million won) • 44 damaged buildings • 81 damaged ships
Tsunami Caused by Earthquake in the Southwest Sea of Hokkaido	1993/07/12	7.8	• Around 390 million won in property damage • 35 damaged ships • No damaged buildings • 3,000 damaged fishing nets
Yeongwol Earthquake	1996/12/13	4.5	• 10 buildings were cracked around Yeongwol-gun and Jeongseon-gun • Falling rocks • Vibrations felt all over Korea
Uljin Coastal Earthquake	2004/05/29	5.2	• No damaged buildings • Large buildings vibrated in Uljin-gun • The biggest earthquake in Korea since the Songnisan earthquake
Fukuoka Earthquake	2005/03/20	7.0	• Elevators were temporarily stopped in Busan • Loading and unloading were temporarily stopped in Busan

Ministry of Public Safety and Security (2014)

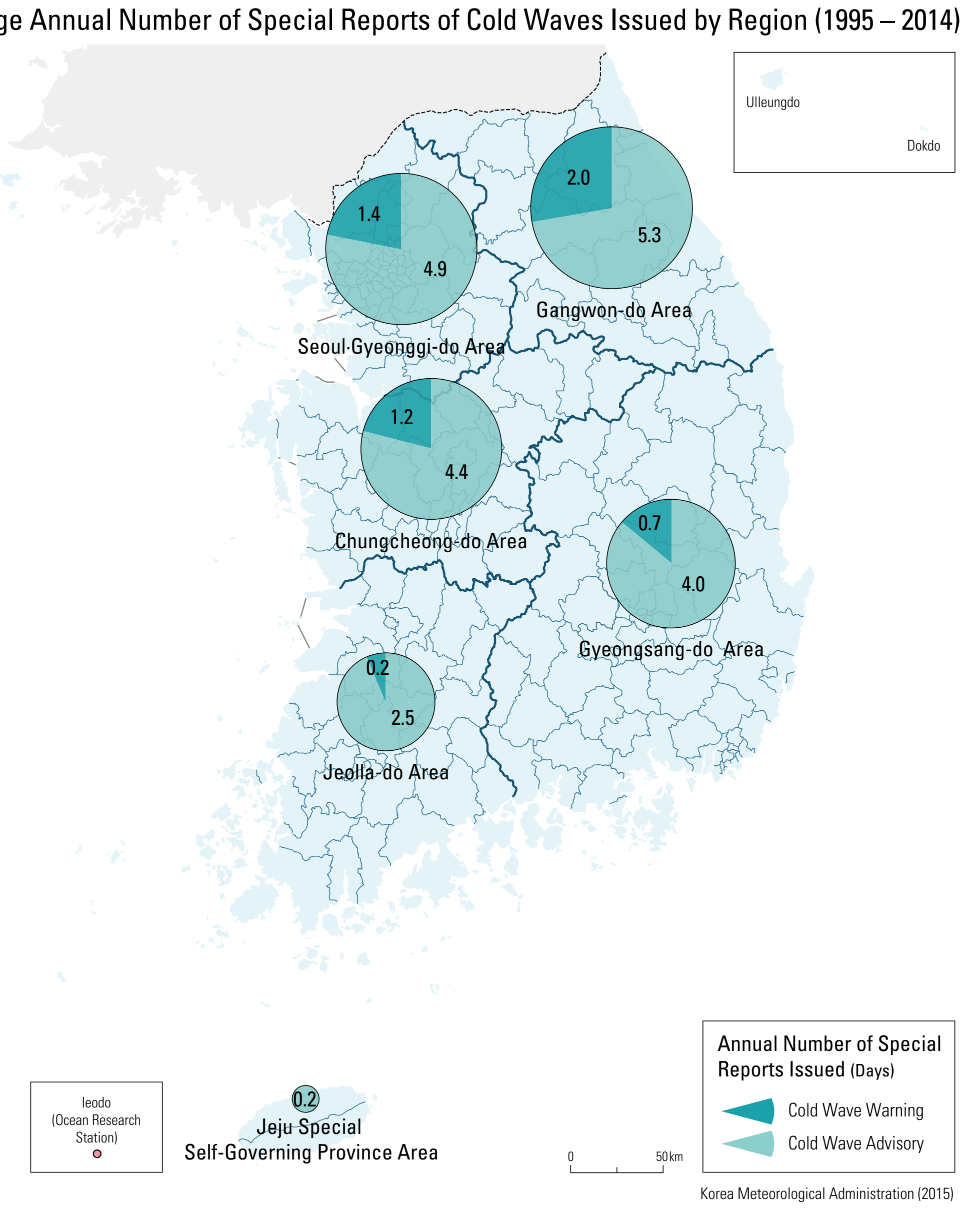
List of Earthquakes by Magnitude

Rank	Magnitude	Date (yyyy/mm/dd)	Epicenter		
			Latitude (°N)	Longitude (°E)	Location
1	5.8	2016/09/12	35.77	129.18	The area 8 km SSW of Gyeongju-si, Gyeongsangbuk-do
2	5.3	1980/01/08	40.20	125.00	Euiju-Sakju-Gwiseong regions, Pyeonganbuk-do
3	5.2	2004/05/29	36.80	130.20	The sea 80 km east of Uljin-gun, Gyeongsangbuk-do
3	5.2	1978/09/16	36.60	127.90	Around Songnisan in Chungcheongbuk-do
5	5.1	2016/09/12	35.76	129.19	The area 9 km SSW of Gyeongju-si, Gyeongsangbuk-do
5	5.1	2014/04/01	36.95	124.50	The sea 100 km WNW of Taean-gun, Chungcheongnam-do
7	5.0	2016/07/05	35.51	129.99	The sea 52 km east of Dong-gu, Ulsan
7	5.0	2003/03/30	37.80	123.70	The sea 80 km WSW of Baengnyeongdo, Incheon
7	5.0	1978/10/07	36.60	126.70	Hongseong-gun, Chungcheongnam-do
10	4.9	2013/05/18	37.68	124.63	The sea 31 km south of Baengnyeongdo, Incheon
10	4.9	2013/04/21	35.16	124.56	The sea 101 km northwest of Sinan-gun, Jeollanam-do
10	4.9	2003/03/23	35.00	124.60	The sea 50 km northwest of Hongdo, Jeollanam-do
10	4.9	1994/07/26	34.90	124.10	The sea 100 km WNW of Hongdo, Jeollanam-do

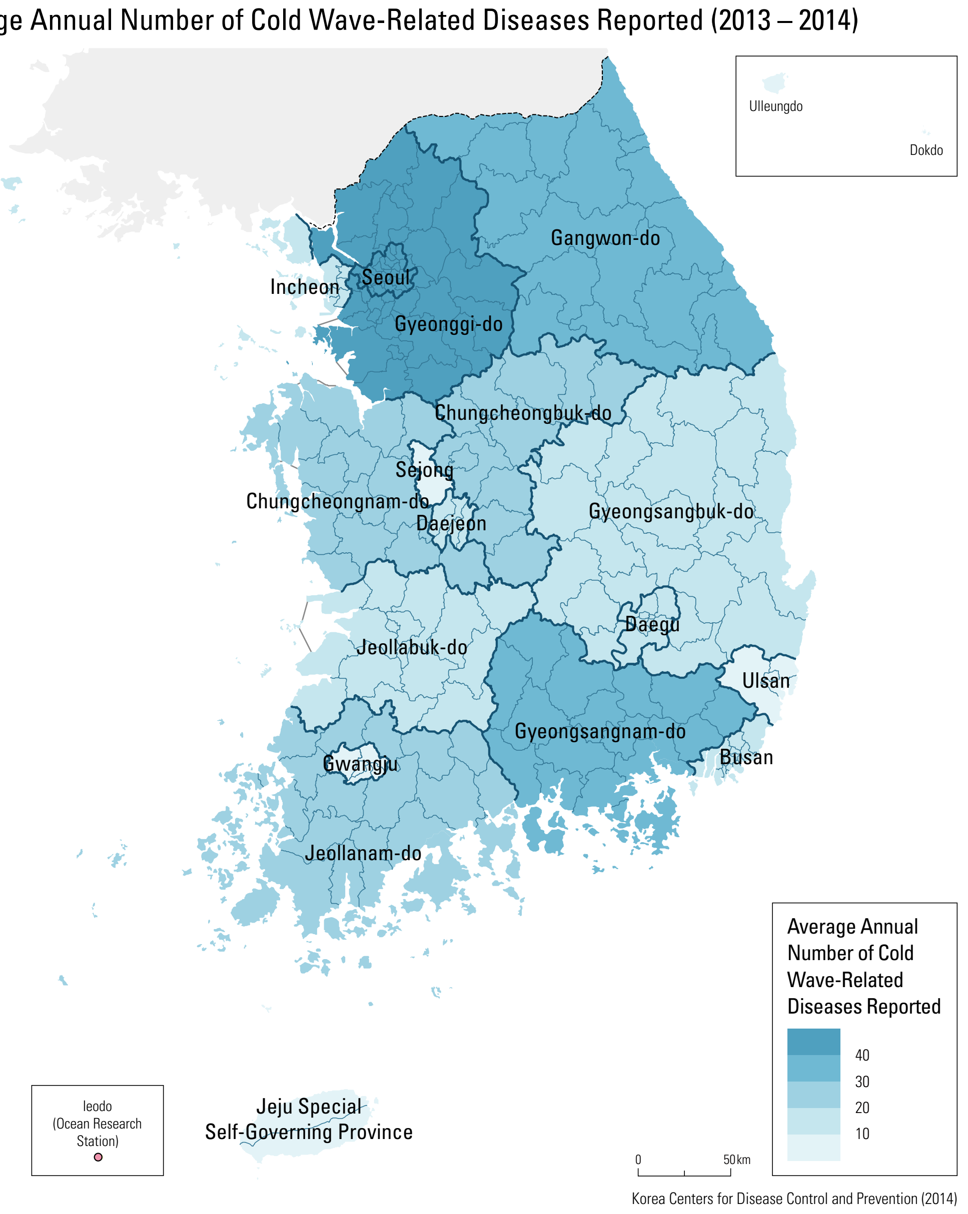
Korea Meteorological Administration (2016)

Cold and Heat Waves

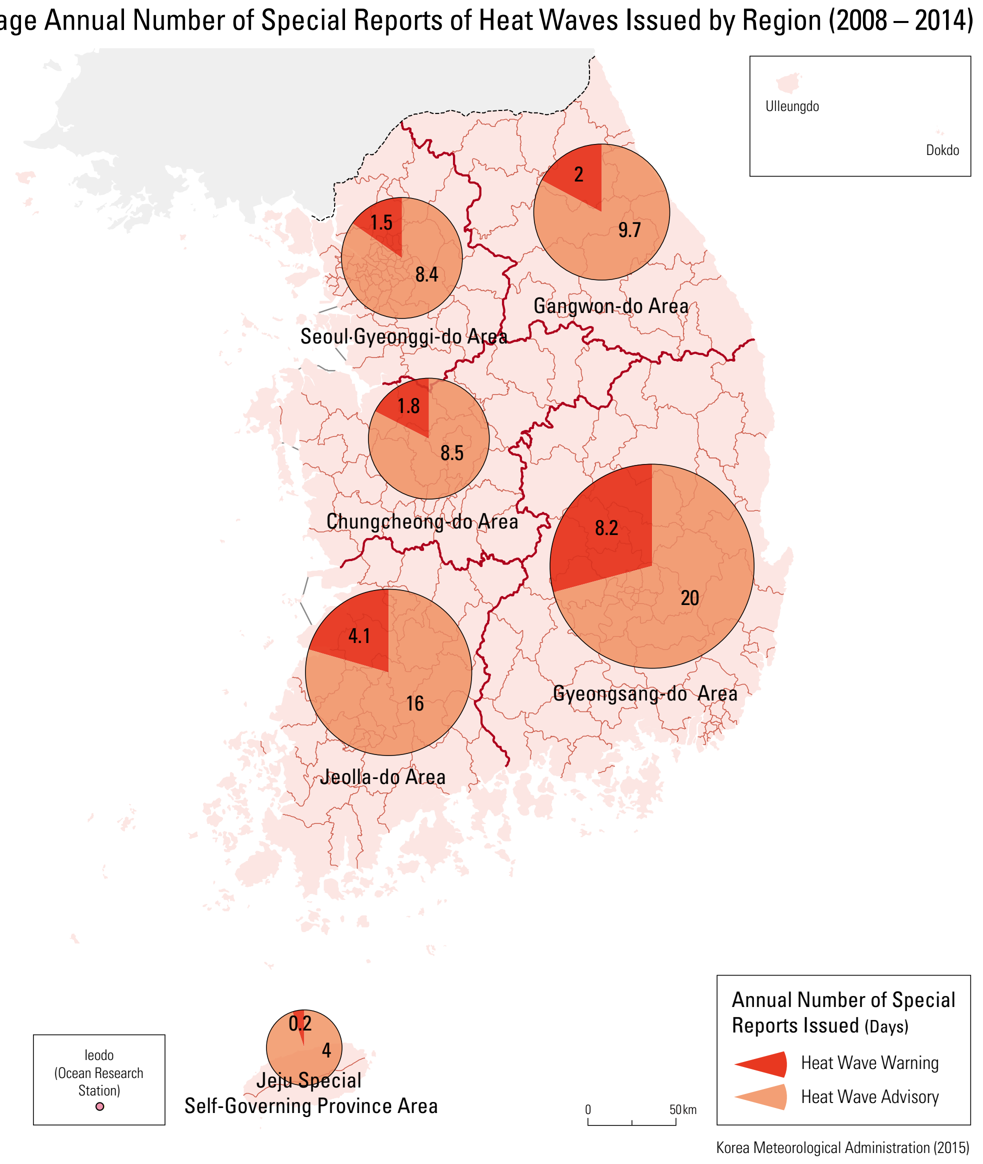
Average Annual Number of Special Reports of Cold Waves Issued by Region (1995 – 2014)



