# Climate Strategy & Disclosure

BTS Group Holdings Public Company Limited

# BTS Climate Strategy

3-part climate management approach

**1. Identify Climate Risks and Opportunities**

Material physical and transition climate-related risks, potential business impacts and response measures.

**2. Develop Climate Strategy**

A practical and forward-looking plan to address climate risks and opportunities and deliver company's strategic priorities.

**3. Agree on Governance for Climate**

Align internal roles and responsibilities for management of climate-related risks and delivery of climate strategy.

# Identify Climate Risks (and Opportunities)

## Approach

BTS conducted a qualitative 'hotspot' analysis to identify climate-related risks (and opportunities) with potential financial impact for the business.

| Step 1: Identify Risks/Opportunities<br>Two Categories of Climate-related Risk | Step 2: Assess Impact of Risks/Opportunities<br>Using Scenario Analysis |
| --- | --- |
| **1. Transition Risks**<br><br>Risks relating to the transition to a low-carbon economy and the mitigation and adaptation requirements which will occur. | **A) Stated Policy Scenario:** The course the world is on based on current stated policy ambitions (e.g. Nationally determined contributions (NDCs)).<br><br>**B) Sustainable Development Scenario:** Aligned with the Paris Agreement to limit global average temperature rise to "well below 2 °C and pursuing efforts to limit to 1.5 °C". |
| **2. Physical Risks**<br><br>Risks relating to the increased severity of extreme weather events and long-term shifts in weather pattern. | **A) Baseline:** Historical data on natural hazards.<br><br>**B) RCP 2.6 RCP 4.5 and RCP 8.5:** A high emissions scenario developed by the IPCC which outlines future projected changes in climatic variables. |

# Scope of Assessment

**Physical Risk:**
BTS Group analysed impact on flooding in RCP 2.6 RCP 4.5 and RCP 8.5 scenario.

**Transition Risk:**
BTS Group analysed transition risk and carbon pricing impacts on cost of electricity in Stated Policies Scenario (STEPS), NDC, and SDS scenarios.

Noted: The time horizon of the assessment covers short-, medium- and long-term

- Assessment consistent with the expected lifetime of the assets or activities




- The scope of our assessment includes our upstream activities

- The scope of our assessment includes our downstream activities and clients

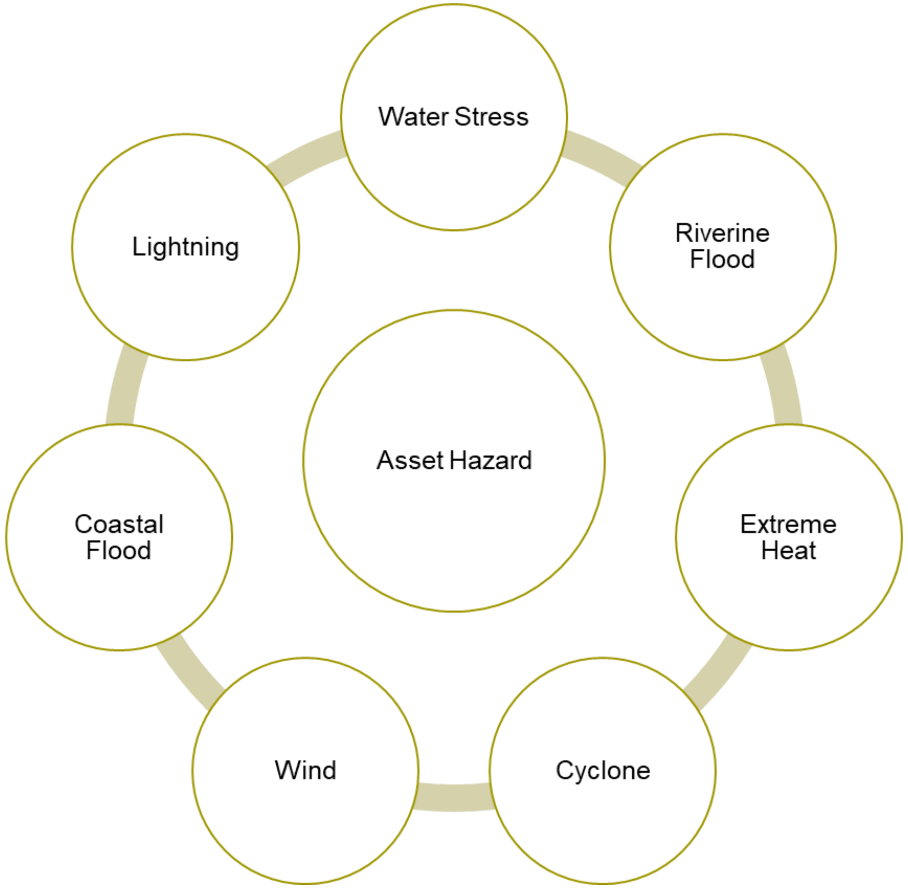
# Physical Risks

BTS Group Holdings Public Company Limited

# Scope of physical risks assessment

- Screening Physical Climate Change Risks Assessment (Hotspot analysis) for existing and proposed Urban Transportation in **Bangkok, including Sky Rail and BRT.**
- Qualitative assessment of threats from natural hazards and extreme events (see Figure 2) based on the location of the BTS assets.
- Assessment using reliable international and national open source data for baseline natural hazards and the "low-end emission case", the "high-end emission case" climate change IPCC scenario of RCP 2.6 or SSP1-2.6 and RCP 8.5 or SSP 5-8.5 that envisaged the highest physical climate risks.
- The hazard assessment was undertaken for timelines including Baseline, 2030, and 2050.
- Considering the ground elevation variation in the range of 1-5 m and no evidence of hilly/mountainous terrain with steep slopes in the project area, landslide hazard was not evaluated even though the region is prone to flooding.

