Research Intelligence

Flood 2024:
Risks and Impacts



September 2024

Krungsri Research

Introduction

As Thailand's rainy season progresses through the second half of 2024, there is a growing risk that extensive flooding will affect parts of the country. Indicators pointing in this direction include: (i) the weakening ONI, which is expected to swing from currently neutral conditions to a La Niña, thereby likely pushing rainfall above normal; (ii) the impact of regular tropical storms; (iii) the fall in the PDO and IOD indices, which are in or moving to a negative phase (i.e., below -0.5), indicating that Thailand is likely to be more exposed to storm conditions; and (iv) the fact that the monsoon index, which reflects short-term weather conditions, is close to normal, thus adding to the likelihood that areas around Thailand will continue to receive their seasonal rains. Krungsri Research expects that the northern, central and northeastern regions together with parts of the South will be the most heavily impacted parts of the country, though flooding will be a particular danger in the lower parts of the North and across the central regions; in the former case, this area acts as a channel funneling rains towards the sea, while the latter is essentially a large flood plain that is routinely exposed to widespread inundation. This will then have the potential to generate significant economic impacts on households, factory, machinery, crops, infrastructure and utilities. Krungsri Research expects that in the baseline scenario, flooding will affect 8.6 million rai in 2024, leading to property and asset losses of THB 3.1 billion and agricultural output losses of THB 43.4 billion. Consequently, total losses could reach THB 46.5 billion, reducing annual GDP by 0.27%.

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Flood risks through the last 4 months of 2024

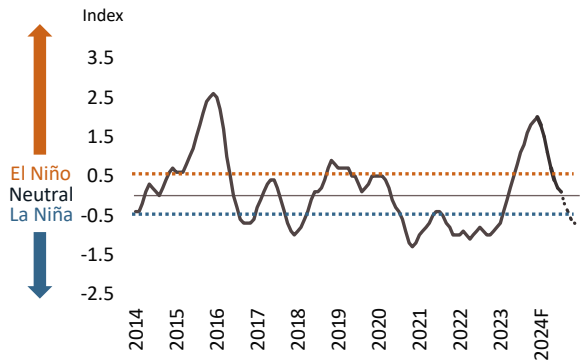
Across the first half of 2024, the tail end of the earlier El Niño left Thailand with hotter, drier weather that then undercut agricultural outputs, especially for field crops such as off-season rice, cassava and sugarcane. The resulting supply shortages meant that in some industries, companies were unable to deliver orders, while rising prices also had knock-on effects on the overall economy.

The weakening El Niño then transitioned to neutral conditions, though with enough momentum to carry the climate rapidly towards a La Niña, which may then trigger flooding across large parts of the country. Several climate indicators support this analysis.

1) **The Oceanic Niño Index (ONI)** is based on sea surface temperatures in the equatorial Pacific that are then used to indicate the likelihood of El Niño/La Niña conditions emerging. As of July 2024, the ONI stood at 0.1, in the center of the neutral zone[1/] (Figure 1) but the index has been weakening since the start of the year, and there is a growing chance that La Niña conditions will emerge[2/]. This is now expected to happen in October (Figure 2), and as ocean temperatures dip below their normal range, the chance that rainfall will be heavier than normal will rise correspondingly[3/].

Figure 1

Oceanic Indices



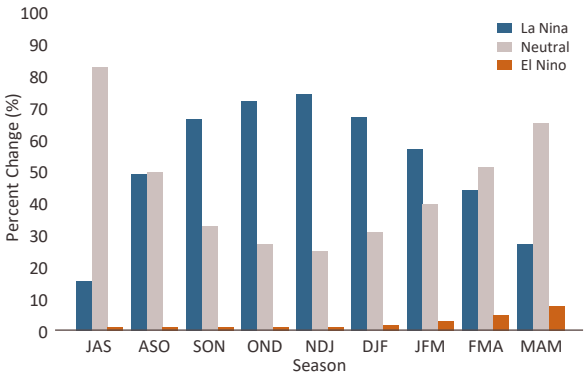
Source: National Oceanic and Atmospheric Administration, forecasted by Krungsri Research

Note: index > +0.5, meaning the rain is less than normal level (El Niño);
index < -0.5, meaning the rain is more than normal level (La Niña)

Figure 2

Official NOAA CPC ENSO Probabilities

Based on -0.5°C/+0.5°C thresholds in ERSSTv5 Niño-3.4 index[4/]



Source: National Oceanic and Atmospheric Administration

1/ The ONI is considered to be 'neutral' when sea surface temperatures in equatorial regions of the Pacific are in a range of -0.5 °C and +0.5 °C of their average.