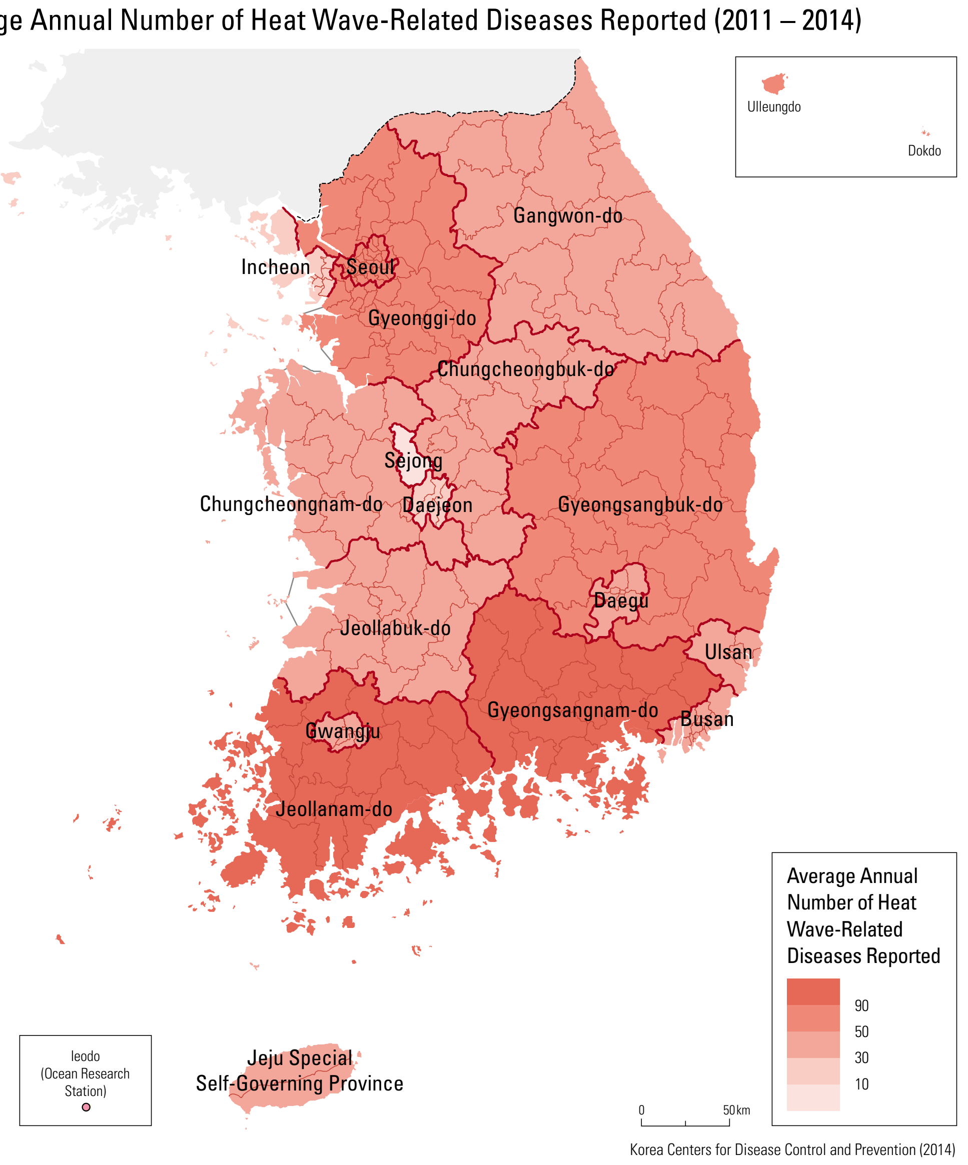
Average Annual Number of Cold Wave-Related Diseases Reported (2013 – 2014)



Average Annual Number of Special Reports of Heat Waves Issued by Region (2008 – 2014)



Average Annual Number of Heat Wave-Related Diseases Reported (2011 – 2014)



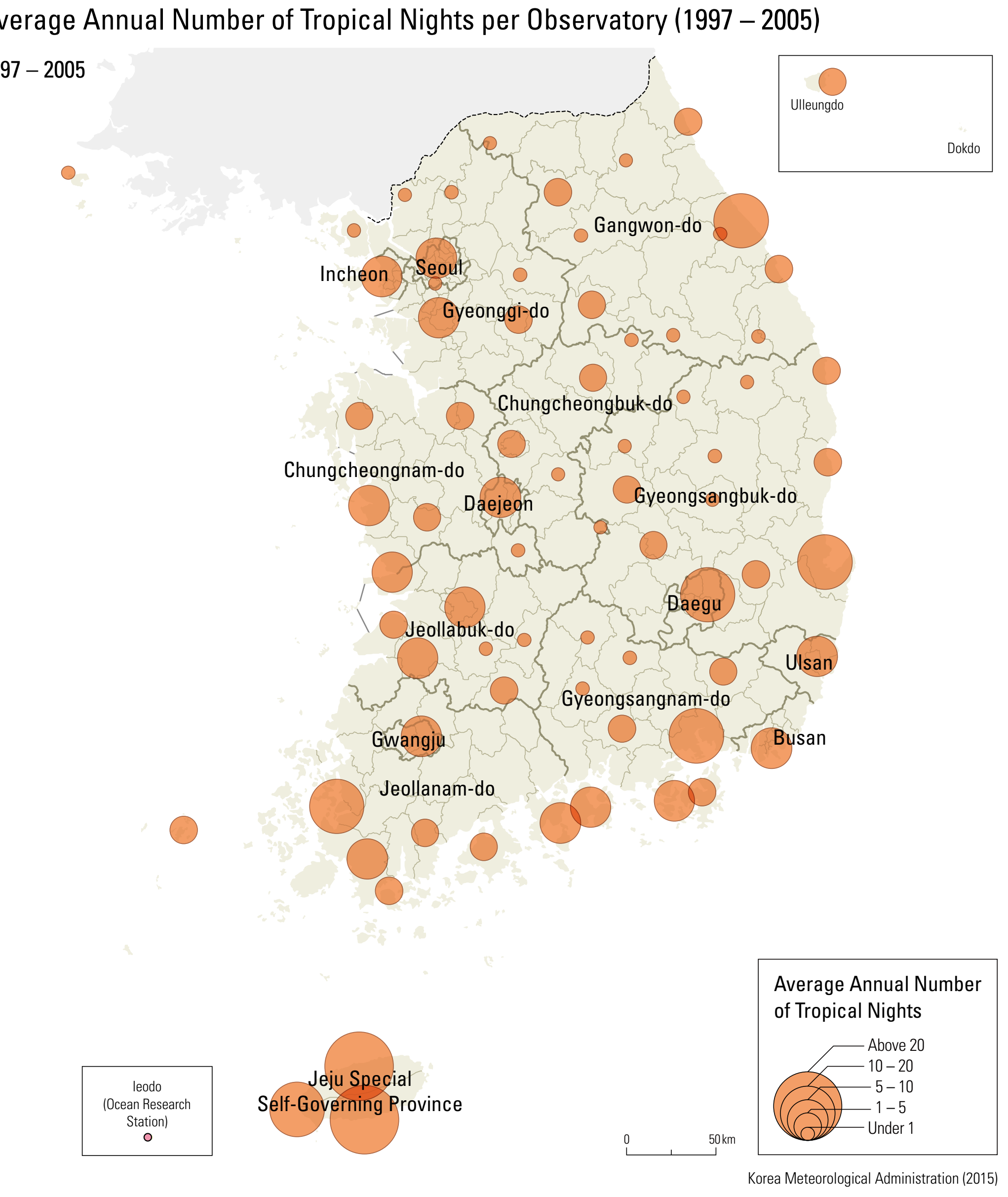
Cold waves are distinguished by a sudden drop in temperature over the Korean Peninsula when the cold, dry Siberian anticyclone expands into the southern China, and the northerly winds are strengthened. During the Northwest monsoon season, it causes cold waves that reach Korea when a high pressure system resides in the east of the Korean Peninsula and low pressure resides in the west during the winter. Cold waves are often detrimental to peoples' lives and health, and cause serious damage. Therefore, a cold wave special report is issued to warn the risk. Cold wave special reports are classified as advisories and warnings. A cold wave advisory is issued in 3 situations. First, it is when the minimum morning temperature is expected to reach below 3˚C, decreases more than 10˚C compared to the previous day, and also when the temperature drops below 3˚C than the annual average. Second, it is when the morning temperature is -12˚C and lasts for more than 2 days. Third, it is when the temperature is so low that damage is expected. Meanwhile, cold wave warning is issued in 3 situations. First, it is when the minimum temperature in the morning is expected to reach lower than 3˚C, by 15˚C below than the previous day and it is expected to be 3 ˚C lower than the annual average. Second, it is when the minimum temperature is -15˚C in the morning and lasts for 2 days or more. Third, it is when the temperature is cold enough to yield 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 and lasts 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.

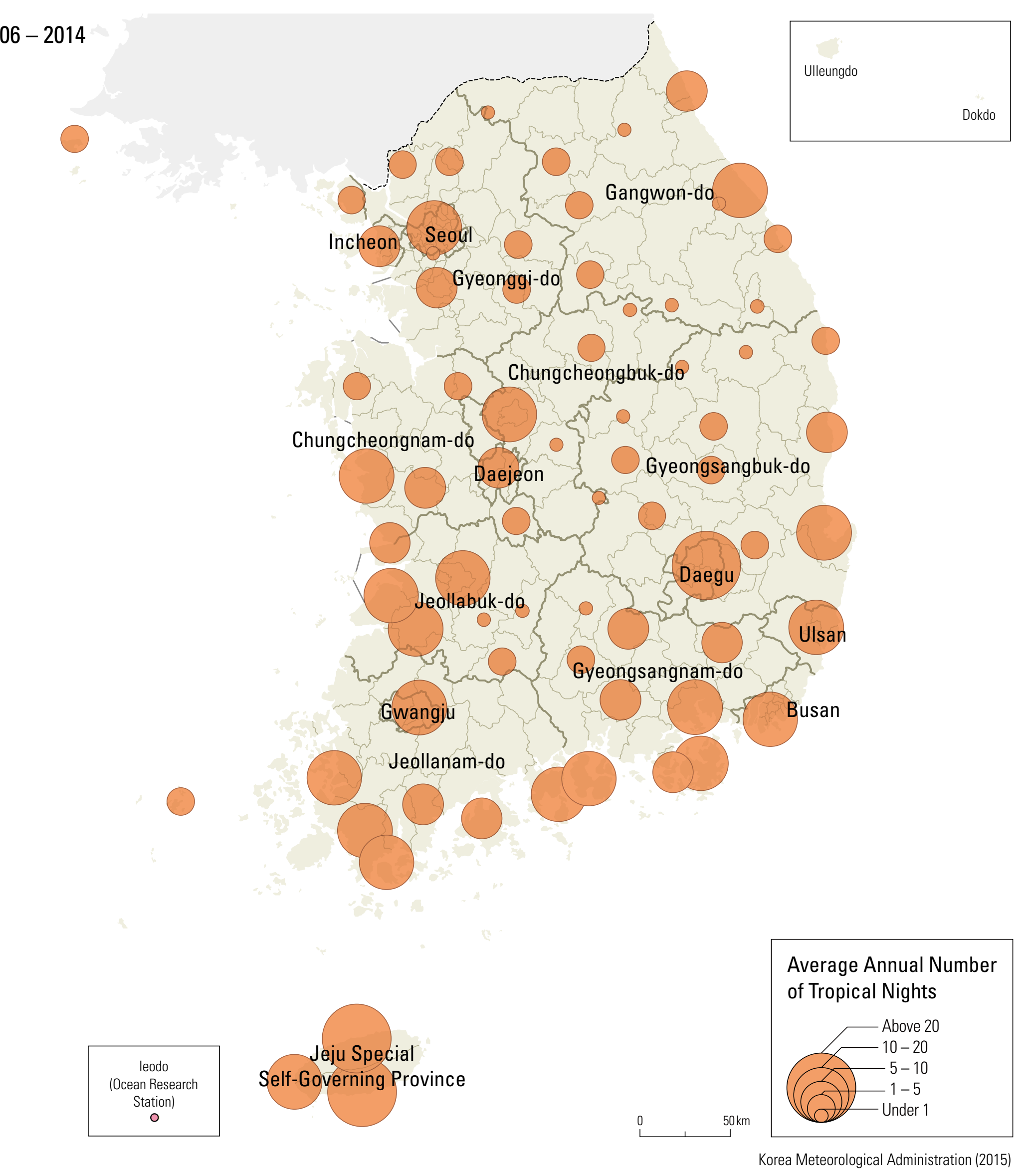
Tropical night is the night with the temperature that does not drop below 25˚C from sunset to sunrise. Tropical nights occur for 13 – 22 days in southern coastal regions (e.g., Busan), and 9 – 22 days in inland regions (e.g., Seoul) annually.

