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2022 flood risks and the impacts of this on agriculture and industry

Thailand is at risk of seeing widespread flooding in 2022, as evinced by: (i) current oceanographic indices, including the ONI, which is indicating the emergence of a moderate La Niña[1/], and the PDO and IOD indices, which are now in a negative phase (i.e., below -0.5), thus pointing to the likelihood of a greater number of storms affecting Thailand directly or indirectly and heavier than normal rainfall; and (ii) the current state of the major reservoirs, which are now at similar levels to 2011, when the last major floods occurred. Areas most likely to experience flooding include the lower parts of the northern region, the upper parts of the central region, and the northeast, though areas where flooding has repeatedly occurred in the past will naturally be particularly exposed to risk. This will then cause damage to property and to economic activity, including to households, factories, machinery and agricultural goods. Krungsri Research thus estimates that 5.3 million rai of land may be flooded in 2022, generating losses to assets of around THB 790 million and damage to agricultural produce worth THB 11.6 billion. This would represent some 0.08% of GDP.

Warning signs of approaching flood risks

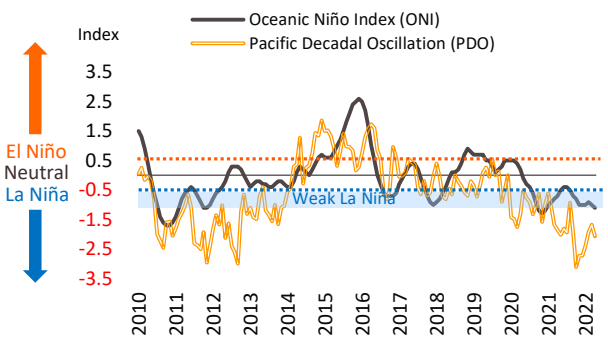
Several environmental indicators are pointing to the risk of flooding in Thailand in 2022.

1) **The Oceanic Niño Index (ONI):** The ONI measures temperatures on the surface of the Pacific near the equator[2/], and since August 2020, this has pointed to La Niña[1/] conditions. This means that Pacific sea surface temperatures are below normal, which then tends to lead to higher-than-normal rainfall in Thailand. As of April 2022, the ONI value was -1.1, indicating a moderate La Niña[1/] (Figure 1).

2) **Average rainfall:** For 2022, rainfall is expected to be 3% higher than normal in Thailand[3/] and to reach an average of 1,635 mm. Although this will be lower than in 2021[4/] (Figure 2), this can raise water levels in the country's reservoirs.

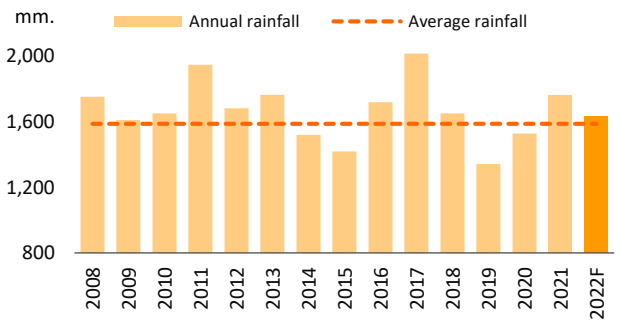
3) **Water storage:** Water levels in the large and medium sized reservoirs are already relatively high, and as of May 2022, large reservoirs held 40.05 billion m^3 of water, or 56.5% of their capacity. This is the highest level in 3 years and is above the 2011 level of 38.13 billion m^3 (55% of capacity) (Figure 4). Likewise, medium sized reservoirs are also currently close to the 2011 level of 63.9% capacity.

Figure 1: Oceanic Indices



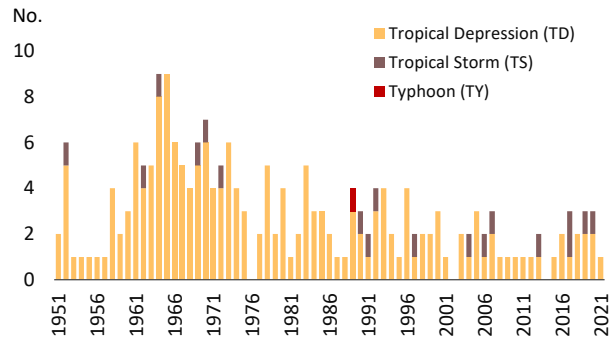
Note: index > +0.5, meaning the rain is less than normal level (El Niño); index < -0.5, meaning the rain is more than normal level (La Niña)
Source: National Oceanic and Atmospheric Administration

Figure 2: Annual Rainfall in Thailand



Source: Thailand Meteorological Department

Figure 3: Number of Storms Affecting Thailand



Source: National Hydroinformatics Data Center, Krungsri Research

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

2/ 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.