2/ The La Niña is a phenomenon witnessed when sea surface temperatures in parts of the Pacific fall below the average, which usually leads to changes in the distribution of atmospheric moisture and higher than normal rainfall in Southeast Asia. The intensity of these events is measured by the ONI Index, with values of -0.5 °C to -0.9 °C considered a weak La Niña. Values of -1.0 °C to -1.4 °C are classified as a moderate La Niña, between -1.5 °C and -2.0 °C is a strong La Niña, and anything over -2.0 °C qualifies as a very strong La Niña. If the ONI is positive and above 0.5 °C, this points to El Niño conditions, which are graded similarly to those for La Niña, though with positive rather than negative deviations from average temperatures.

3/ Average refers to the 30-year mean for 1991-2020.

4/ In particular, the area of importance lies between 5 °N and 5 °S and between 170 °W and 120 °W. This is referred to as the Nino 3.4 Region.

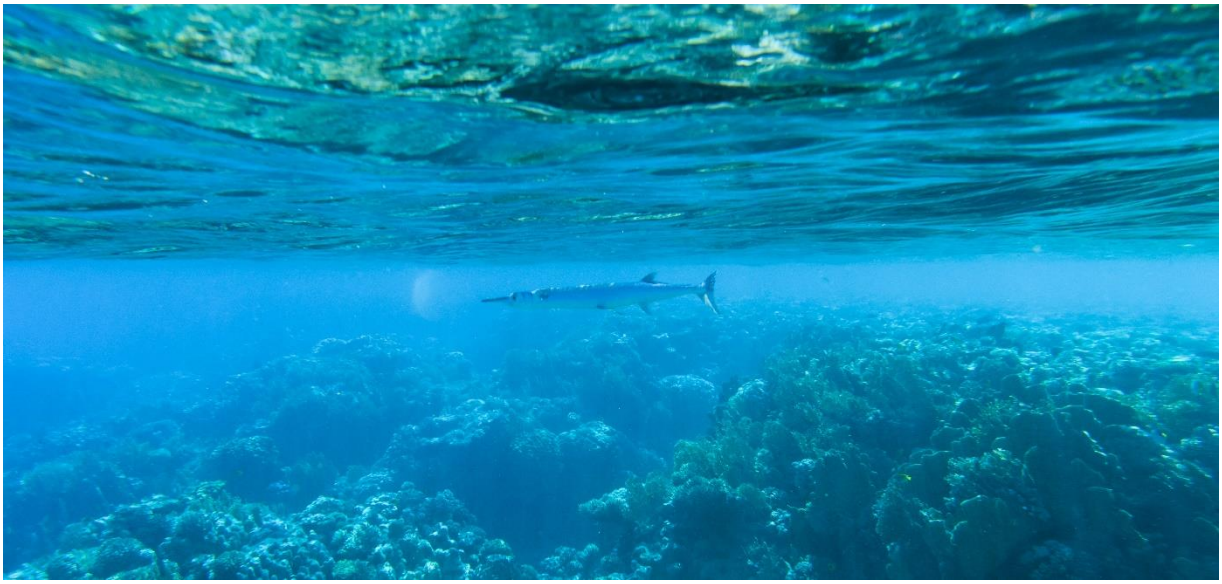
Box 1 The ENSO phenomenon

The **E**l **N**iño **S**outhern **O**scillation (ENSO) is a climate phenomenon that occurs as a result of the interaction between changes to sea surface temperatures in the equatorial Pacific and air pressure and weather systems overlying the Pacific Ocean.

During the 'warm phase' of the ENSO, more usually called an El Niño, higher than normal sea surface temperatures in the central and eastern parts of the equatorial Pacific cause changes to dominant winds, which then move from west to east. This in turn increases moisture and rainfall on the eastern side of the Pacific and a corresponding drop in rains on its western side.

The ENSO's 'cold phase', or the La Niña, occurs when this situation runs in reverse. Thus, sea surface temperatures fall below normal, winds reverse and blow from east to west, and rainfall rises on the western side of the Pacific and falls on its eastern side.

The current state of the ENSO is reflected in the value of the ONI. This records the temperature of surface waters in the equatorial Pacific, and is averaged over a three-month period. Thus, for example, the JAS reading is the average ONI for July, August and September. The most recent ONI value is the July 2024 reading, which averages temperature variations relative to the baseline for the three months of June, July, and August.