Average Annual Number of Tropical Nights per Observatory (1997 – 2005)

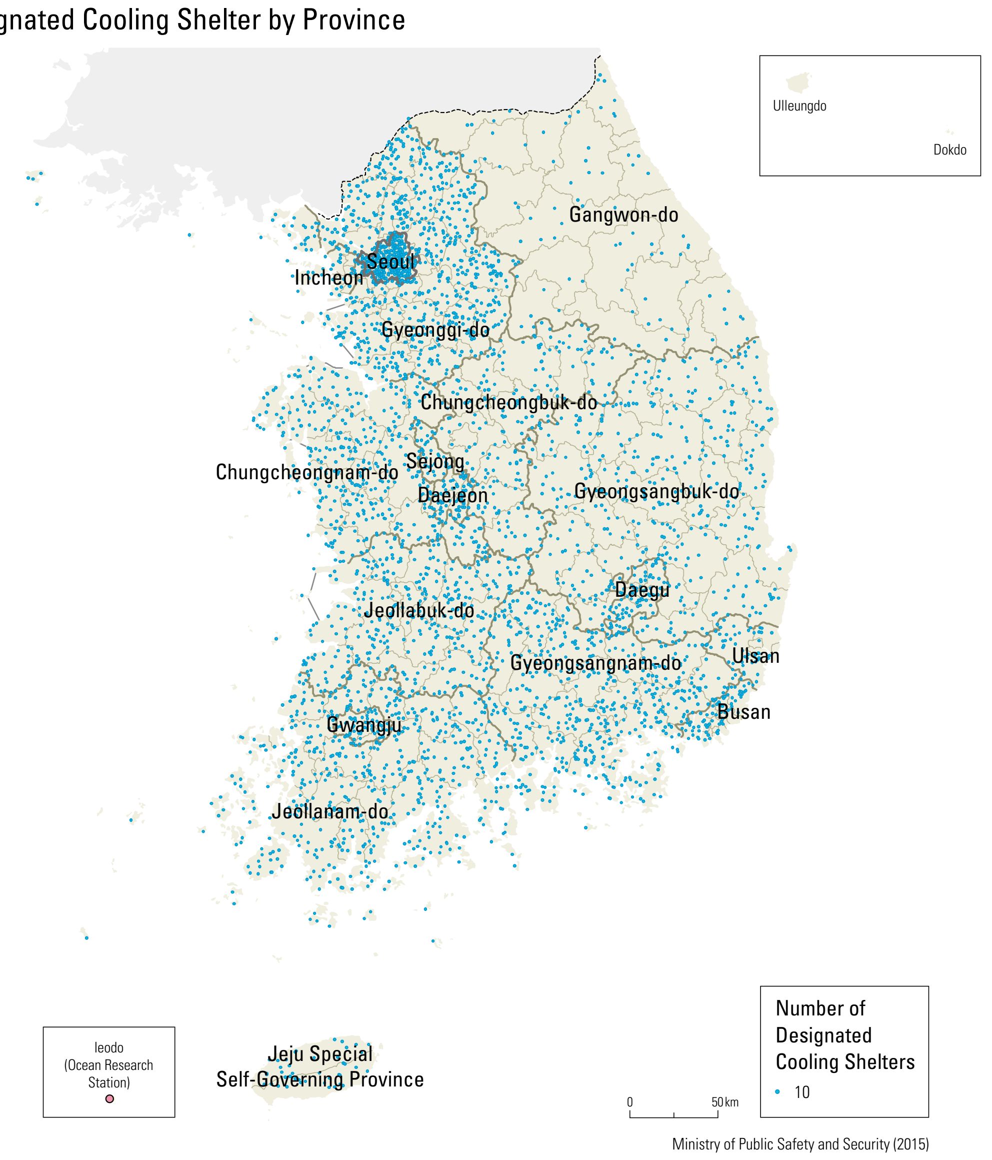
1997 – 2005



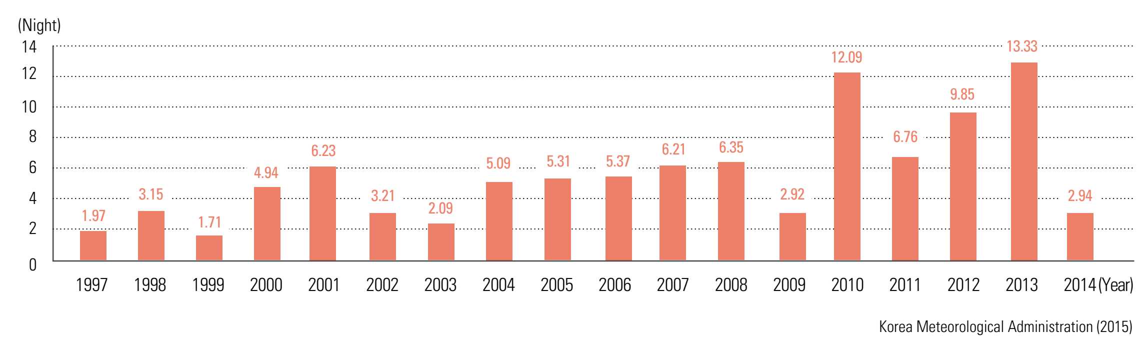
2006 – 2014



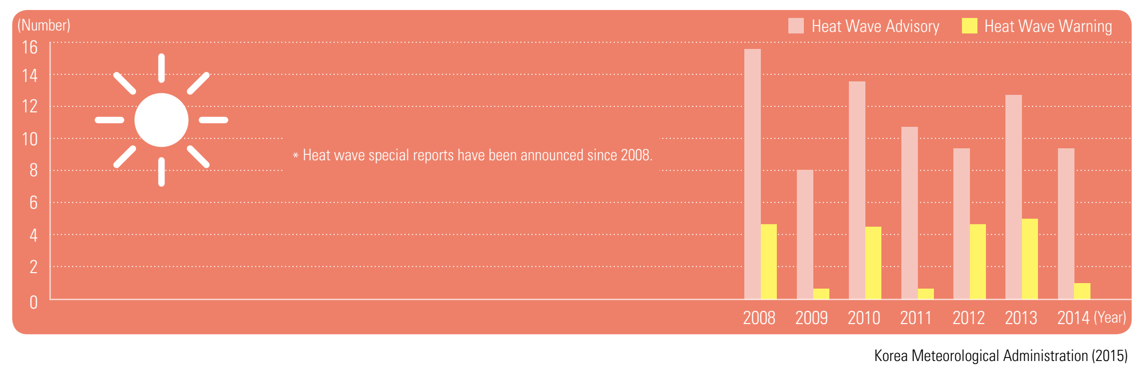
Designated Cooling Shelter by Province



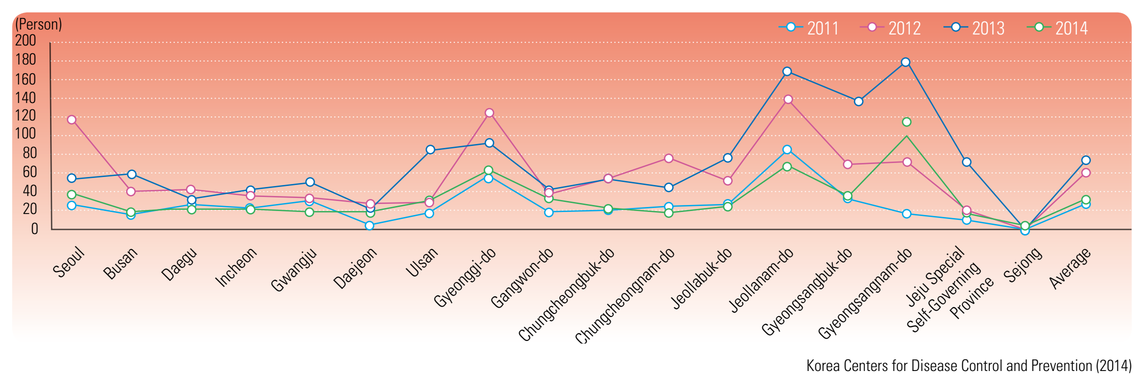
Average Annual Number of Tropical Nights by Year (1997 – 2014)



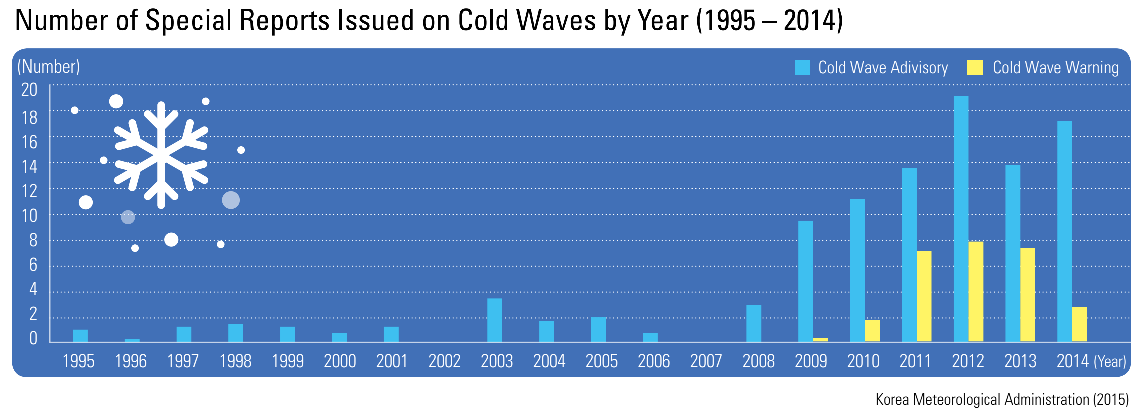
Number of Special Reports Issued on Heat Waves by Year (2008 – 2014)



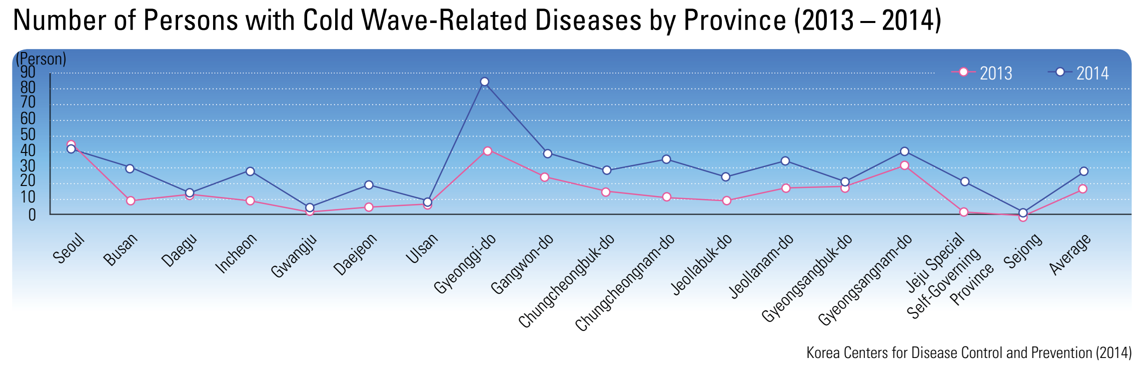
Number of Persons with Heat Wave-Related Diseases by Province (2011 – 2014)



Number of Special Reports Issued on Cold Waves by Year (1995 – 2014)