**Figure 2**: Natural Hazards Selected



# Assessment Approach

The physical risks of the Bangkok have been assessed according to the following approach:

### Risk Screening

Screening of risks related to BTS using a mix of global and regional climate models.

### Risk Review and Analysis

Preparing a set of risk findings. This will include using climate projections to analyse the materiality of future risks

### Financial Estimation

Identify the financial impact from 1 selected risk for both low- and high-end scenarios of all timeframes (2030,2040 and 2050)

### Physical Risk Adaptation

Identify high level adaptation and mitigation measures plan of the relevant physical risks

# Water Availability: Baseline

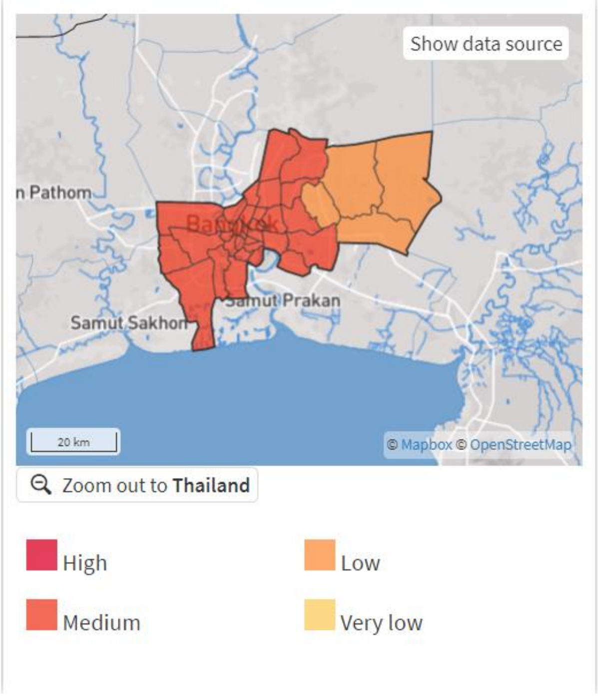
| Parameter | Definition/ Methodology/ Data | Source | Hazard Category | Hazard Criteria |
|---|---|---|---|---|
| Likelihood of Water Scarcity | This is the maximum water scarcity hazard level for the selected area, describing expected frequency of water scarcity. The classification uses simulated water resource availability, and expert guidance. | Think Hazard[1] | Medium | Up to a 20% chance of droughts in the coming 10 years |
| Water Stress | Baseline water stress is defined as the ratio of the total annual water withdrawals to the total available annual water renewable supply, accounting for upstream consumptive use. Higher value indicate more competition among users. | WRI-Aqueduct Water Risk Atlas[3] | High | Water stress 10-40% (Medium-High) (see in the next slide) |
| **Overall Hazard** | | | **High** | Conservative |

# Water Availability: Baseline

- **Water Scarcity** measures the deficiency of precipitation over an extended period, especially a season or more, resulting in a water shortage for some activity, group, or environmental sector.
- According to the currently available information the **ThinkHazard has, the water scarcity is classified as “Medium” for the baseline**, signifying that there is up to a 20% chance that droughts will occur in the coming 10 years.
- **Water stress** measures the ratio of total water withdrawals to the available renewable surface and groundwater supplies. **The Water Risk Atlas classifies water stress to be “High” for the baseline**.
- Thus, the overall hazard associated with availability of water is considered to be “High” for baseline.

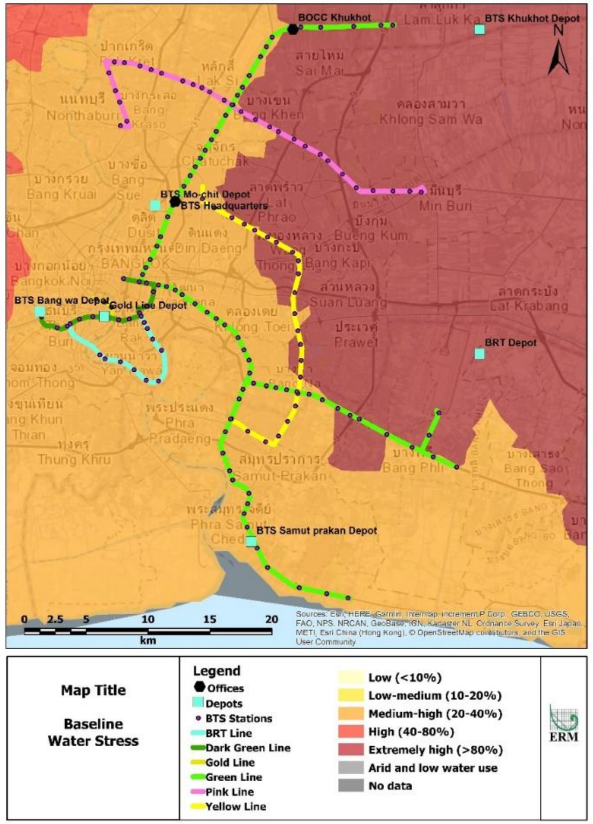
| | Water Scarcity | Water Stress | Overall |
|---|---|---|---|
| **Baseline** | Medium | High | High (Conservative) |