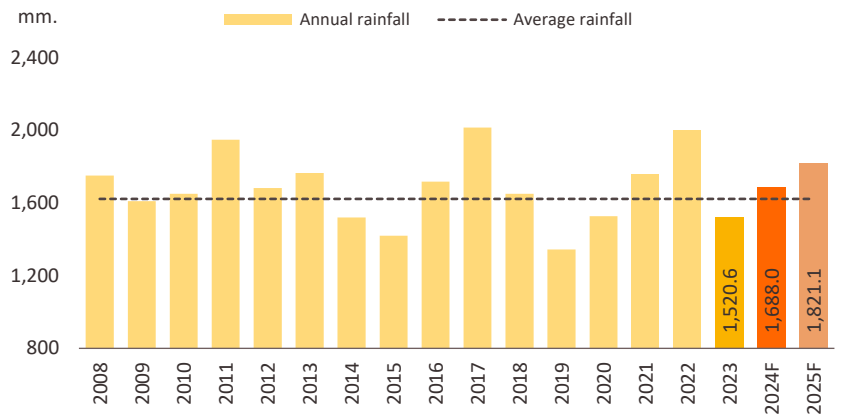


2) **Rainfall is expected to rise 15.0-16.0% above average through July to December 2024[5/],** and so from the middle of the year onwards, there has been an increased risk of flash flooding, particularly in flood plains and other flood-prone areas. However, as a result of the weakening El Niño, rainfall was below normal in the first half of 2024 and so for the year as a whole, average rainfall is expected to come to 1,688 mm, only very slightly above the 30-year average[6/]. 2024 rainfall is also some way off the 2011 total of 1,948 mm, which was a full 20.0% above normal (Figure 3).

In light of this, although heavy rainfall through the latter half of 2024 is adding to the risk of flooding, the strong EL Niño in the first half of the year meant that rainfall was down by -17.1% and so the ground was dry and ready to absorb large quantities of water. The current situation therefore differs markedly from 2011, which had higher water levels and soil moisture accumulation since the beginning of the year.

Figure 3

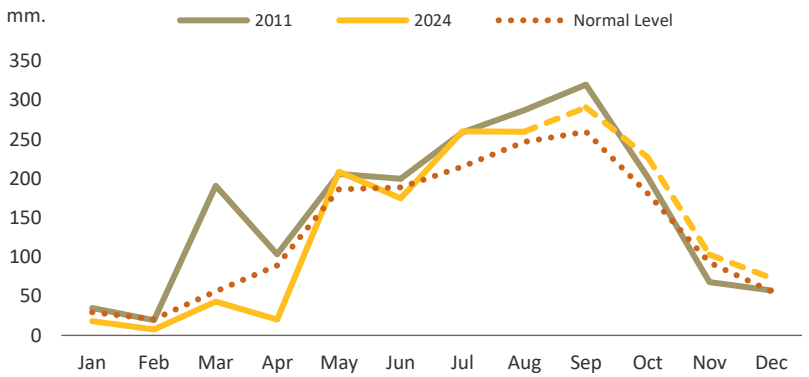
Annual Rainfall in Thailand



Note : Forecast by Krungsri Research
Source: Thailand Meteorological Department

Figure 4

Comparison of monthly rainfall in 2011 and 2024



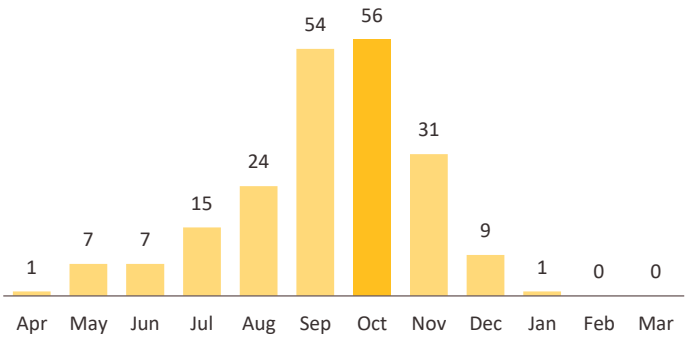
Note : Forecast by Krungsri Research
Source: Thailand Meteorological Department

5/ This refers to the 30-year average for 1991-2020.
6/ Over the past 30 years, annual rainfall has averaged 1,623 mm.

3) **Number of cyclones,** data gathered over the past 73 years show that on average, Thailand is affected by 2-3 tropical cyclones (i.e., tropical depressions and typhoons) each year, though over the past decade, this has fallen to more like 1 or 2 storms annually. Krungsri Research expects that Thailand will face 1-2 tropical cyclones entering the country, which is fewer than the 5 storms that hit Thailand during the major floods of 2011. The north and northeast of Thailand are closest to the normal storm tracks and the peak time for storms is September and October, when the rains are usually at the most intense (Figure 5), and so during this period, these regions are likely to experience flash flooding and rivers breaching their banks (Figure 6).