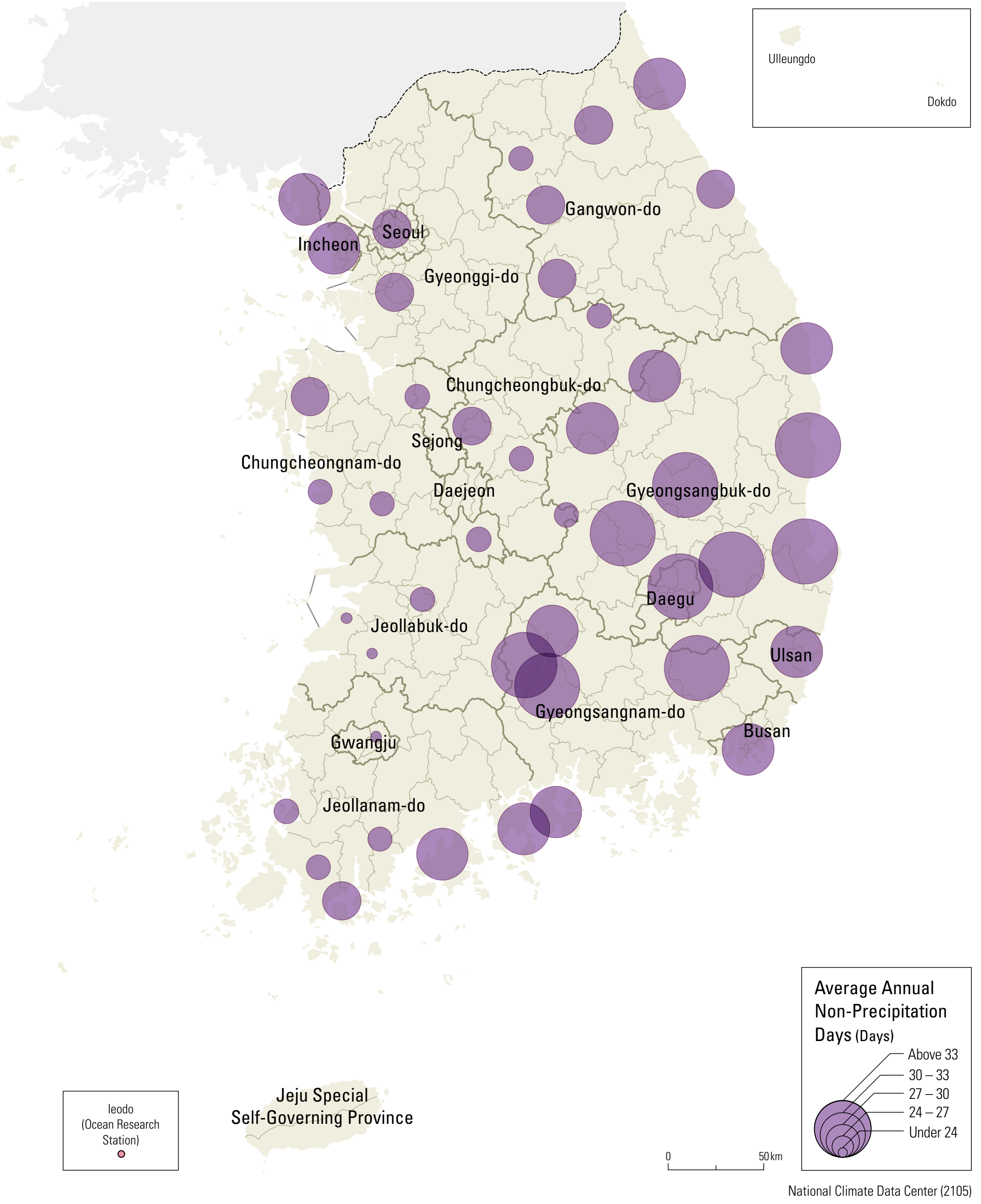


Number of Persons with Cold Wave-Related Diseases by Province (2013 – 2014)



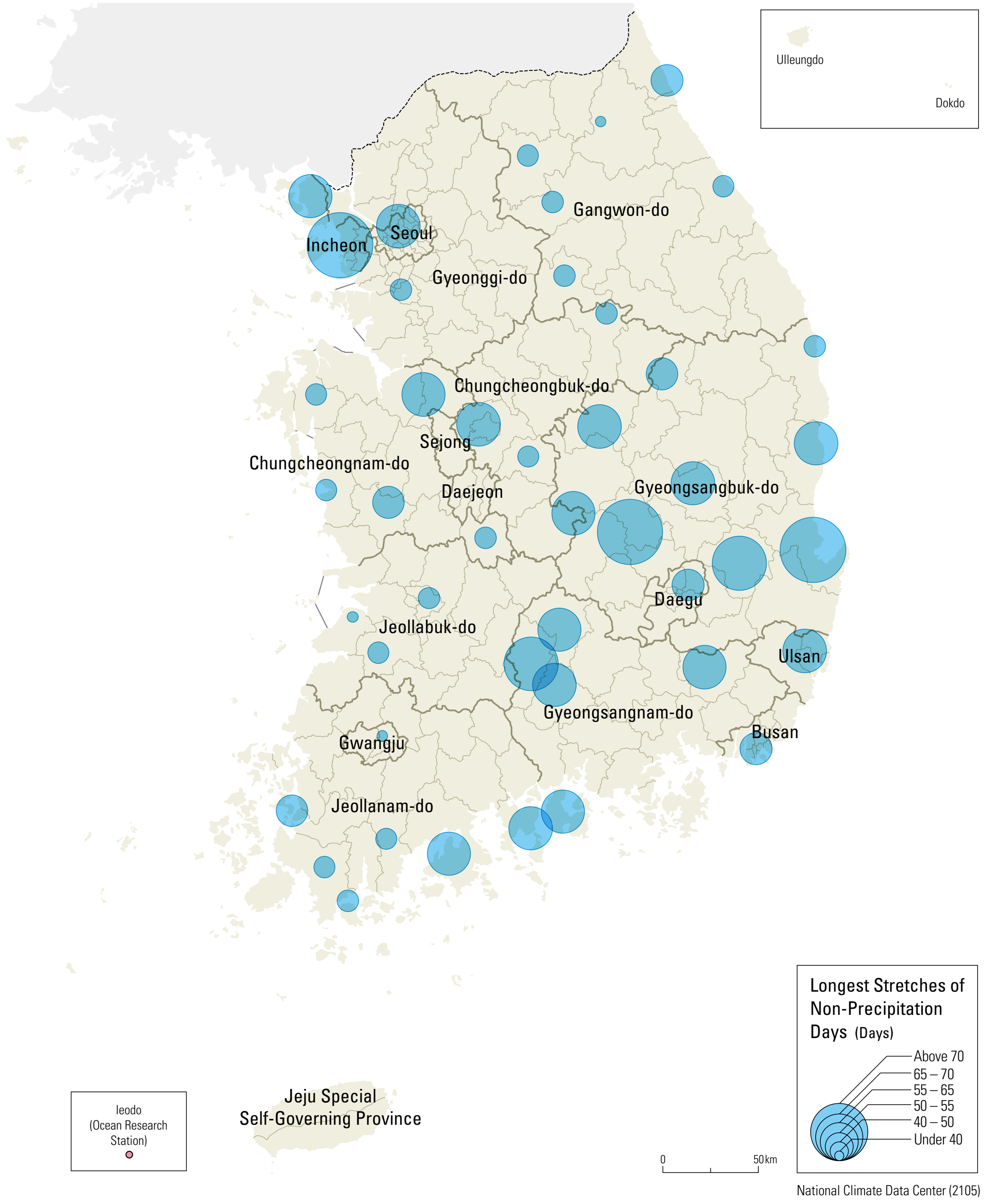
Drought

Average Annual Non-Precipitation Days per Observatory (1973 – 2014)



National Climate Data Center (2105)

Longest Stretches of Non-Precipitation Days per Observatory (1973 – 2014)



National Climate Data Center (2105)

A picture of Soyanggang taken by the Arirang-2 Satellite in April 2012 (Usual day)

A picture of Soyanggang 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	Chungcheongbuk-do	Chungcheongnam-do	Jeollabuk-do	Jeollanam-do	Gyeongsanbuk-do	Gyeongsangnam-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, Korea Water Resources Corporation (2015)

Annual Precipitation and Average Water Storage Rates (1990 – 2014)

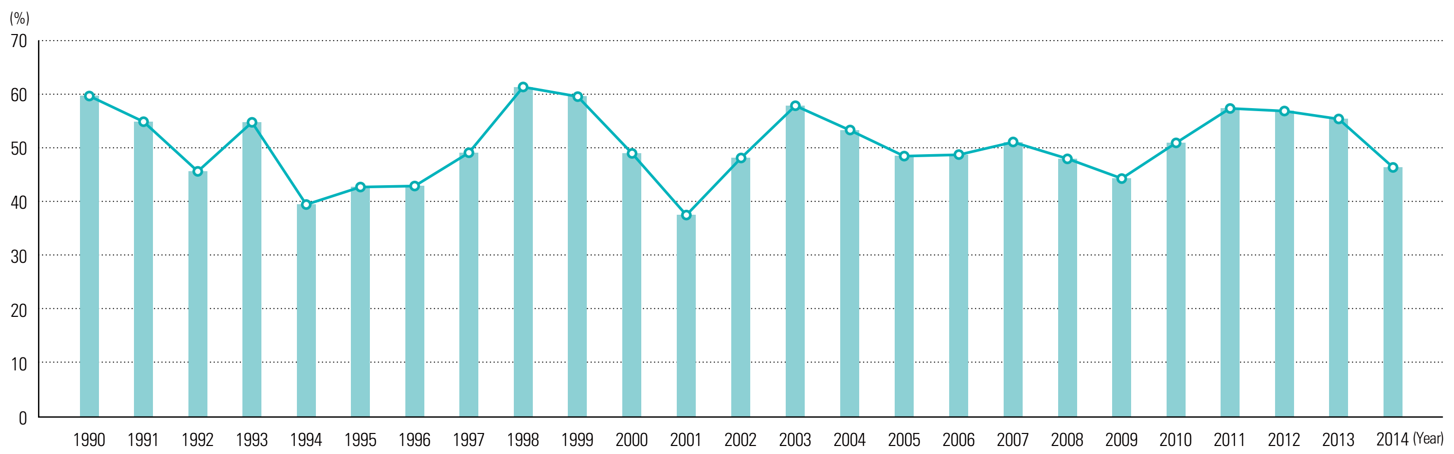
Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Precipitation (mm)*	1,574	1,173	1,050	1,376	840	1,035	1,032	1,258	1,572	1,539	1,378	962	1,610
Amount of Inflow (Million m³)	27,068	11,061	9,276	16,787	6,738	12,389	8,675	13,738	20,704	17,574	14,608	7,289	18,091
Amount of Discharge (Million m³)	4,940	6,158	7,236	6,685	8,551	11,604	9,899	11,863	19,756	17,084	16,807	8,631	15,854
Average Amount of Storage (Million m³)**	6,120	5,516	5,226	6,289	4,578	4,992	4,715	5,296	6,486	6,583	6,205	4,739	6,084
Average Storage Rate (%)***	60	55.2	45.9	55	39.7	42.9	43.2	49.4	61.6	59.9	49.3	37.7	48.4

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Precipitation (mm)*	1,829	1,495	1,285	1,454	1,464	906	1,172	1,374	1,668	1,402	1,169	1,042
Amount of Inflow (Million m³)	29,928	20,197	16,254	22,191	20,969	9,254	12,854	19,495	25,867	19,178	14,458	11,329
Amount of Discharge (Million m³)	29,299	21,150	16,923	22,398	19,083	11,706	12,140	17,533	25,711	18,640	15,985	11,598
Average Amount of Storage (Million m³)**	7,310	6,748	6,139	6,170	6,463	6,069	5,602	6,445	7,295	7,229	7,037	5,885
Average Storage Rate (%)***	58.1	53.6	48.8	49	51.4	48.2	44.5	51.2	57.7	57.2	55.7	46.6

* 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

Ministry of Land, Infrastructure, and Transport, Korea Water Resources Corporation (2015)

Average Water Storage Rates by Year (1990 – 2014)



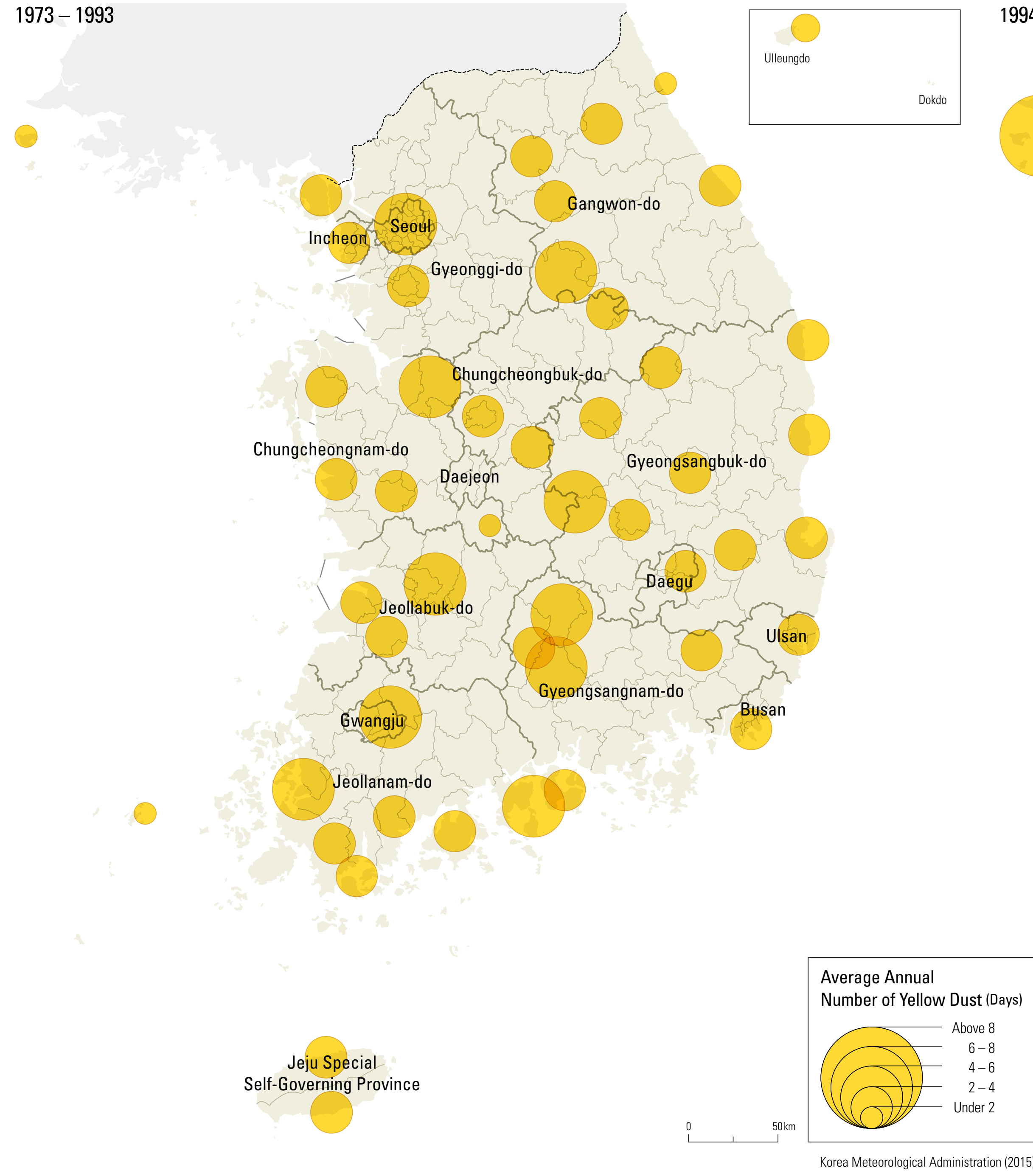
Ministry of Land, Infrastructure, and Transport, Korea Water Resources Corporation