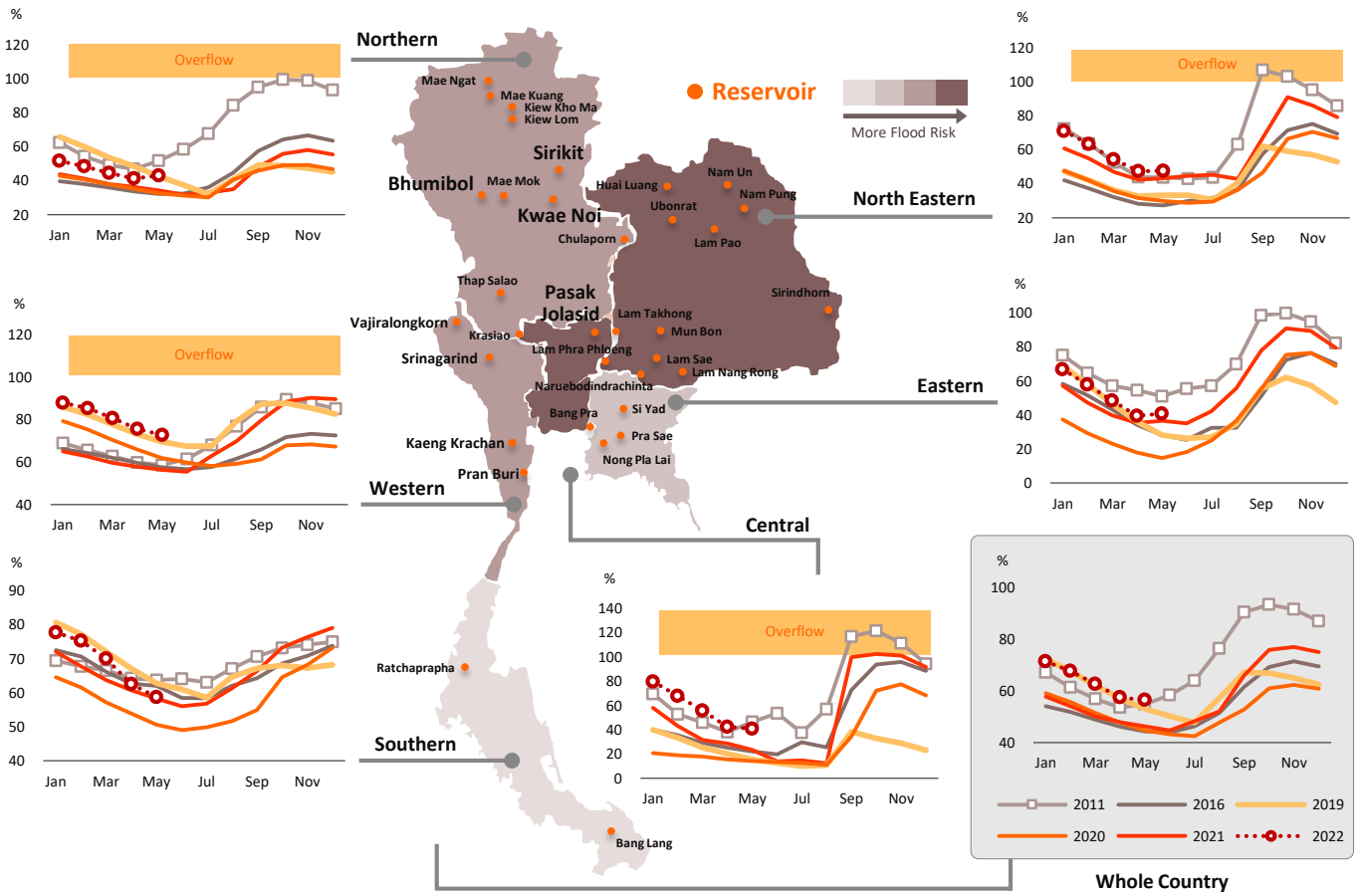
3/ Here, 'normal' is the average for the last 30 years (i.e., 1991- 2020).

4/ During the 2021 rainy season, rainfall in Thailand was 8% above average, and for the whole year this was up 11%.