**Figure 4**: Water Scarcity (likelihood) Map




*__Source__: Think Hazard*

**Figure 5**: Water Stress




*__Source__: WRI-Aqueduct Water Risk Atlas*

# Water Availability: RCP 2.6

- WRI-Aqueduct Water Risk Atlas does not provide water-stress related projections for RCP 2.6 scenario.
- Since drought and water scarcity are often interrelated, and droughts can trigger or amplify water scarcity, while water scarcity can aggravate droughts, the Standardized Precipitation Evaporation index (SPEI) which is an indicator of droughts is scrutinized from Climate Change Knowledge Portal for both low-end and high-end emission scenarios.
- SPEI is the difference between precipitation and the amount of water that evaporates (+ve means wet area and –ve means drought area): no unit.
- The SPEI projections lies in near normal range, but compared to baseline, it indicates slightly drought like conditions in the 2030's & 2040's and slightly wet like conditions in 2050's.

| Indicator | BSL | 2030 | 2040 | 2050 |
|---|---|---|---|---|
| **SPEI** | 0.03 | -0.04 | 0.07 | 0.08 |
| **Projection (change compare with BSL)** | [redacted] | -0.07 | 0.04 | 0.05 |

Reference: Climate Change Knowledge Portal

| Drought/Wet severity | SPEI |
|---|---|
| Extremely wet | ≥2.00 |
| Severely wet | 1.50–1.99 |
| Moderately wet | 1.00–1.49 |
| Near normal | −0.99–0.99 |
| Moderate drought | −1.00–(−1.49) |
| Severe drought | −1.50–(−1.99) |
| Extreme drought | ≤−2.00 |

SPEI Standardization

| Category | Drought (Change in annual drought probability |
|---|---|
| Significant Increase | <-1 |
| Moderate Increase | <-0.5 |
| Slight Increase | <0 |
| No Change | 0 |
| Slight Decrease | >0 |
| Moderate Decrease | >0.5 |
| Significant Decrease | >1 |

Source: Climate projection trend legend categorized by ERM

# Water Availability: RCP 2.6

- Water stress simply means **the ratio of amount of water we consume (numerator) and the available of water (denominator) e.g. from surface groundwater and precipitation**.
- According to the projection result in slide 20, SPEI index is used to check how the available of water is changing and SPEI projections lies in near normal range, it means the available of water (denominator) is not changing much compared to the available of water from the baseline.
- Since the water stress from the baseline is "High" and the projection of water availability from RCP 2.6 is not much different. Assume that the consumption of water remains the same or increase along with the population of the project area. In that case, the water stress would either be the same or increase because if consumption is increasing at a much higher rate as compared to renewable waters, the water stress would be on the higher side.
- Therefore, the hazard associated with availability of water is considered to be the same as in baseline, "High" under RCP 2.6 scenario for all the time-horizons.

| Baseline | 2030 | 2040 | 2050 |
|---|---|---|---|
| High | High | High | High |

# Water Availability: RCP 8.5

- The projected change in water stress from baseline in 2030’s and 2040’s is near-normal with an increase in eastern and northeastern parts of Bangkok.
- On the other hand, the SPEI projections under RCP8.5 scenario lies in near normal range*, indicating slightly wet like conditions in 2050s.

**Projection: SPEI (RCP 8.5)**

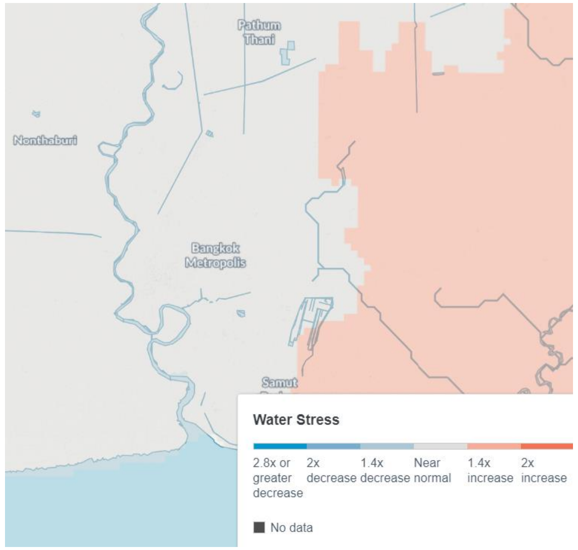
| Indicator | BSL | 2030 | 2040 | 2050 |
|---|---|---|---|---|
| **SPEI** | 0.03 | 0.03 | 0.07 | 0.2 |
| **Projection (change compare with BSL)** | | 0.00 | 0.04 | 0.17 |

Reference: Climate Change Knowledge Portal

*Used the same references provided in slide 20

| Baseline | 2030 | 2040 | 2050 |
|---|---|---|---|
| High | High | High | High |