Figure 5

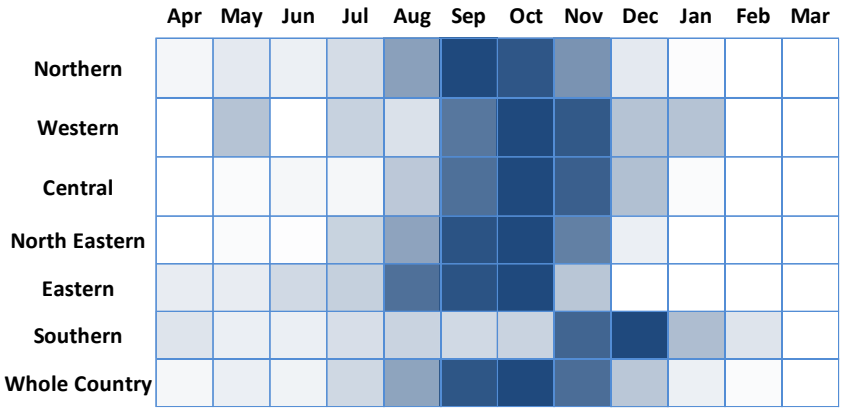
Total Number of Storms Crossing Thailand over the Last 73 Years (1951-2023)



Source: National Hydroinformatics Data Center, Krungsri Research

Figure 6

Period of Flood Risk by Region



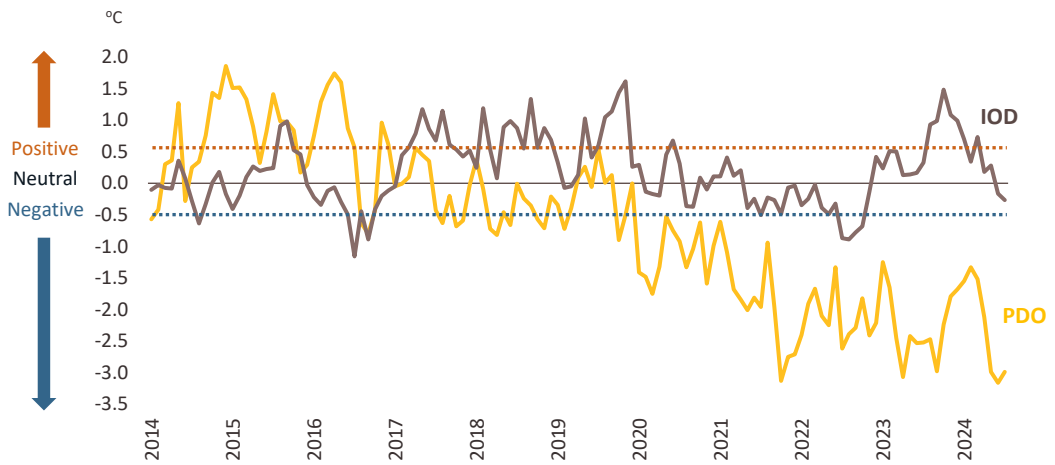
Note : Based on an assessment of the highest flood levels, and the frequency and probability of flooding over 1990-2023.

Source: Water Situation Analysis Section (Royal Irrigation Department), Krungsri Research

4) **The impact of storms and the monsoon,** in addition to major storms directly entering the country, Thailand also faces risks from the influence of storms and monsoons. Even if these do not directly hit Thailand, they may move into neighboring countries and later dissipate or change direction, still affecting rainfall levels in Thailand. This will particularly affect the east and northeast of Thailand through the second half of the year, when these areas will see rainfall rise as a result of storms, warm water currents, and monsoon conditions blowing in from the Pacific. These risks are reflected in the Pacific Decadal Oscillation Index (PDO)[7/] and the Western Pacific Monsoon Index, which are negative and falling, indicating that rainfall is likely to rise. At the same time, areas in the west of Thailand will be impacted by the storms, warmer currents, and monsoon rains connected with the Indian Ocean, and as with the Pacific, the Indian Ocean Dipole Index (IOD)[8/] and Indian Monsoon Index are negative with a downward trend further.

Figure 7

The Pacific Decadal Oscillation (PDO) and Indian Ocean Dipole (IOD) Indices



Source: JAMSTEC, Bureau of Meteorology (Australian Government), National Oceanic and Atmospheric Administration

5) **Water levels in large and mid-sized reservoirs are currently above average.** As of the end of August, the country's large reservoirs held a total of 44.62 billion m^3 of water, or 62.9% of capacity. This is above the average for the past 14 years[9/] but below the 53.19 billion m^3 (76.4% of capacity) stored in 2011 during the year of the Great Flood (Figure 8). Similarly, 2.82 billion m^3 is currently held in mid-sized reservoirs. This represents 55.4% of capacity and is higher than the average over the past 6 years[10/].

7/ The Pacific Decadal Oscillation (PDO) is a phenomenon caused by differences in sea temperatures on either side of the Pacific in the region 20 °N. During a negative phase, water in the east is warmer, and this tends to raise rainfall in Thailand and nearby areas above normal levels, with positive and negative phases typically cycling over a period of around 30 years. As of July 2024, the PDO had a value of -3.0.