4) **Tropical cyclones[5/]:** The Meteorological Department estimates that Thailand will experience two tropical cyclones in 2022, and these should cross the north and northeast of the country. However, historical data shows that on average, 3 storms hit Thailand annually[6/] (Figure 3) and over the past 5 years, the total has averaged 2.6[7/].

5) **Indirect effects:** In addition to storms and cyclones that hit Thailand directly, the country's hydrology may also be affected by storms that dissipate in neighboring countries, or that change track to then affect Thailand. The risk of this is reflected in two oceanographic indices, the Pacific Decadal Oscillation (PDO)[8/] and the Indian Ocean Dipole (IOD)[9/], which have values of respectively -2.1 (April 2022) and -0.4 (May 2022). These are expected to remain negative for the remainder of 2022, and as such, neighboring countries are likely to receive a greater volume of rainfall this year and so the quantity of water entering Thailand via land will increase. For comparison, over the past 5 years, Thailand has been affected by an average of 5 cyclones or storms per year[7/].

Figure 4 : % Water Supply



Source: Thaiwater, Krungsri Research

5/ Including depressions tropical and typhoons.
6/ Average for 1951-2021.
7/ Average for 2017-2021.
8/ The Pacific Decadal Oscillation (PDO) is a phenomenon caused by differences in sea temperatures on either side of the Pacific. During a negative phase, water in the east is warmer, and this tends to raise rainfall in Thailand and nearby areas above their normal levels.
9/ The Indian Ocean Dipole (IOD) or the Dipole Mode Index (DMI) is an oscillation in local water temperatures between the east and west sides of the Indian Ocean. 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.

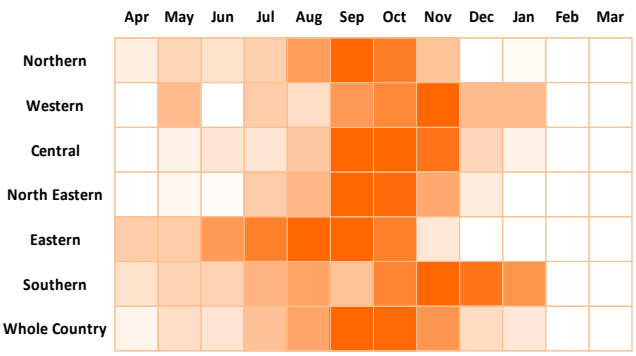
Areas at risk of flooding

If rainfall is as high as expected, many parts of the country will be at risk of flooding, especially during the period from August to October (Figure 5), when the influence of tropical cyclones on Thailand is at its highest and so the rains are at their heaviest (Figure 6). This may then lead to flash floods and rivers breaching their banks. Krungsri Research has thus analyzed the parts of Thailand most at risk of flooding.

- **North and central regions: The risk of flooding will be high if rainfall is concentrated south of the major dams.** Rainfall in the north will flow southwards (Figure 7.) When this meets rainfall from the west flowing southeastward that is not expected to be held up locally[10/] (Figure 4), this will generate a substantial body of water in the Chao Phraya floodplain. The risk then is that this will breach riverbanks and cause widespread flooding, with attendant economic losses, especially in areas that have been repeatedly hit by flooding (Figure 8). **However, if the rains are concentrated north of the major dams, the risk of flooding will be reduced in both the north and central parts of the country** since as of May 2022, the reservoirs behind northern dams were only at 43%[11/] capacity and so they will be able to retain a substantial amount of water. Nevertheless, it remains to be seen how the situation will pan out in October, and rainfall and water movements in the north and center of the country will need to be watched carefully during this period, when the volume of rainfall is expected to be respectively 10% and 20% above average in these areas.

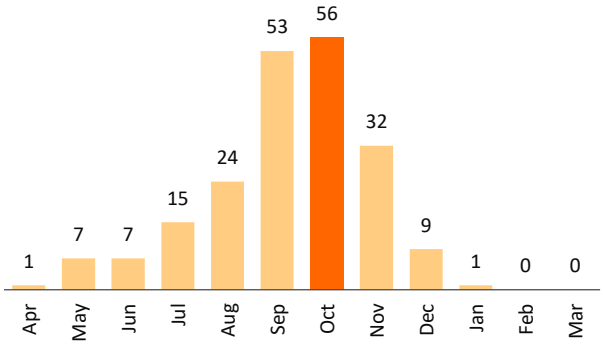
- **Northeastern region: There is a high risk of flooding in areas that are regularly inundated along the River Mun[12/]** since at present, local reservoirs are 47.6% full, compared to 2011's level of 43.8%. Risks will be especially elevated during October, when rainfall is forecast to be 20% above normal. Across the region, rains tend to drain from west to east and into the Mekong River (Figure 7.) **Therefore, a crucial factor in determining the extent of flooding will be the level of the river; if this is high, the draining of rainwater will be slowed, and flooding will be longer and more extensive than if the river is low.**