**Figure 6**: Projected Change in **Water Stress** 2030’s (RCP 8.5)




***Source**: WRI-Aqueduct Water Risk Atlas*

**Figure 7**: Projected Change in **Water Stress** 2040’s (RCP 8.5)


***Source**: WRI-Aqueduct Water Risk Atlas*

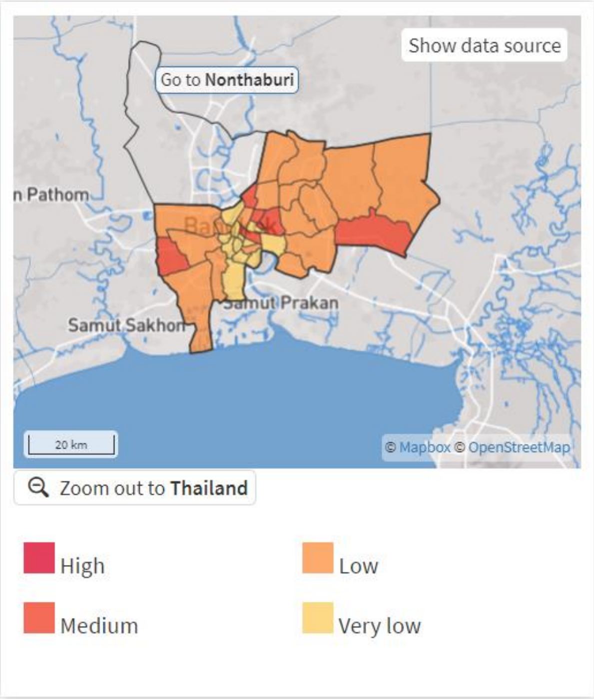
- According to Figure 6 and 7, water stress considers that it lies “near-normal” over certain regions and increase in eastern and north-eastern parts when compared with baseline, along with the fact that the SPEI lies in the “normal range”, the associated future hazard is also considered to be same as of baseline, i.e., “High” for all time horizons under RCP 8.5 scenario.

# Inland Flood: Baseline

| Parameter | Definition/ Methodology/ Data | Source | Hazard Category | Hazard Criteria |
|---|---|---|---|---|
| Urban Flood Likelihood | describing expected frequency of flood damage. Urban flood describes surface flooding of impermeable urban surfaces and overflow of saturated urban drainage systems and channels, resulting from sustained or intense rainfall | Think Hazard[1] | Medium | Chance of more than 20% for occurrence of potentially damaging and life threatening urban flood in coming 10 years |
| Riverine Flood Likelihood | describing expected frequency of flood damage. Urban flood describes the water level in a river or stream rises and overflows onto the neighbouring land. The water level rise of the river could be due to excessive rain. | Think Hazard[2] | Medium | Chance of more than 20% for occurrence of potentially damaging and life threatening urban flood in coming 10 years |
| Riverine Flood Likelihood | Global flood maps presents the areas/zone affected by floods with return periods of 1 in 100 and 1 in 500 year. Flood maps are developed using hydrological models and historical flood data | FM Global Flood Map[3] | High | Area to be flooded by a flood of 1 in 100 year return period |
| Riverine Flood Inundation depth | The flood hazard map presents the extents and depth of a flood for a given return period. Flood hazard maps are reported to be developed using GLOFRIS model which provides long-term simulations of discharges and flood levels under different climatic conditions. | WRI-Aqueduct Floods[4] | Low | Depth of inundation < 0.15m |
| **Overall Hazard** | | | Medium-High | Conservative |

# Flood: Baseline

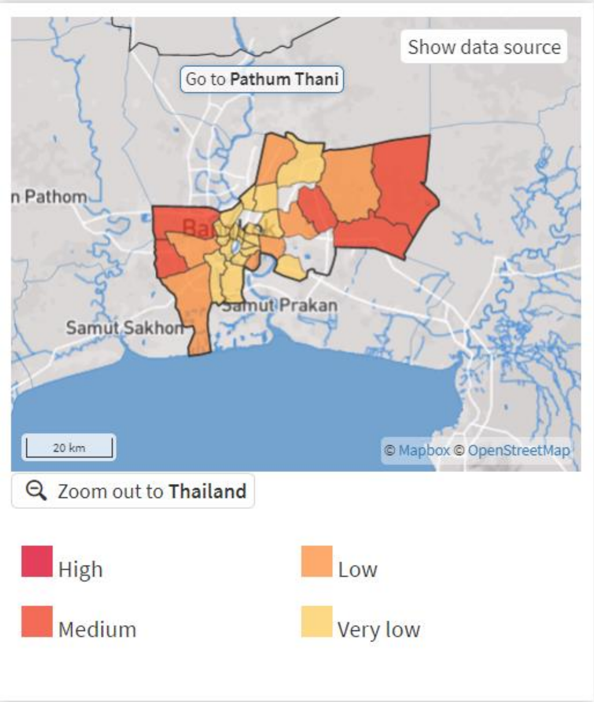
**Figure 8**: Flood Likelihood Map (Urban)




***Source**: Think Hazard*

**High risk area**: Bang su, Huai Kwang, Pathumwan, Latkrabang and Nhongkham

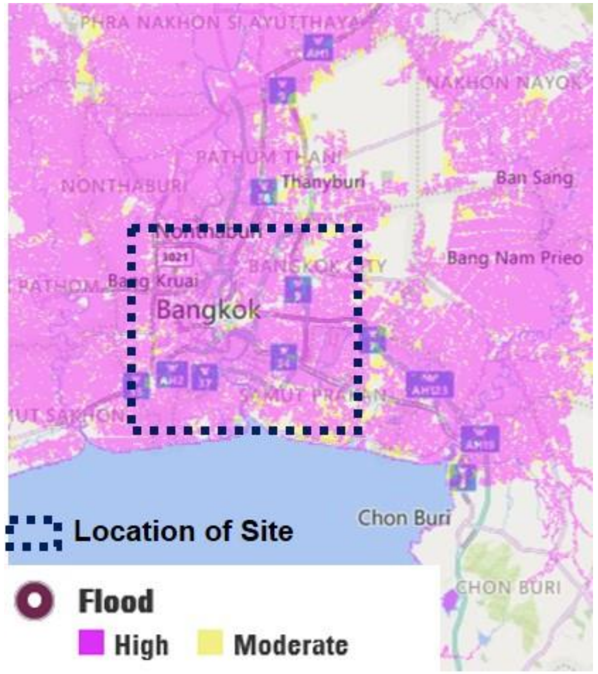
**Figure 9**: Flood Likelihood Map (Riverine)