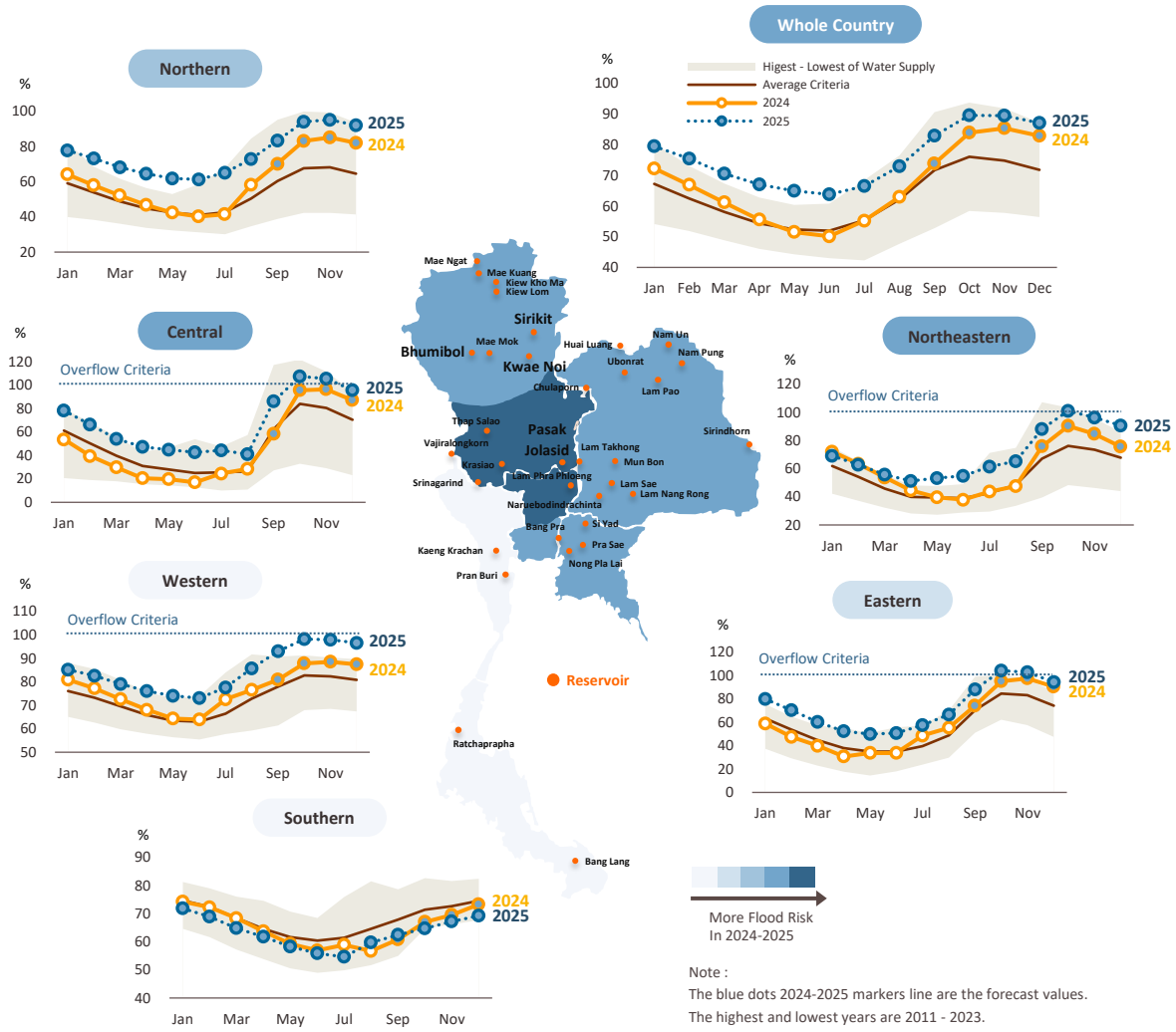
8/ The Indian Ocean Dipole (IOD) (or the Dipole Mode Index (DMI)) measures the oscillation in local water temperatures between the east and west sides of the Indian Ocean in the areas 50 °E-70 °E, 10 °S-10 °N and 90 °E-110 °E, 10 °S-0 °N. When the index is in a negative phase, warm water collects in the east of the Indian Ocean, and this is linked to an increase in rainfall in Thailand and neighboring countries. In July 2024, the IOD stood at -0.3.

9/ Available data covers the 14 years from 2011 to 2024. Through this period, average water levels in large reservoirs at the end of August were at 59.3% of capacity.

10/ The data that is available covers the 6 years from 2019 to 2024. Through this period, average water levels in mid-sized reservoirs at the end of August stood at 53.6% of capacity.