Figure 5: Period of Flood Risk by Region



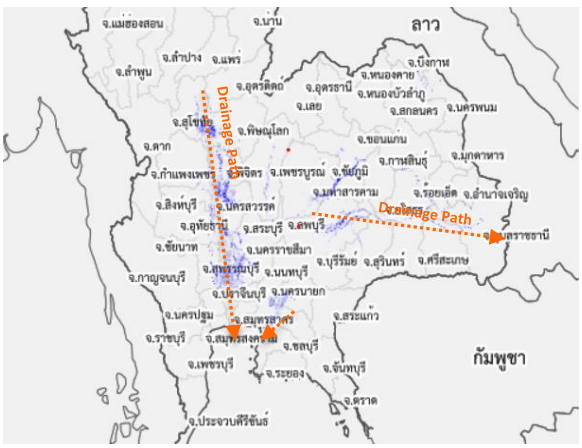
Note : Based on an assessment of the highest flood levels, and the frequency and probability of flooding over 1990-2020.
Source: Water Situation Analysis Section (Royal Irrigation Department), Krungsri Research

Figure 6: Total Number of Storms Crossing Thailand over the Last 71 Years, by Month



Source: National Hydroinformatics Data Center, Krungsri Research

Figure 7: Drainage Path of Flood Waters

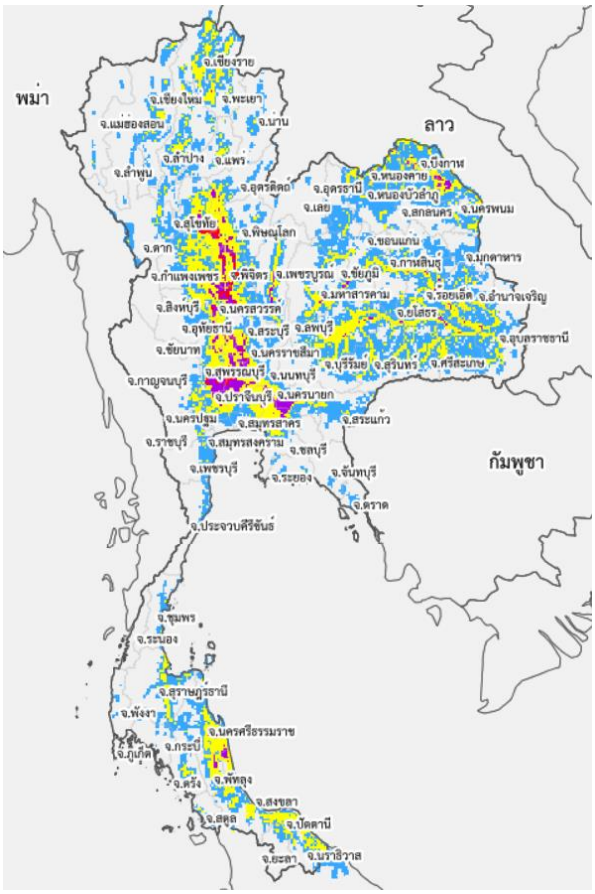


Note : Example of flood's drainage path in October 2021
Source: Geo-Informatics and Space Technology Development Agency (GISTDA), Thailand Flood Monitoring System, Krungsri Research

10/ As of May 2022, reservoirs in the west of Thailand were 72.8% full. This is above the 2011 level of 58.6%.
11/ This is below the level during 2011 and the great flood, when this stood at 52%.
12/ Areas along the path of the river include Nakhon Ratchasima, Buriram, Surin, Roi Et, Yasothon, Sri Saket, and Ubon Ratchathani.

- **Southern region: There is a danger of flooding being caused both directly by tropical cyclones and indirectly by seasonal storms in neighboring countries, with the rains peaking over November and December.** In addition, in October, rainfall is expected to be 5-10% heavier than normal, increasing the risk of high winds and sudden flooding. This may then cause damage to the palm and rubber plantations that are important parts of the local economy as well as to homes, other buildings, and transport infrastructure. Eastern parts of the South are most likely to experience repeated flooding (Figure 8).