***Source**: Think Hazard*

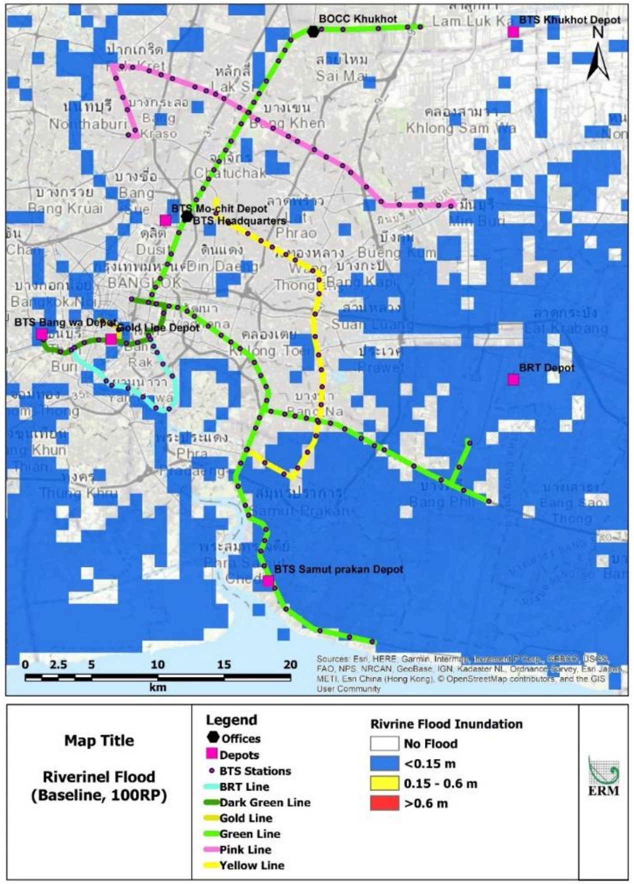
**High risk area**: Taling Chan, Bungkum, Nong Chok and Latkrabang

**Figure 10**: Flood Likelihood Map




***Source**: FM Global Flood Map*

**Figure 11**: Riverine Flood Inundation Map




***Source**: WRI-Aqueduct Flood*

# Floods: Baseline Hazard Evaluation

- The overall risk associated with riverine and urban flooding for baseline is evaluated to be **“Medium-High”** based on following:
  - ThinkHazard classifies risk allied with riverine and urban floods as “Medium” based on the currently available information the tool has.
  - Riverine flood inundation map from WRI-aqueduct indicates inundation as low across project area.
  - Flood likelihood map (FM Global Flood Map) indicates a probability of inundation across most parts of the project area.
  - Past floods caused damages in terms of financial, property, and casualties.

**Photo 1**: Flooding in the Chatuchak area on Nov. 6, 2011

***Source**: https://www.khaosodenglish.com/news/2018/09/06/2018-wont-be-2011-for-bangkok-flooding-experts/*

# Floods: Climate Change RCP 2.6

- Since WRI-Aqueduct Flood Tool doesn't provide projections for the low-end emission scenario; therefore, the RCP 2.6 scenario analysis is conducted based on CMIP5 from Climate Change Knowledge Portal.
- The indicators used are the "largest 1-day precipitation" and "largest 5-day cumulative precipitation."
- The projected significant (moderate to significant) increase in 1-day (5-day) precipitation, compared to baseline, during the two-time horizons under low-end emission scenario may likely increase the risk associated with flood from **"Medium-high"** in baseline to **"High"** in future time horizons.

**Risk Categorization (RCP2.6)**

| Baseline | 2030 | 2040 | 2050 |
|---|---|---|---|
| Medium-High | High | High | High |

**Projection: Floods (RCP 2.6)**

| Indicator | BSL (mm) | 2030 (mm) | 2040 (mm | 2050 (mm) |
|---|---|---|---|---|
| 1- Day Maximum Rainfall (mm) | 80.3 | 93.9 | 92.8 | 91.7 |
| Projection (change compare with BSL) | | 17% | 16% | 14% |
| Maximum Consecutive 5 Days Rainfall (mm) | 221.5 | 236.7 | 243.15 | 249.6 |
| Projection (change compare with BSL) | | 7% | 10% | 13% |

Source: Climate Change Knowledge Portal

| Category | Chang in maximum rainfall (%) |
|---|---|
| Significant increase | > 10% |
| Moderate increase | >5% |
| Slight Increase | >0% |
| No Change | 0% |
| Significant decrease | <0% |
| Moderate decrease | <-5% |
| Slight decrease | <-10% |

Source: Climate projection trend legend categorized by ERM

# Floods: Climate Change RCP 8.5

- Bangkok, built on the floodplains of the Chao Phraya River, is expected to be one of the urban areas hit hardest by warming temperatures[1].
- Flood hazard maps from WRI-Aqueduct Flood Tool are evaluated to assess the flood hazard during the 2030s and 2050s under high-end emission scenario for flood with a return period of 1 in 100 year.
- The hazard due to riverine flooding is projected to remain Low with flood inundation depth of less than 0.15 m.
- However, the climate change projections under RCP8.5 scenario for 1-day and 5-day maximum precipitation show a significant and moderate to significant increasing trend, compared to the baseline (see Table below).