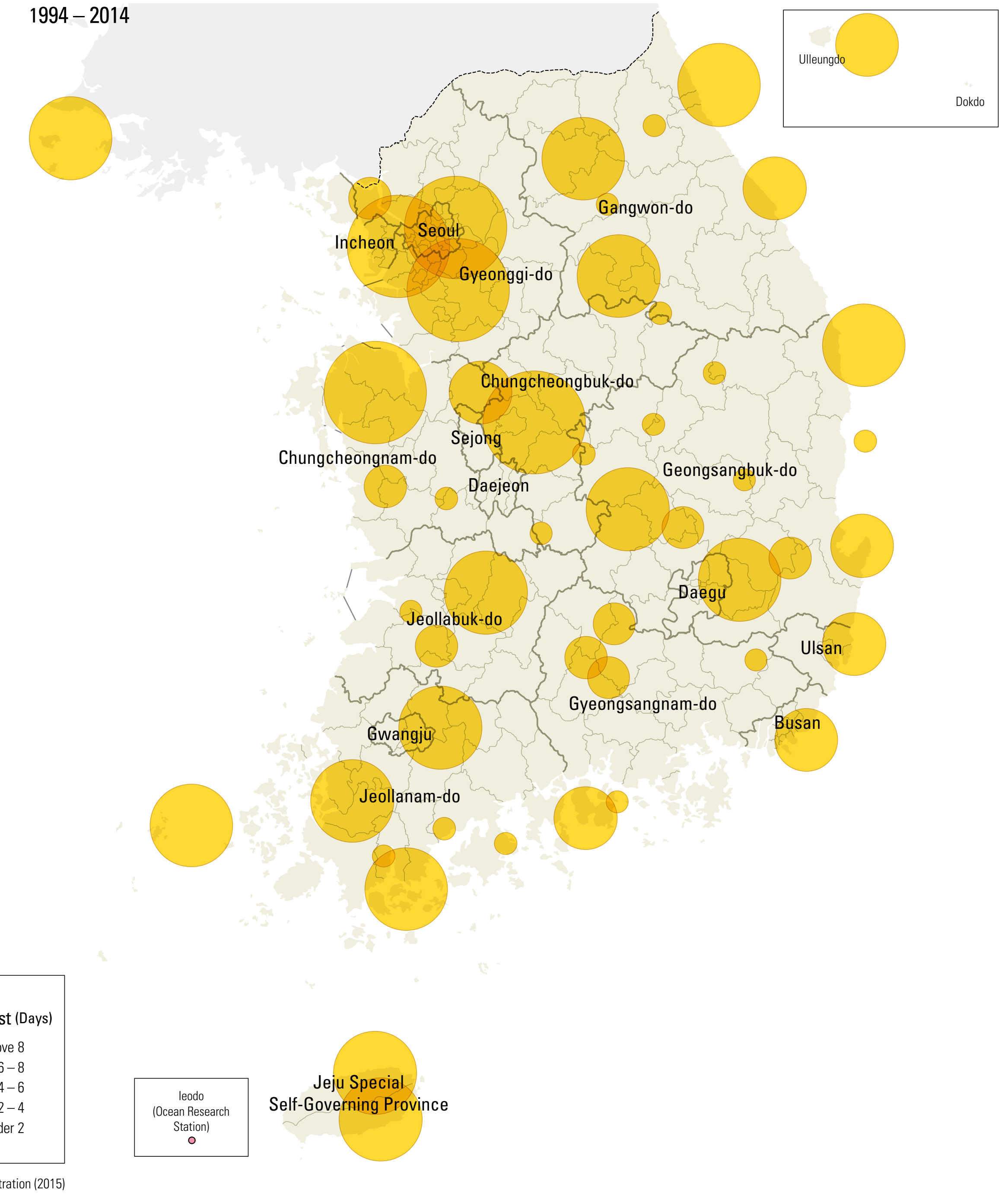
Drought refers to water scarcity and reduction of streamflow, reduction in lake or reservoir storage, and lowering of ground-water levels due to a lack of rainfall, and intense sunshine. In the past, drought intensity was evaluated based on the number of consecutive drought days. These days, it is determined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

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.

Yellow Dust

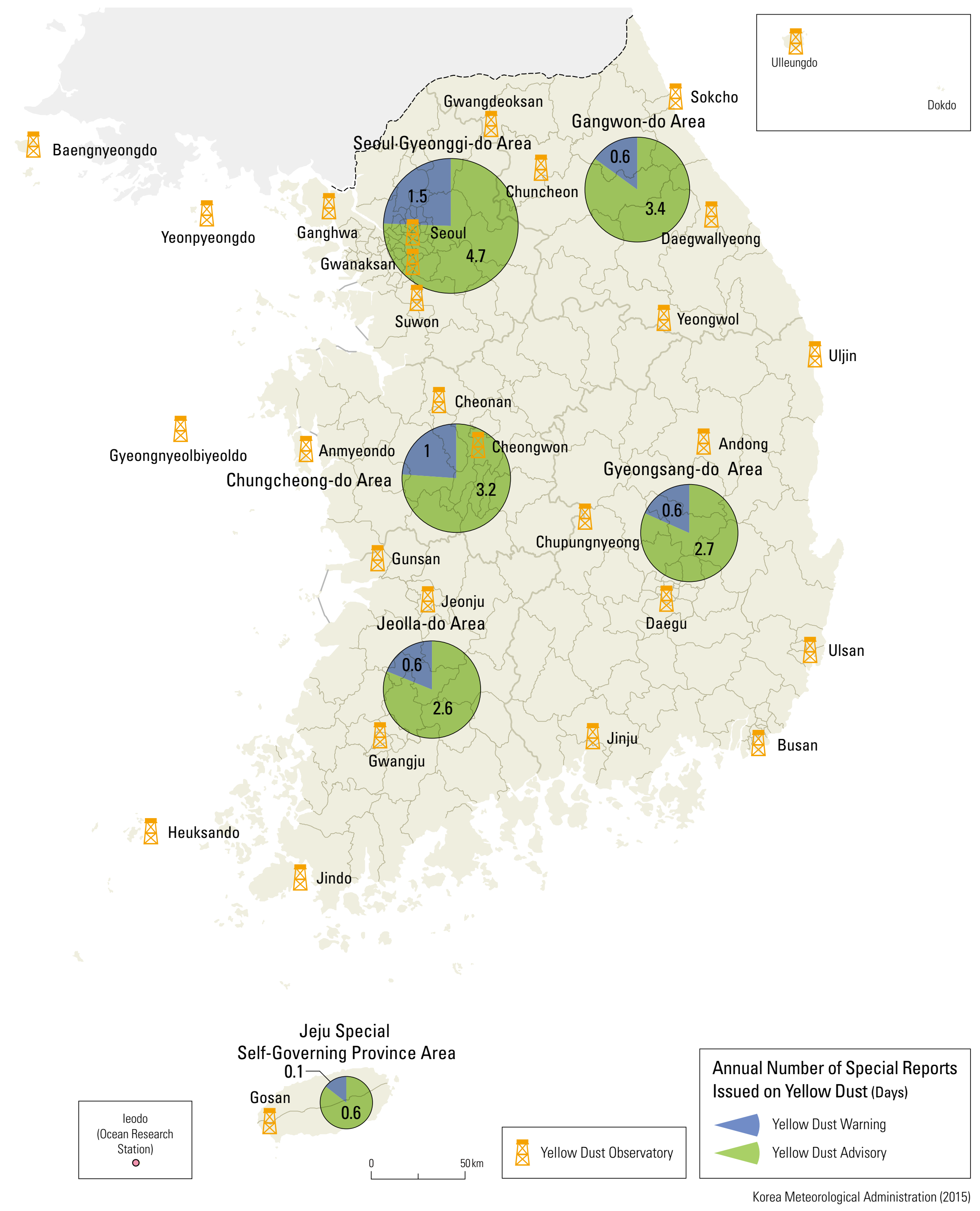
Average Annual Number of Yellow Dust Days





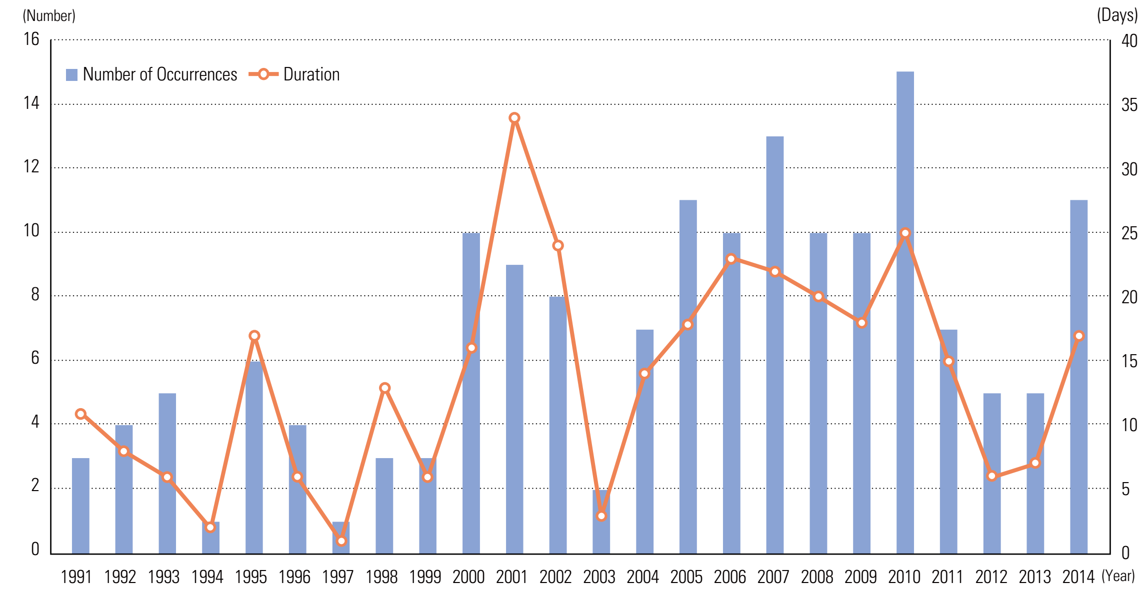
Korea Meteorological Administration (2015)

Distribution of Yellow Dust Observatories and Average Annual Number of Special Reports Issued on Yellow Dust by Region (2004 – 2014)



Korea Meteorological Administration (2015)

Annual Frequency of Yellow Dust Occurrences (1991 – 2014)



National Climate Data Center (2105)