Figure 8

% Water Supply and Flood Risk



Note : 2024 31 August is latest data
Source: Thaiwater, Krungsri Research

Given the influence of the factors described above, rainfall will likely trend above normal through the second half of the year, and coupled with the intensification in the rainy season, what was already slightly above normal levels of water in reservoirs can be expected to rise further and to approach historic highs[11/]. Through the middle of the rainy season in July and August, rainfall increased in all parts of the country, and so the risk of flooding is intensifying. It remains to be seen how the situation will develop as the rainy season intensifies in September and October, but with rainfall already set to strengthen, it will be important to track the situation closely.

Areas in the northern, northeastern, and central regions together with parts of the South are thus now at high risk of flooding. The lower north will be especially exposed to risk, since this region channels water from higher to lower parts of the country, as will the central region, which receives flood waters from the north and so has been subject to repeated flooding. Should widespread inundation occur, this will naturally generate losses for the agricultural sector, which is already suffering from the impacts on agriculture outputs of drought at the start of the year, though losses will extend beyond agricultural areas to include damage to buildings, homes, consumer goods, transportation routes and utilities.

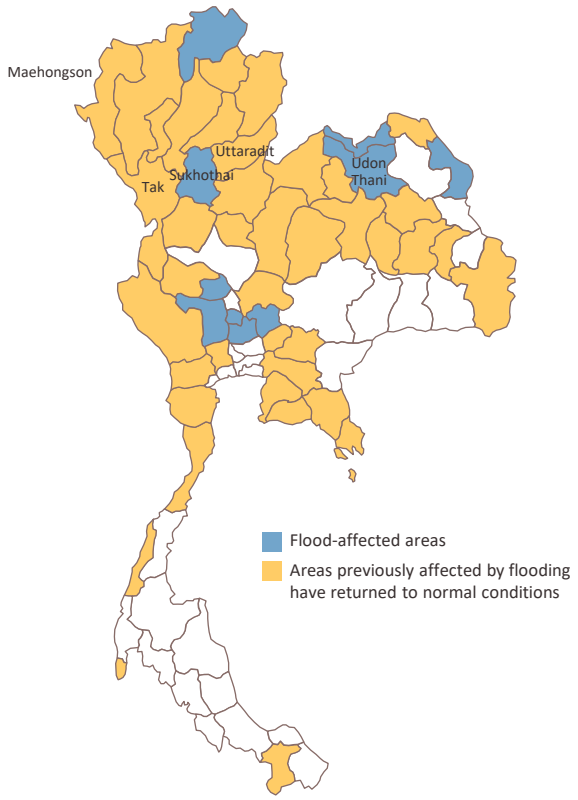
11/ That is, the highest level reported in monthly data over the period 2011-2023 (the upper edges of the gray bands on the graphs showing regional reservoir levels in Figure 8).

2024 flooding to date

Over January to June, Thailand was affected by monsoon and low-pressure conditions in neighboring countries that then caused flooding, especially in central and northern regions[12/]. From the start of the year through to 8 September[13/], 50 provinces experienced some degree of flooding, though as of 8 September 2024, the situation had returned to normal in 40 of these, and so flood conditions only persisted in 10 provinces[14/] (Figure 9). Nevertheless, over the 30-day period from 9 August to 7 September[15/] , 1.4 million rai experienced flooding and this impacted 0.18 million households. The most seriously hit provinces have been Chiang Rai (0.27 million rai), Sukhothai (0.20 million rai), Nakhon Phanom (0.15 million rai), Phayao (0.14 million rai) and Phichit (0.12 million rai). Likewise, the crops suffering the most widespread damage have been rice (0.31 million rai), corn (4,280 rai), sugarcane (935 rai) and cassava (654 rai).

Figure 9

Flood Area as of September 8, 2024



Source : Smart Water Operation Center,
Royal Irrigation Department, Krungsri Research
Note : As of 8 September 2024

12/ Information from the National Agricultural Big Data Center shows that losses valued at THB 100.5 million have occurred on 8,600 rai in the 7 provinces of Kamphaeng Phet, Uthai Thani, Phayao, Tak, Uttaradit, Suphanburi and Kanchanaburi.

13/ Source: Data on current rain water management published by the Bureau of Water Management and Hydrology, 8 September, 2024.

14/ Chiang Rai, Sukhothai, Chainat, Suphanburi, Ang Thong, Saraburi, Ayutthaya, Nong Khai, Udon Thani, and Nakhon Phanom are still affected by flooding.

15/ These losses are based on estimates and have not yet been verified through on-site assessments. Source: Geo-Informatics and Space Technology Development Agency.