**Projection: Floods (RCP 8.5)**

| Indicator | BSL (mm) | 2030 (mm) | 2040 (mm) | 2050 (mm) |
|---|---|---|---|---|
| **1- Day Maximum Rainfall (mm)** | 80.3 | 88.4 | 92.3 | 96.3 |
| **Projection (change compare with BSL)** | | 10% | 15% | 20% |
| **Maximum Consecutive 5 Days Rainfall (mm)** | 221.5 | 238.2 | 253.5 | 268.9 |
| **Projection (change compare with BSL)** | | 8% | 14% | 21% |

**Figure 12**: Riverine Flood (RCP 8.5, year 2030)

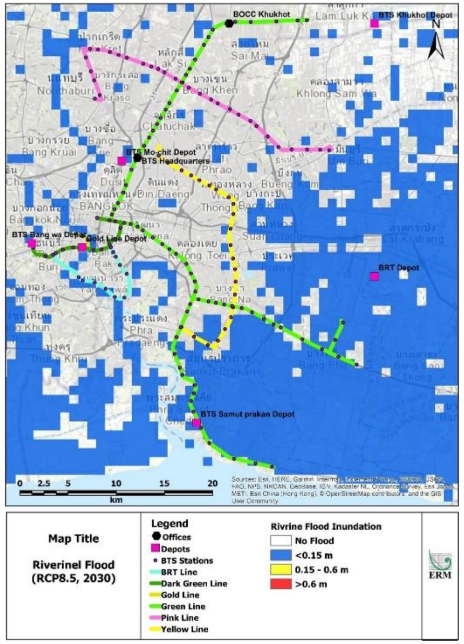
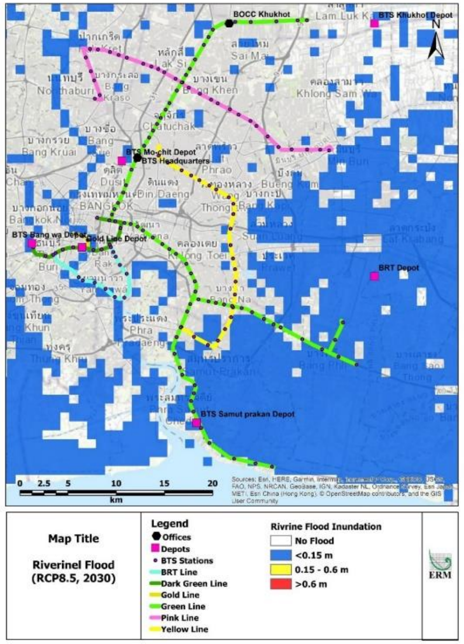



**Figure 13**: Riverine Flood (RCP 8.5, year 2050)




***Source**: WRI-Aqueduct Flood*

| Category | Chang in maximum rainfall (%) |
|---|---|
| Significant increase | > 10% |
| Moderate increase | >5% |
| Slight Increase | >0% |
| No Change | 0% |

# Floods: Climate Change RCP 8.5

- Such increase in extreme precipitation may lead to frequent riverine and localised floods.
- Moreover, changes in land use pattern due to rapid urbanisation is likely to aggregate flood risk in future.
- Nearly 40 percent of Bangkok is estimated to be inundated each year as soon as 2030 due to more extreme rainfall, according to the World Bank.[1]
- Accordingly, considering the "Medium-High" baseline flood hazard, and projected increase in an extreme precipitation, flood hazard is evaluated to "High" in all future time-horizons under RCP8.5 climate change scenario.

**Risk Categorization (RCP 8.5)**

| Baseline | 2030 | 2040 | 2050 |
|---|---|---|---|
| Medium-High | High | High | High |

**Photo 2**: Representative Photo of Flooded Street in Bangkok

***Source**: https://www.bangkokpost.com/photo/1342351*

# Historical Floods

| Date | Reason | Impact | Reference |
|---|---|---|---|
| December 1983 | N.D. | Inundation of Sukhumvit Road,<br>Estimated 462m baht damage of roads,<br>400 million baht damage in total, 55 deaths | Bangkok Post, October 21, 201:<br>https://www.bangkokpost.com/photo/262533/splash-from-the-past |
| October, 1995 | N.D. | Worst flood ever experienced then,<br>Flood lasted over October to November<br>2,27 m of flood inundation in some areas,<br>2.6 million population impacted,<br>26 major roads were damaged,<br>70 rai of farmlands were affected,<br>Damages were estimated to be billions of THB | |
| October, 2011 | More than normal rainfall | 680 people killed<br>13 million affected people<br>Estimated restoration cost of 1.5 trillion baht | Thai Flood 2011: Rapid Assessment for Resilient Recovery and Reconstruction Planning,<br>http://documents1.worldbank.org/curated/en/677841468335414861/pdf/698220WP0v10P106011020120Box370022B.pdf |
| June 21, 2016 | 141.5 mm of rainfall over a period of 24 hours (highest over 25 years) due to low pressure over Vietnam | Flooding in 36 areas,<br>Traffic disruption,<br>Inundation of ~60 cm in some areas | Flood List, June 22, 2016: http://floodlist.com/asia/thailand-bangkok-flood-june-2016 |