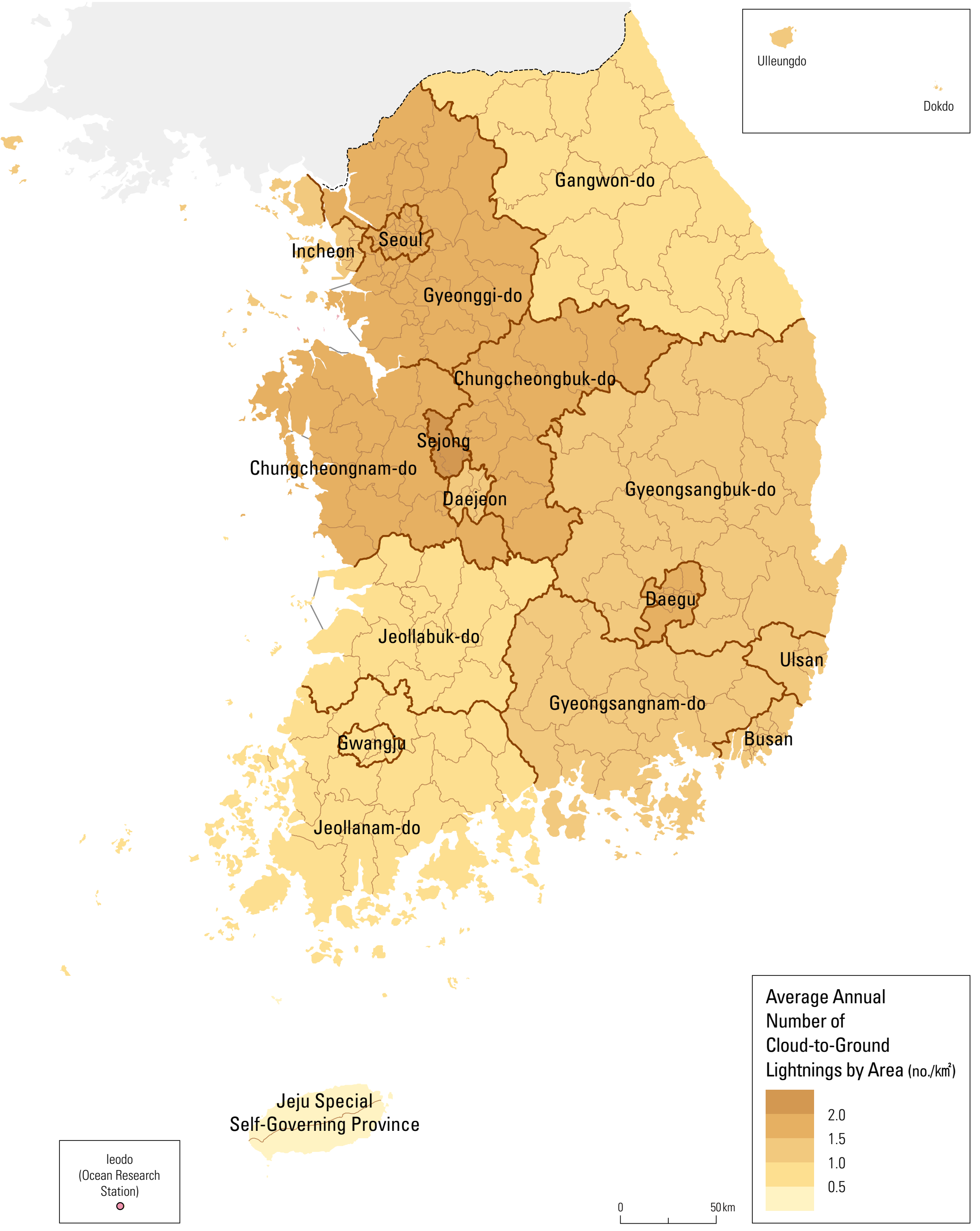
Yellow dust occurs when fine sand dust blown up by the wind from the northern part of China and dry/red clay zones of Mongolia, spreads in the air, covers the sky, and then descends gradually to certain regions. Yellow dust generally occurs from March to May when cyclones are active. Sometimes, they reach 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, so that the sky is seen as yellowish brown, and yellow-brown dust covers the land.

The dust causes a variety of problems in human health, agriculture, industry, transportation, and the oceans. Although Korea and Japan are far from the main dust sources, they are normally impacted by them. 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 4 times greater than that of the 1970s.

The yellow dust special weather reports issued by the Korea Meteorological Administration are classified as advisories and warnings. An advisory is issued when an hourly average particulate matter (PM-10) density of 400 μg/m³ is expected to last for more than 2 hours. A yellow dust warning is issued when an hourly average particulate matter (PM-10) density of 800 μg/m³ is expected to last for more than 2 hours.

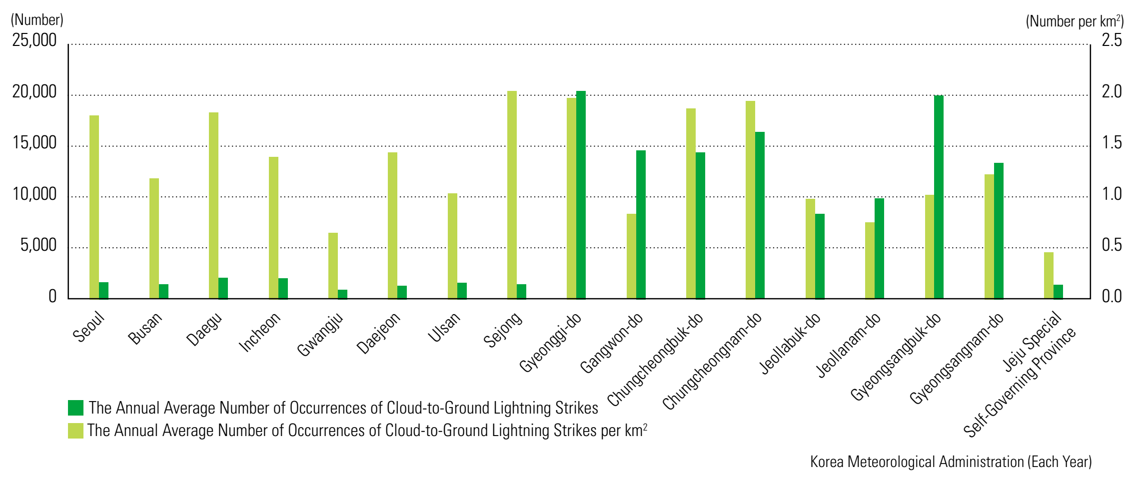
Cloud-to-Ground Lightning

Average Annual Number of Cloud-to-Ground Lightning Strikes by Province (2012 – 2014)



Korea Meteorological Administration (2015)

Number of Cloud-to-Ground Lightning Strikes by Province (2012 – 2014)



Korea Meteorological Administration (Each Year)

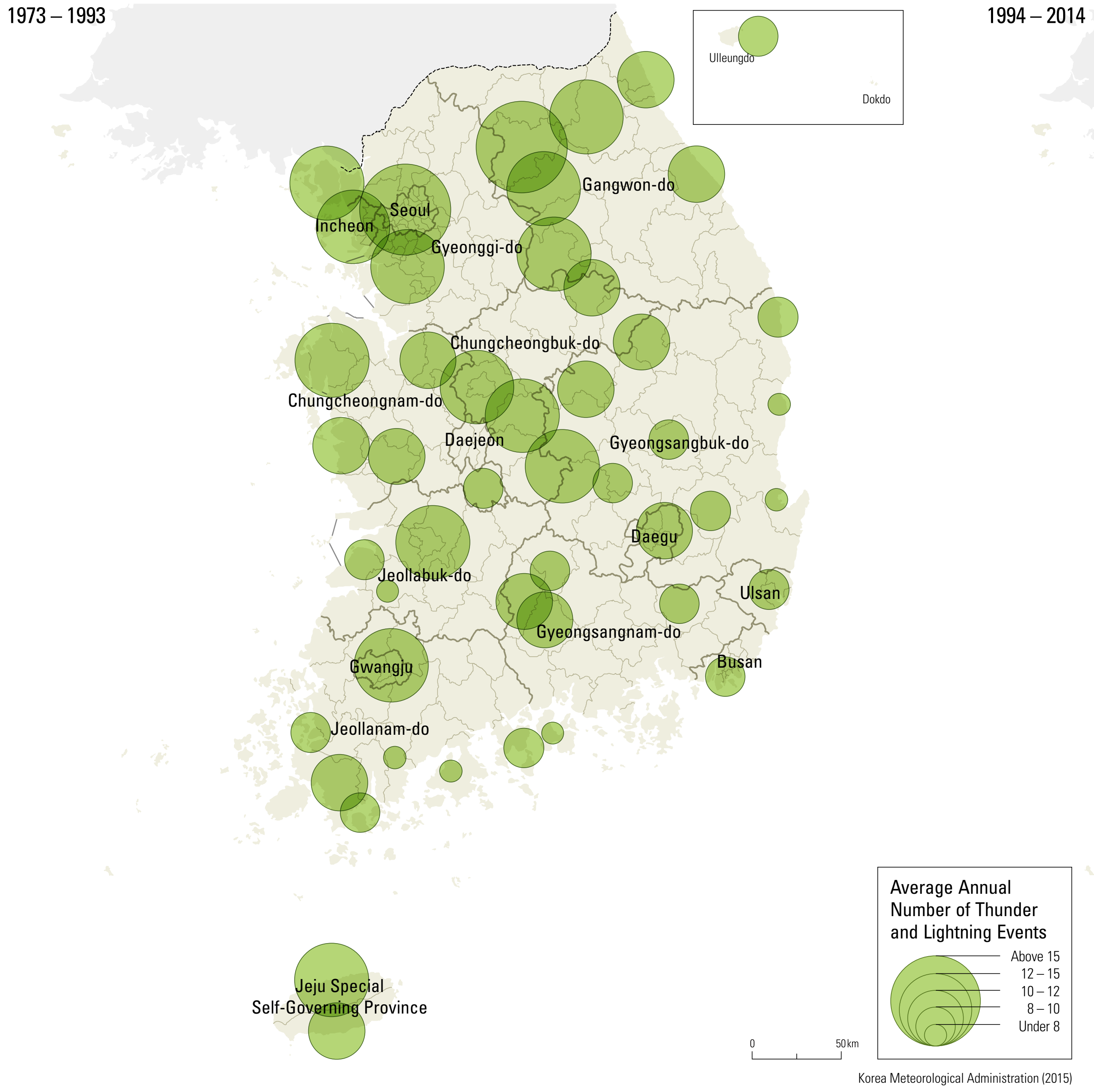
Number of Cloud–to–Ground Lightning Strikes per Season

Province	Spring	Summer	Fall	Winter	Total
Seoul	41	3,026	183	3	3,253
Busan	63	2,199	388	16	2,666
Daegu	692	3,127	975	0	4,794
Incheon	105	4,294	223	10	4,632
Gwangju	11	835	124	3	973
Daejeon	27	2,083	220	0	2,330
Ulsan	141	2,631	535	7	3,314
Sejong	98	2,372	346	1	2,817
Gyeonggi-do	5,656	51,161	3,313	29	60,159
Gangwon-do	8,358	32,637	1,181	10	42,186
Chungcheongbuk-do	4,882	34,221	2,569	4	41,676
Chungcheongnam-do	2,070	40,068	5,479	101	47,718
Jeollabuk-do	682	21,791	1,049	92	23,614
Jeollanam-do	333	22,420	5,135	122	28,010
Gyeongsangbuk-do	11,346	42,344	5,097	18	58,805
Gyeongsangnam-do	3,840	28,312	6,429	59	38,640
Jeju Special Self-Governing Province	176	2,193	161	34	2,564

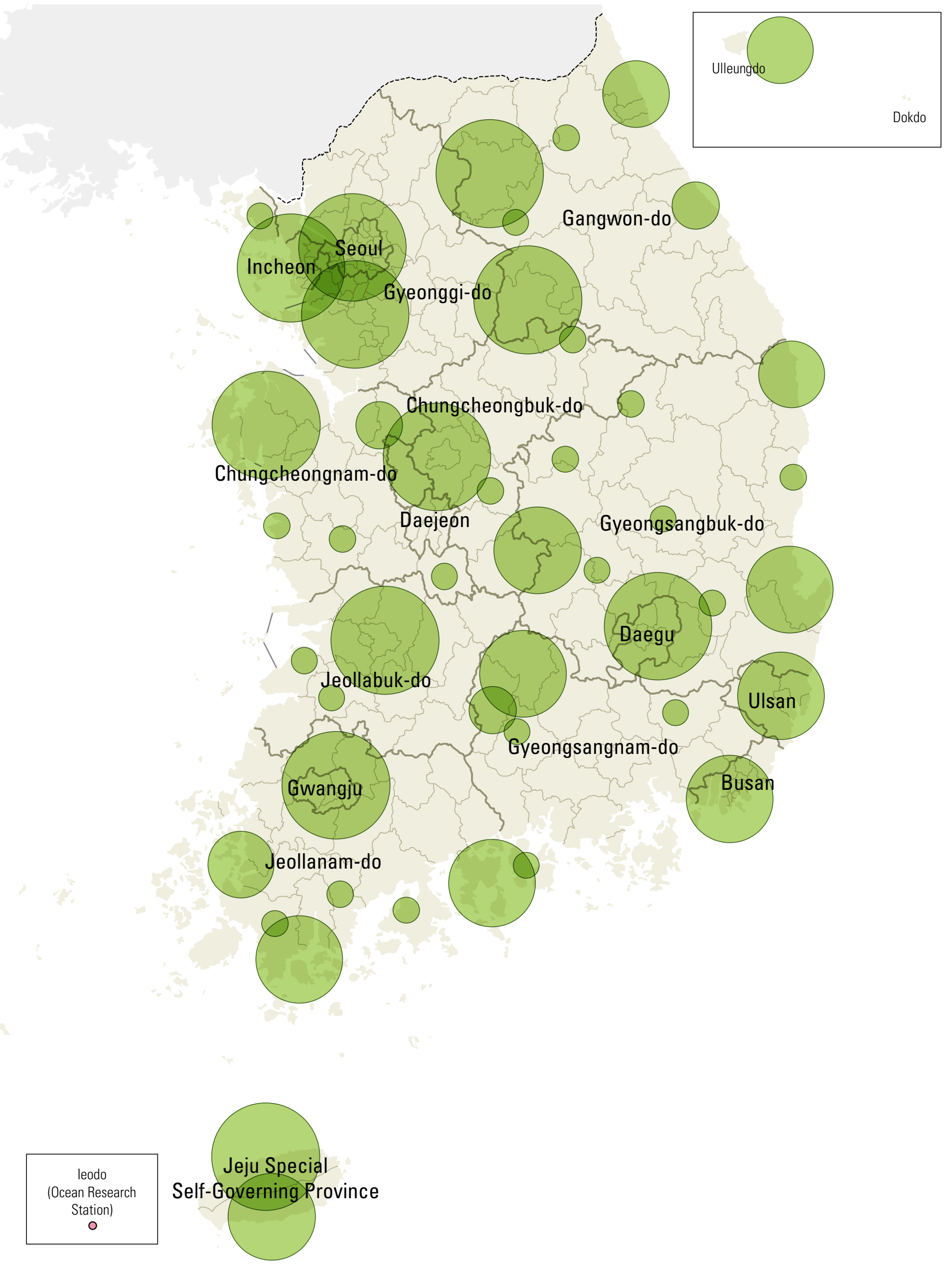
Korea Meteorological Administration (2015)