Flood risks for the remainder of 2024

As previously mentioned, **the risk of flooding in 2024 is expected to continue rising, particularly in September and October, affecting all regions except the South. For the Southern region, the risk is higher in November and December**, due to the influence of monsoon troughs and tropical cyclones, which regularly pass through Thailand each year[16/]. Taking into account factors related to weather conditions and other environmental signals pointing to a high risk of flooding, Krungsri Research has produced a flood risk assessment based on the following assumptions**.**

1) **Storms:** The country will be hit by at least 1 or 2 tropical storms, and because La Niña conditions are expected to emerge in September, these will bring with them a greater than average volume of rain.
2) **Rainfall:** The onset of a La Niña will imply higher than average rainfall over the remaining 4 months of 2024, with forecast losses escalating in proportion to the volume of rainfall.
3) **Areas affected:** Although both large and mid-sized reservoirs had more than 40% spare capacity as of the end of August 2024**, if rains fall outside the catchment areas for these, this will add to losses.** This is a particular risk in the central region if rains fall south of the reservoirs or outside the 13 low-lying areas in the lower Chao Phraya river basin that are regularly flooded or that serve as flood abatement zones[17/] (Figure 10).
4) **Water levels in the main waterways:** This will naturally be influenced by the volume of water flowing through watersheds, but if this exceeds the capacity of these rivers, there will clearly be a risk that riverbanks will be breached, and nearby areas flooded (Figure 10).

Additionally, there are several uncontrollable and unforeseen factors that may further increase the risk of flooding in 2024. For example, high tides in the Gulf of Thailand or high-water levels in aquifers and other natural sources of water, especially in the Mekong River basin, will slow the discharge of water to the sea, increasing the risk of flooding and adding to its extent if it does occur. However, the government can also help to alleviate overall levels of risk by anticipating problems, for example by preparing low-lying areas that can accommodate excess water, better managing reservoir levels, clearing waterways and increasing their throughput, moving machinery to areas likely to be flooded in advance of floodwaters, improving overall levels of water resource management, and checking and reinforcing dams, embankments, levies, public utilities and infrastructure generally.

16/ Source: Three-month weather forecast for Thailand for September to November, 2024, issued 26 August, 2024.

17/ Areas that have been repeatedly flooded over the 9 years between 2011 and 2020 or that serve as flood abatement areas include: Thung Chiang Rak, Thung Fang Sai Khlong Chai Nat-Pa Sak, Thung Tha Wung, and Thung Bang Kum, which receive water from Khlong Chai Nat-Pa Sak; Thung Pa Mok, Thung Phak Hai, and Thung Jao Jet, which receive water from Noi River; Thung Bang Kung, and Thung Bang Bal, which receive water drawn from Chao Phraya River; Thung Pho Phraya, which receives water from Tha Chin River; and Thung Phraya Banlue, Thung Phra Phimon, and Thung Rangsit Tai, which receive water drawn from canals in the local area.

Table 1

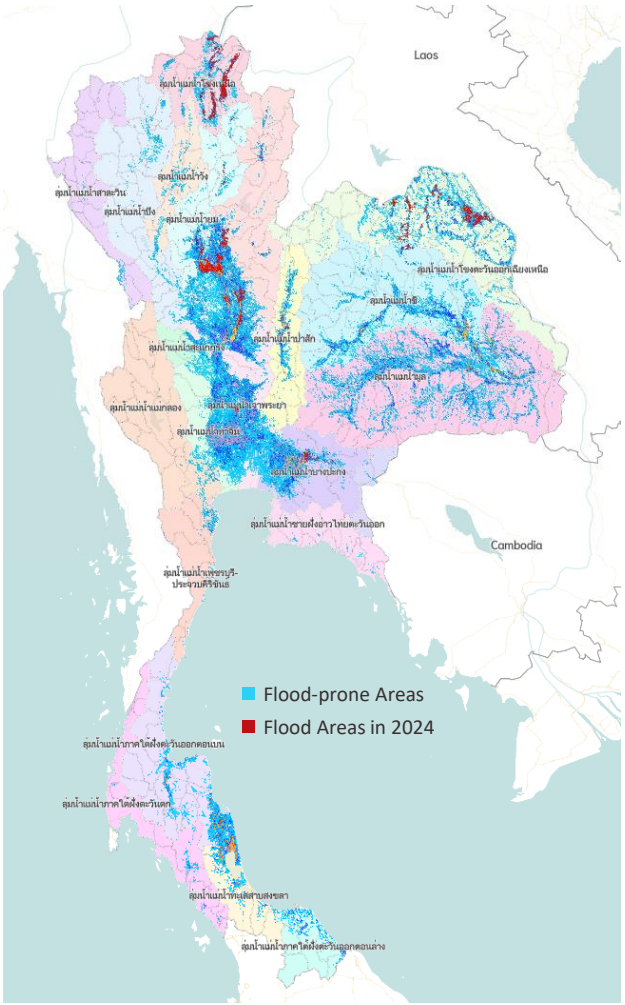
Flood Assessment Scenario

In 2024, Flood Assessment Scenario	Best Case	Base Case	Worst Case
	6.2 Mn. Rais	8.6 Mn. Rais	11.0 Mn. Rais
Probability	**20%**	**50%**	**30%**
Number of cyclones (No.)	**0 - 1**	**1 - 2**	**2 - 3**
Total rainfall last 4 months of the year (Above normal rate)	**11%-15%**	**16%-20%**	**> 20%**
Storage levels in large reservoirs at the end of October (% Capacity)	**71%-75%**	**76%-80%**	**81%-85%**

Source: Krungsri Research

Figure 10

Flood-prone Areas (Flood Bed) and Main Basin



Source: Geo-Informatics and Space Technology Development Agency (Public Organization)



Is flooding really better than drought? The current economic impacts of flooding and the outlook for the rest of 2024.