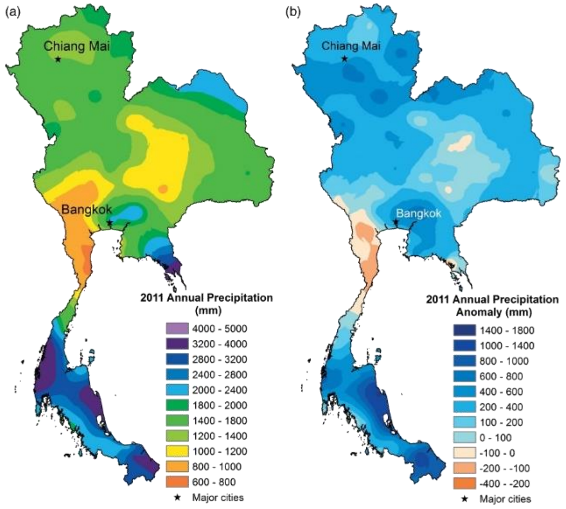
# Special Case: Floods of 2011

- The flood in 2011 was ranked as world's fourth costliest disaster over the period of 1995-2011, after the two earthquakes in Japan (2011 and 1995) and hurricane Katrina in USA (August 2005)[1].
- The floods of 2011 were accounted to heavy precipitation (1439 mm) exceeding (143%) the average seasonal rainfall over two decades[1].
- The literature review suggests that the flood in 2011 accounted for heavy precipitation received during four cyclonic activities (1 in August and 3 in October), resulting in the filling and overtopping of reservoirs. Consequently, large amounts of water were released resulting in the inundation of downstream areas.[1, 2]
- Further, due to relatively flat topography, the floodwater drains out very slowly in the Chao Phraya River basin.[3]
- Additionally, **due to rapid urbanisation in Bangkok** (i.e., turning traditional paddy fields into developed lands) had made the situation even worse as the developed lands are unable to accommodate flood waters as it does in the past.

**Figure 14**:Locations of Dams Overtopped in 2011

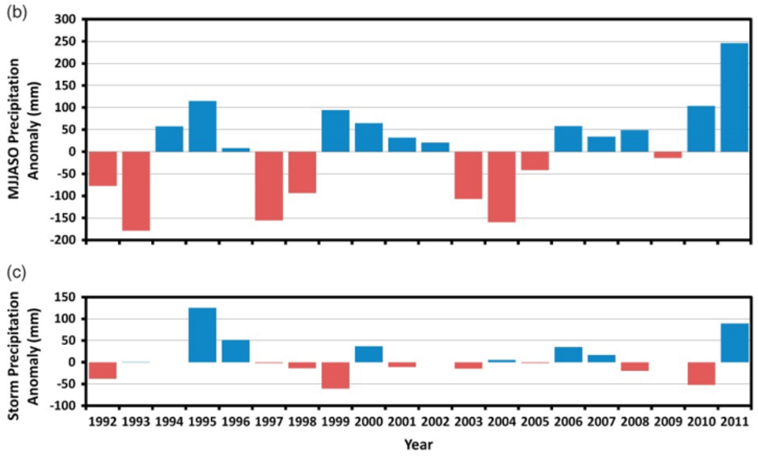
# Special Case: Floods of 2011

**Figure 15**: Precipitation Anomaly in 2011




- Using Thai Meteorological Department data, Emma et al. (2013) reported that the Northern Thailand received a precipitation between 1400mm and 1800mm in year 2011, which is ~23% above normal at country level.
- Bangkok also received surplus rainfall annual rainfall of 2073mm (i.e., 530mm or ~25.5% higher than the normal) in 2011.

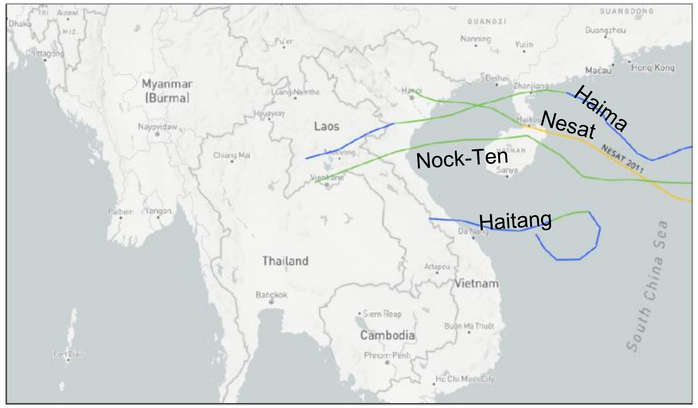
**Figure 16**: Monsoon vs Tropical Storm Precipitation




Red Bar: negative precipitation anomaly
Blue Bar: positive precipitation anomaly

- The monsoon rainfall anomaly of +246.1 mm was reported to be highest in last 20 year.
- During 1992 to 2011, 52 tropical cyclones (or their remnants) were reported to cross Thailand, with an average of 2.6 storms per year.
- At country level, in 2011 the remnants of four Tropical storms caused +89.3 mm anomaly of rainfall, with a contribution of ~33% in anomalously high rainfall in Thailand.

**Figure 17**: Tropical Storms around Thailand in 2011

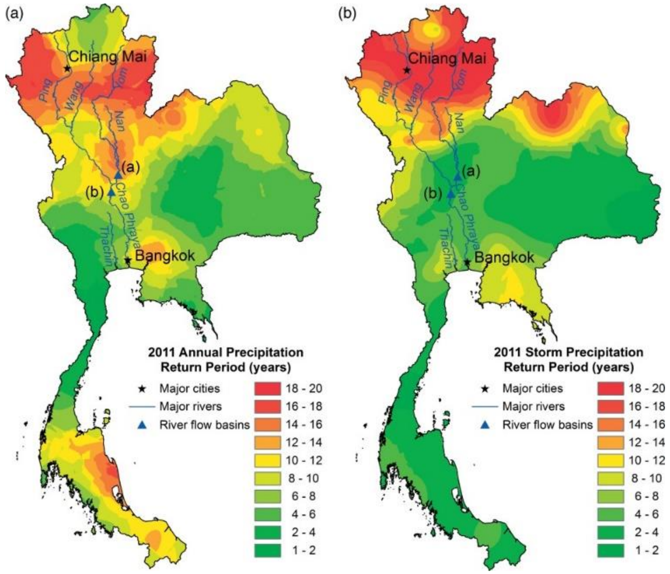



| Storm Name | Date Range | Storm Type |
|---|---|---|
| Nesat | Sep 23-30, 2011 | Typhoon |
| Haitang | Sep 23-27, 2011 | Pacific Typhoon |
| Nock-Ten | Jul 24-31, 2011 | Tropical Storm |
| Haima | Jun 16-25, 2011 | Tropical Storm |