Average Annual Number of Thunder and Lightning Events per Observatory

1973 – 1993



1994 – 2014

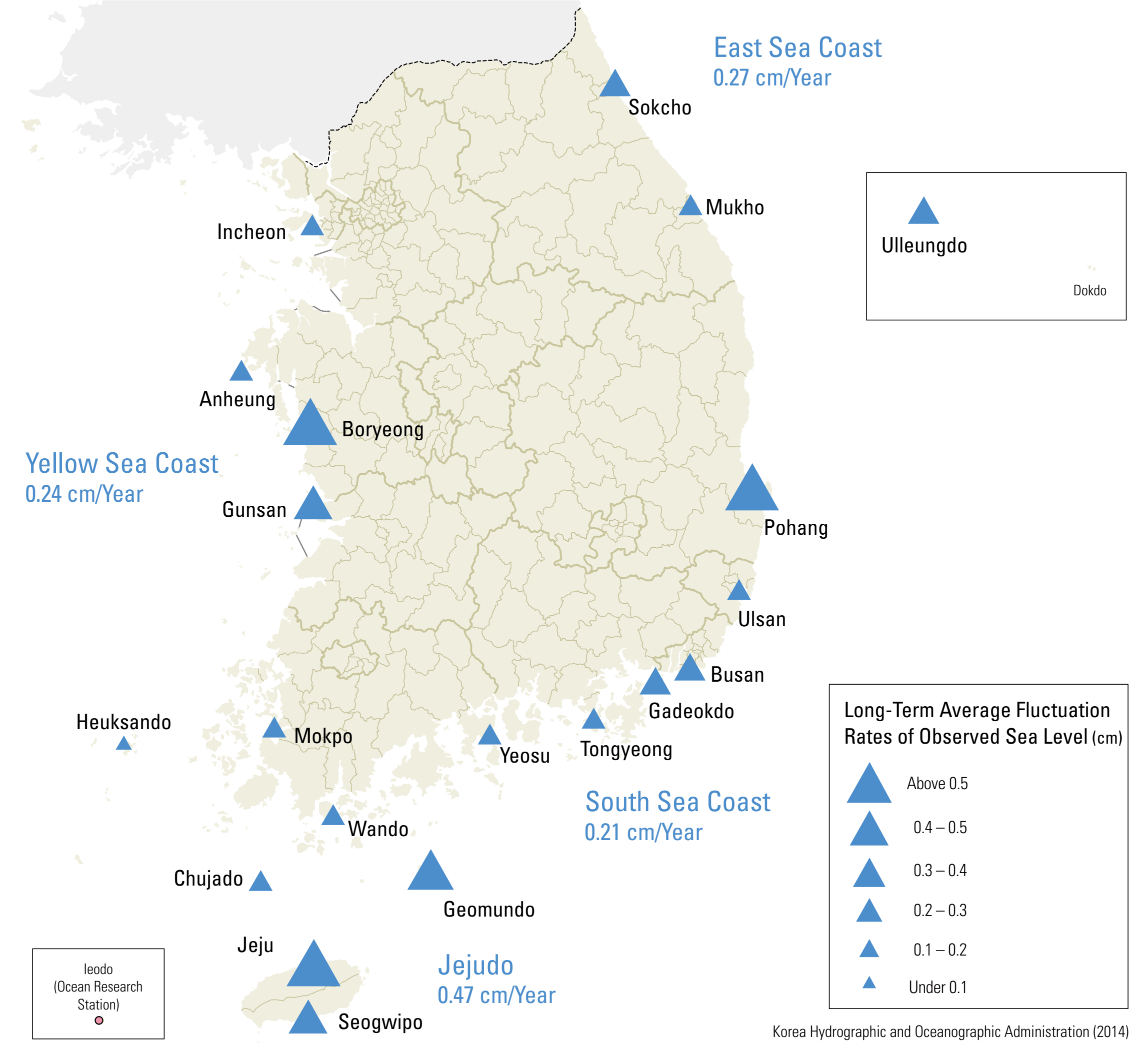


Korea Meteorological Administration (2015)

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 summer.

Sea Level Rise

Long-Term Average Fluctuation Rates of Observed Sea Level



Korea Hydrographic and Oceanographic Administration (2014)

Sea level surrounding the Korean Peninsula has increased. 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 0.24 cm/yr, 0.21 cm/yr, and 0.27 cm/yr in the Yellow, South, and East seas, respectively. Mean sea level fluctuation in Jejudo is the highest at 0.47 cm/yr. Boryeong in the Yellow Sea recorded the highest sea level fluctuation among all the seas at 0.65 cm/yr. Areas with the highest sea level fluctuation recoded are Jejudo (0.55 cm/yr in the Yellow Sea), Geomundo (0.41 cm/yr in the South Sea), and Pohang-si (0.58 cm/yr in the East Sea), respectively.

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 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 RCP 4.5 (8.5) scenario, the sea level around Korea will rise by 53 cm (65 cm) in both the South Sea and Yellow Sea, and 74 cm (99 cm) in the East Sea within the latter part of the twenty-first century (2071 – 2100). Meanwhile, global average sea level is expected to rise by 70.6 cm (88.5 cm) for the same time 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 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 level can be seen in coastal lowlands.

Representative Concentration Pathways (RCP)

RCP are a series of climate change scenarios that are used for determining greenhouse gas reduction policies per socio–economic setting. There is a total of 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, but it is not seen as a feasible plan. RCP 4.5 (540 ppm) is a scenario for when greenhouse gas reduction policies are carried out considerably, while RCP 6.0 (670 ppm) is for when the policies are carried out to some degree. RCP 8.5 (940 ppm) is for when greenhouse gases will continue to be emitted at the current rate without any reductions.

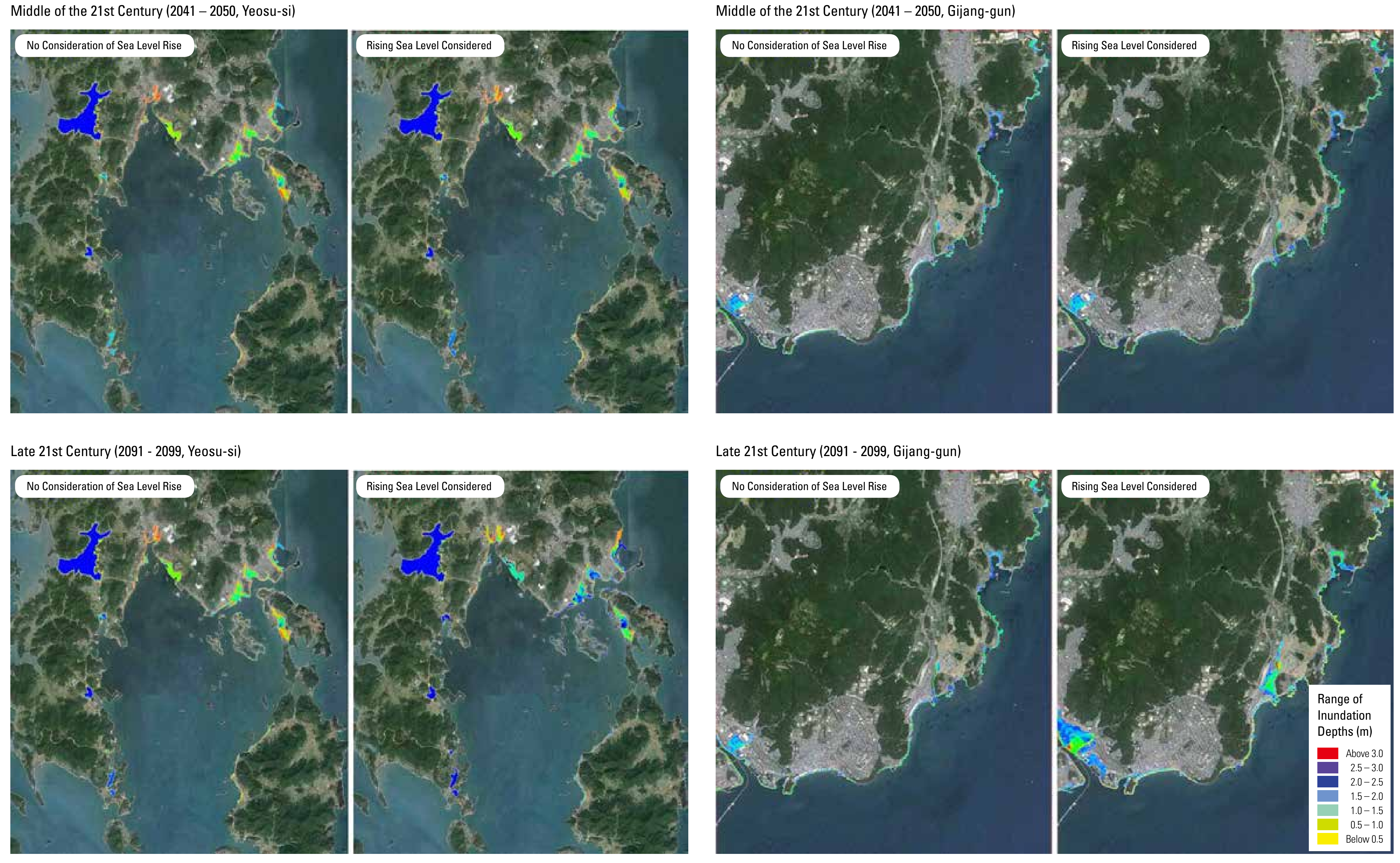
Inundation Range According to Sea Level Rise Scenarios

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		Fluctuation Rate	100-Year Return Period		Fluctuation Rate
	No Consideration	Considering Rise		No Consideration	Considering Rise	
Average Inundation Depth (cm)	149.1	162.3	13.2	157.6	207.7	50.1
Inundation Area (km²)	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		Fluctuation Rate	100-Year Return Period		Fluctuation Rate
	No Consideration	Considering Rise		No Consideration	Considering Rise	
Average Inundation Depth (cm)	77.90	82.50	4.60	82.70	100.6	17.90
Inundation Area (km²)	0.49	0.58	0.09 (17.7%)	0.56	1.37	0.81 (145.1%)

Prevention and Response to Natural Disasters

Korean invented the world's first rainfall gauge, recorded weather and natural disasters, and created unique dynamics. According to historical records, natural disasters occurred 40,000 times in Korea from the Three Kingdoms period to the end of the Joseon Dynasty. These natural disasters were inevitable. However, people have tried to manage these kinds of disasters by strengthening prediction, prevention, and preparedness.

In ancient times, Korean ancestors 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 influenced by droughts and floods constantly. When floods occurred during the Three Kingdoms period, they have 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 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 Annals of the Joseon Dynasty recorded floods occurred in Seoul for 450 years. In addition, water levels of the Hangang and streams in Seoul appear in the record that is related to ritual ceremonies for rain and sun held during the Joseon Dynasty. According to these records, there were 176 floods around Seoul in this period.

Efforts to Prevent Natural Disasters

The Rainfall Gauge of the Joseon Dynasty

This rainfall gauge was invented around 1440. It was the official device 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 lot 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 curving the mountains in order to get enough space for agriculture. These terraced paddy fields also prevent land erosion.