The consequences of flooding can be much more varied than for drought, since this can include damage to livestock, homes, factories and other structures, machinery, vehicles, and transportation routes. However, the impact on agricultural crops may vary, and if flood waters rise only slowly and recede rapidly, some crops may be entirely unharmed, but if flood waters are fast moving and standing bodies of water take an extended period of time to drain away, the extent of losses to crops such as rice, sugarcane, cassava and vegetables and other agricultural produce can be extremely significant. Moreover, this will then have downstream impacts and as supply chains tighten, industries that are reliant on agricultural inputs will face shortages, while limited supply will almost inevitably feed through into higher prices.

To provide insight into the likely scale of these problems, Krungsri Research has assessed the expected extent of 2024 flood impacts in terms of the area of agricultural land impacted by flooding and the economic consequences of this. Three scenarios have been modeled, each reflecting steadily worsening outcomes[18/] (Table 2).

- **Best case:** In the low-impact scenario, 6.2 million rai are affected by flooding, resulting in property and asset losses worth THB 2.2 billion, along with an additional THB 31.2 billion in crop losses. The total losses amount to THB 33.4 billion, or -0.19% of GDP.
- **Base case:** In this scenario, 8.6 million rai are inundated, resulting in property losses of THB 3.1 billion and crop losses of THB 43.4 billion. The total losses amount to THB 46.5 billion, or -0.27% of GDP.
- **Worst case:** In the high-impact scenario, 11.0 million rai of land are flooded, resulting in property losses of THB 4.0 billion and crop losses of THB 55.5 billion. With total losses amounting to THB 59.5 billion, the worst-case flooding would reduce annual GDP by -0.34%.

Table 2

Projected Economic Losses from Flooding

Flood impact forecast for 2024	9 August - 7 September	Best Case	Base Case	Worst Case
Assumptions of Affected Areas	1.4 Mn. Rais	6.2 Mn. Rais	8.6 Mn. Rais	11.0 Mn. Rais
Probability		20%	50%	30%
Asset Loss (Million Baht)	490	2,200	3,100	4,000
Agriculture Loss (Million Baht)[19/]	6,900	31,200	43,400	55,500
Total Loss (Million Baht)	7,390	33,400	46,500	59,500
As percent of GDP (Current Price)	0.043%	0.19%	0.27%	0.34%

Source: Krungsri Research

18/ Forecasts are derived from the area of land currently affected by flooding and the likelihood of floods occurring in additional areas through the remainder of 2024. This is based on an assessment of historical data collected by the National Hydroinformatics Data Center, the Office of Agricultural Economics, the Office of the National Economic and Social Development Council, the Geo-Informatics and Space Technology Development Agency, the Department of Disaster Prevention and Mitigation, the Royal Irrigation Department, and the National Agricultural Big Data Center.

19/ Calculated by Krungsri Research based on data on affected land as of 30 August, 2024 and the assumption that losses occur on 60-70% of all agricultural land impacted by flooding. Loss value = (production losses = Total area of completely damaged agricultural land x Yield per rai) x Average agricultural product price in 2024.

The level of flood damage to the economy depends on: 1) rainfall and water management, 2) the affected area, and 3) the location of economic units (households, factories, agricultural areas). Given this, if flooding occurs in economically significant areas, the resulting impacts will be correspondingly more severe, so for example, if locations that are home to industrial estates, major agricultural operations, or important transportation routes are damaged, this is much more likely to trigger impacts across the length of supply chains, from upstream production through to downstream distribution and on to the economy more broadly.

However, Krungsri Research expects that the floods in the second half of 2024 will not be as severe as the great floods of 2011, nor will they impact the economy to the same extent. The World Bank estimated the damage from the 2011 floods at as much as THB 1.44 trillion[20/] as it is anticipated that in 2024, there will be less rainfall and more water storage capacity, both from large and medium-sized dams. Additionally, the improved water management capabilities of the government (e.g., warning systems, maintenance, budget support) and enhanced private sector flood protection measures, particularly in industrial estates, will contribute to more effectively mitigating the impact.



20/ Source: 04 Thailand's National Adaptation Plan, The Institute for Sustainable Development of Natural Resources and Environment (mnre.go.th).

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