Figure 8: Frequency of Flooding over the 11 Years from 2005-2015



Source: Thailand Flood Monitoring System (TFMS), Krungsri Research

◢ Expected impacts of flooding on the economy and national GDP

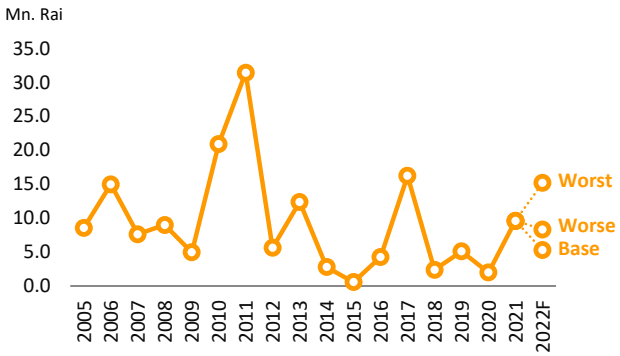
Floods typically cause a greater range of damage than do droughts, with this extending to include houses, factories, other built structures, machinery, vehicles, transport infrastructure, and farm animals. Agricultural crops may also be damaged, though the extend of this will depend on the extent and length of the flooding, and if flooding is only shallow and short-lived, this may cause no losses to crops. However, if the flooding is deeper and the water takes an extended period of time to drain, crops such as rice, sugarcane, cassava, and other horticultural and agronomic crops may be severely damaged, with knock on effects for industrial supply chains and, if this leads to supply shortages, higher prices for consumers.

To better understand the potential effects of this, Krungsri Research has analyzed the impacts of flooding under 3 different scenarios[13/] (Figure 9 and Table 1). These are described below.

- **Base case (rainfall is 3% above normal):** In this situation, 5.3 million rai of land is affected by flooding, with THB 790 million in damage to assets and THB 11.6 billion baht in damage to agricultural produce. This would represent a loss to GDP of -0.08%.
- **Worse case (rainfall is 10% above normal):** In the Worse case, 8.3 million rai of land is affected, leading to THB 1.25 billion in damage to property and THB 18.2 billion in damage to agricultural goods. This would then translate into a cut to GDP of -0.12%.
- **Worst case (rainfall is 20% above normal):** Under the worst-case scenario, 15.2 million rai is flooded, causing damages worth respectively THB 2.27 billion and THB 33.2 billion to property and agricultural goods, and shaving -0.22% from GDP.

13/ This is on the assumption that 50-60% of the locations that are flooded will be agricultural areas.

Figure 9: Total Area Flooded in Thailand



Source: National Hydroinformatics Data Center, Krungsri Research

Table 1: Projected Economic Losses from Flooding

Scenario of Flood Area	Base Case	Worse Case	Worst Case
	5.3 Mn. Rais	8.3 Mn. Rais	15.2 Mn. Rais
Asset loss (Million baht)	790	1,250	2,270
Agriculture loss (Million baht)	11,600	18,200	33,200
As percent of GDP	0.08	0.12	0.22

Source: Krungsri Research

The extent to which flooding will affect GDP depends on: (i) the level of rainfall and the water management policies that are implemented; (ii) the areas that are flooded; and (iii) the location of economically important units of production (e.g., households, factories, and agricultural areas). If flooding occurs in areas that are more economically significant (i.e., in areas that are home to industrial estates, major agricultural regions, or important logistics network), there is a risk that this will impact manufacturing supply chains across their length, from upstream inputs to downstream outputs, and as such, the effect on the economy overall and on GDP will be more exaggerated.

Nevertheless, there is a wealth of factors that are outside human control and the impact of which cannot accurately be assessed but which may have an important role to play in determining the extent of flooding in 2022. This includes the water levels in the Gulf of Thailand and in the interior of the country, especially in the Mekong River basin; if these are elevated, this will increase the drainage time for rainwater and add to the risk of more serious flooding. At the same time, though, actions by the government would help to alleviate these problems[14/] and this would include: managing lowland areas to receive floodwaters, effectively managing reservoir levels, clearing obstructions in waterways, preparing machinery and equipment ahead of time in high-risk areas, drawing up and implementing effective water dispersal plans, checking on embankments, dams, and retaining walls, and ensuring that public utilities are ready for use. Acting promptly and effectively on these fronts will help to reduce both the extent and the impacts of flooding.

14/ The cabinet agreed the 2022 rainy season water management plan on 3 May, 2022. The plan lays out 13 measures to be taken and has been assigned a budget of around THB 10 billion.

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