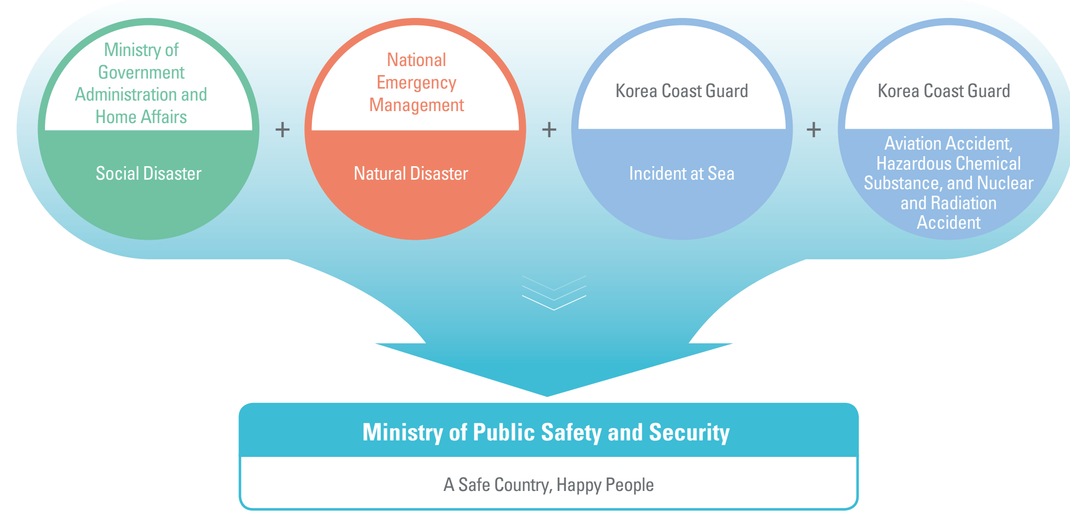
Traditional Houses of Jejudo

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

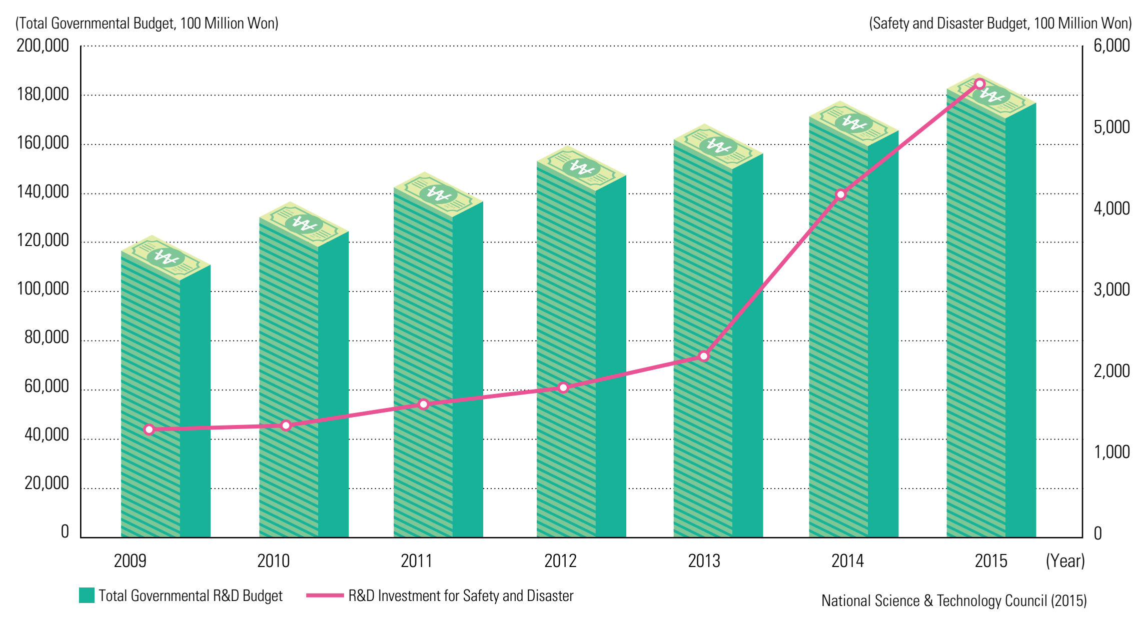
Udegi and Jjukdam of Ulleungdo

Udegi is an outer with thin pillars standing together, and string with woven like blinds. Jjukdam is a hallway to surround 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.

Reformed Disaster Safety Management Systems Integrated as Ministry of Public Safety and Security

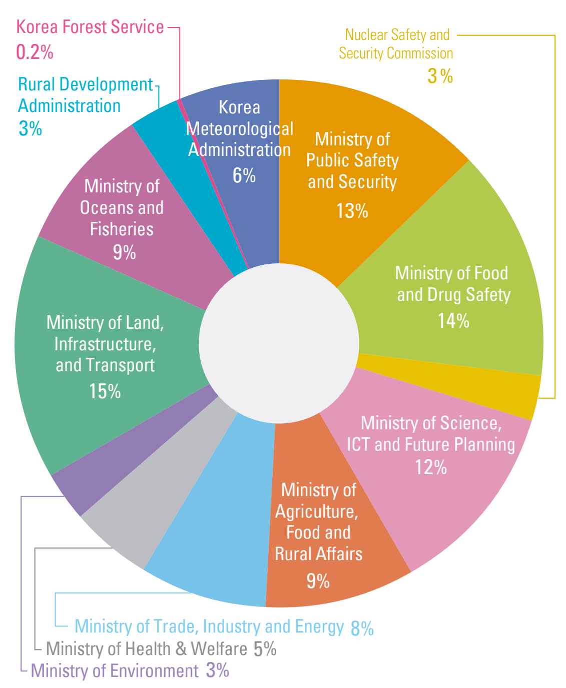


Total Government R&D Budget and the Amount of R&D Budget Spent on Human Safety and Human Disaster Management (2009 – 2015)

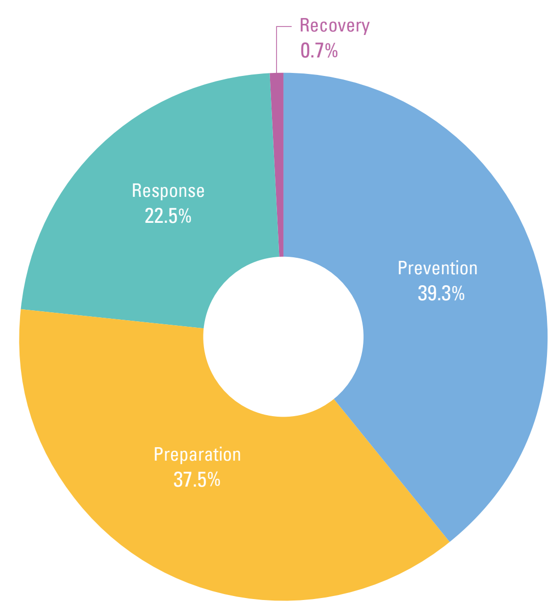


National Science & Technology Council (2015)

R&D Cost in the Area of Safety and Disaster by Department (2015)



Investment Ratio According to Steps in Disaster Management (2015)



National Science and Technology Council (2015)

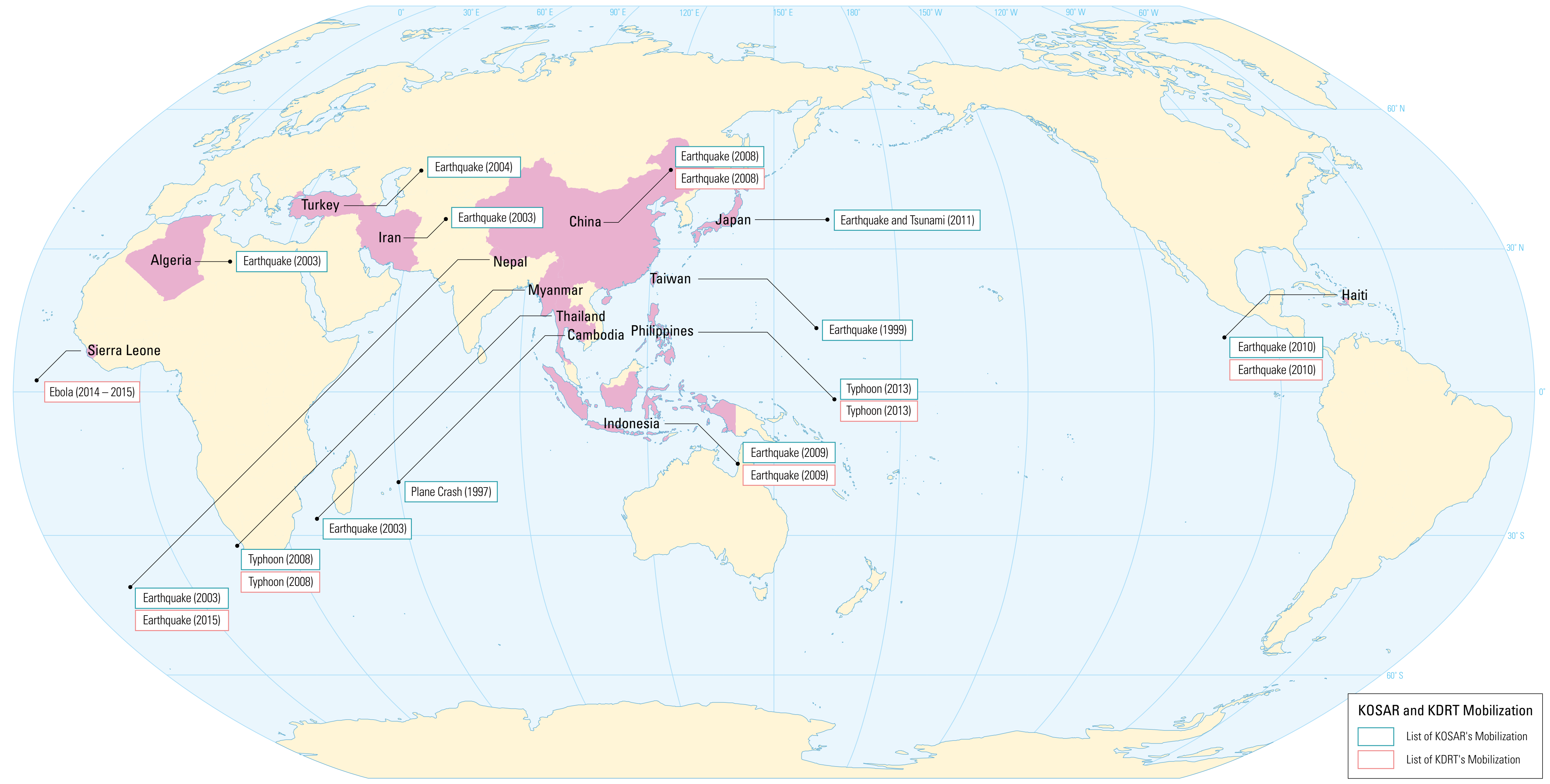
The Ministry of Public Safety and Security is an organization for human safety and disaster management that handles all types of disaster-related problems.

It was established to create a prompt, comprehensive system, in order to cope with disasters and safety problems by building a systematic disaster and safety management system.

Similar to that in the past, most natural disasters in Korea in recent years are caused by localized heavy rains, typhoons, and tsunamis. However, the type and extent of damage caused by natural disasters have been increasing. In addition, 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.

International Cooperation

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



KOICA (2015)

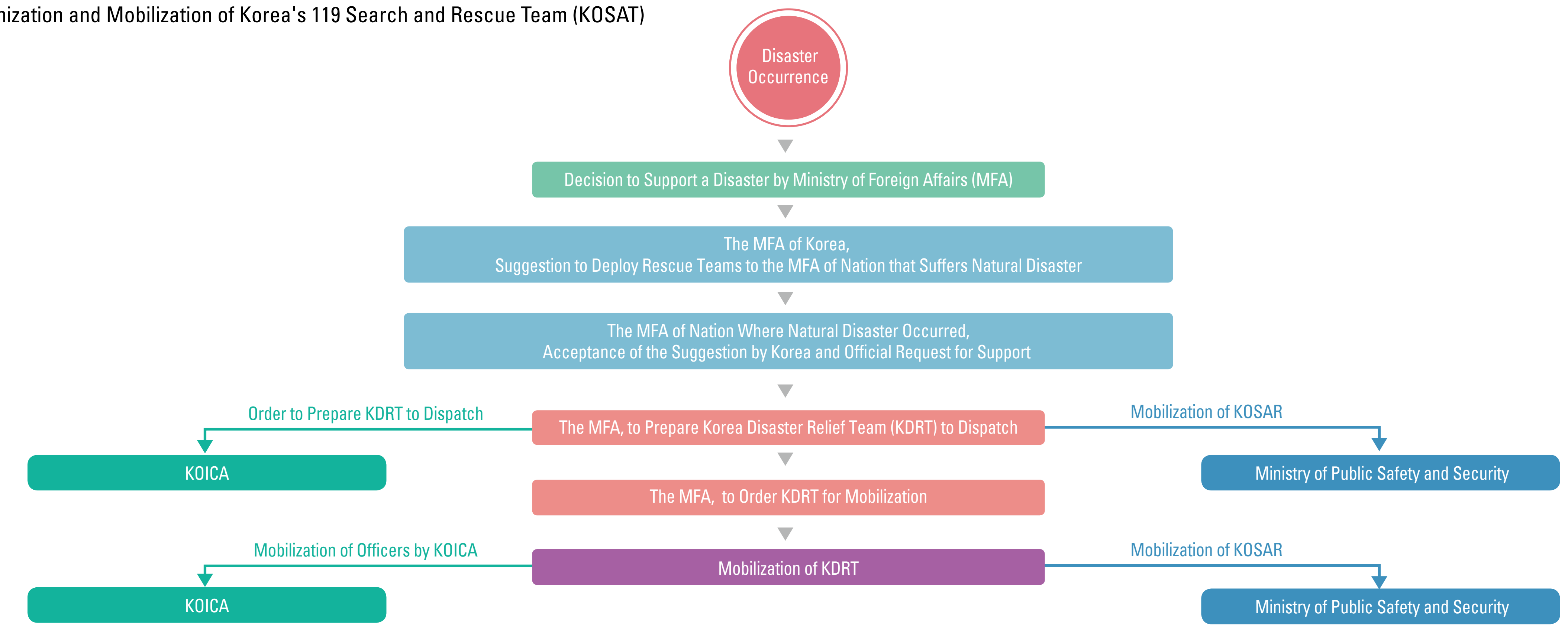
Activity of KDRT (Haiti Earthquake)

Activity of KOSAR (Tohoku Earthquake, Japan)

Activity of KDRT (Typhoons in the Philippines)

Activity of KDRT (Nepal Earthquake)

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



Korea has made various efforts to prevent and overcome natural disasters and hazards. In addition, Korea has not only cooperated internationally with other countries in disaster fields, but also supported humanitarian aid to many countries suffering from natural disasters, big accidents, conflicts, and complex catastrophes. Also, 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 the 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 big disaster occurs overseas, they play a greater role in prevention and in protecting people who suffer any type of disaster. 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 big 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 in contribution to international disaster relief. The decision is made according to the Government-Civilian Overseas Emergency Relief Council established by the Overseas Emergency Relief Act.