***Source**: NOAA Hurricane Tracks*

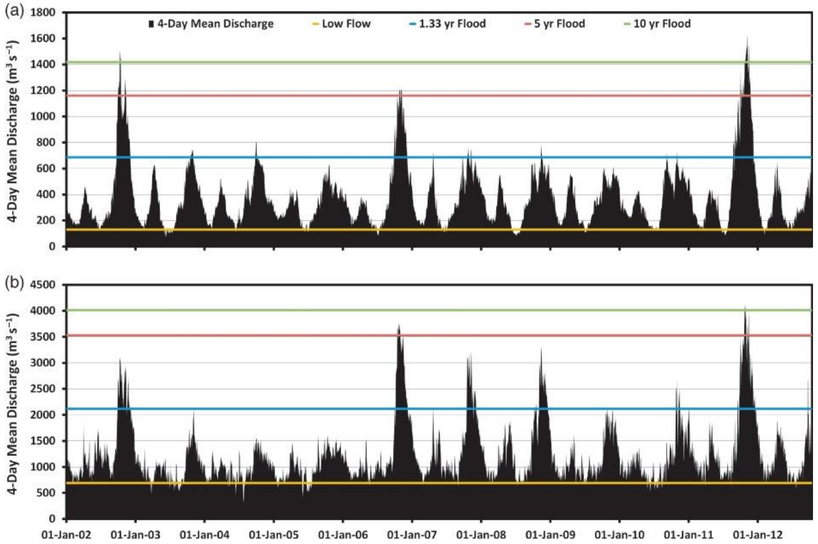
# Special Case: Floods of 2011

**Figure 1**8: Return Period of 2011 Rainfall




- *The rainfall return-period analysis employed rain gauge data for the 20-year period 1992–2011. The return periods for 2011 annual total rainfall and annual tropical storm rainfall were computed for each of the 100 weather stations in Thailand using the standard method*
- *This method divides the number of years with complete rainfall data by the number of years where the annual (or storm) rainfall total is greater than or equal to the observed total in 2011*
- *In this study historical data was available only for 20 years, hence longest return period calculated was limited to 20 years, which may be an under estimation of the return period.*
- *Accordingly, the rainfall received in year 2011 in Bangkok was estimated to be corresponding to return period of 10 years.*
- *Whereas, central and northern areas of Thailand indicated rainfall return periods to be in the range of 2-20 year return period.*

**Figure** 19: River Flow Return Period




- *Satellite-derived river flows in the Chao Phraya River basin – the Thai region most heavily flooded in 2011 - were obtained from the Dartmouth Flood Observatory online repository of global river discharge data*
- *Riverflows are computed from satellite passive microwave observations and calibrated using global hydrological modelling*
- *Riverflows obtained with this satellite method agree well with flow estimates from ground-based discharge gauges*
- *The peak discharge in 2011 was the highest since January 2002 at both sites with the northern site showing a flood return period of 10–20 years and the southern site a flood return period of about 10 years.*
- ***A consensus of three different estimates suggests a return period for the 2011 Thailand flood of 10–20 years. However, these estimates may be biased low due to the limited 20–30 years extent of the historical data used for model building**.*

# Extreme Heat: Baseline

**Baseline**

- To categorise the hazard associated with Extreme Heat, **the Maximum of Daily Max-Temp** and **Warm Spell Duration Index (WSDI)** from the Climate Change Knowledge portal are analysed.
- **For Bangkok, the Maximum of Daily Max-Temp is 38.1°C during baseline, having an aggregate of 12 days annually contributing to unusually warm events.**
- Thus, based on the criteria presented in the Table, the hazard associated with **Extreme Heat is categorised to be "High" for the baseline.**
- Most of the regions in Thailand reported temperature greater than 40°C in April 2016 (a 65 year record heat wave)[1].
- Bangkok recorded average peak temperature of 40°C, with a peak temperature of 44.2°C in April 2016[2].

| Wet Bulb Globe Temperature | Hazard Category |
|---|---|
| >32$^0$C | High |
| >28$^0$C | Medium |
| >25$^0$C | Low |
| <25$^0$C | Very Low |

| Baseline Hazard |
|---|
| High |

# Extreme Heat: Climate Change SSP1-2.6

- SSP1-2.6 scenario is conducted based on CMIP6 from Climate Change Knowledge Portal.
- The indicators used are the **"Warm Spell Duration Index (WSDI)"** and **"Maximum of Daily Max-Temperature**"
- Even though under SSP1-2.6, a scenario aiming to limit the increase of global mean temperature to 2 °C , the model projected that the
  - Warm Spell Duration Index (WSDI) is likely to be increase by 20 days in 2030s, 31 days in 2040s and 42 days in 2050s indicating a significant increase compared to the baseline value of 12 days.
  - Maximum of daily Max-Temp also likely to be increase by 0.6°C by 2030s, 0.9 °C by 2040a and 1.2°C by 2050s from the baseline value of 38.1°C.
- Hence, the hazard associated with extreme heat is considered to be "High" in all time-horizons under the SSP1-2.6 scenario.

| Baseline | 2030 | 2040 | 2050 |
|---|---|---|---|
| High | High | High | High |

**Projection: Extreme heat (SSP1-2.6)**

| Indicator | BSL | 2030 | 2040 | 2050 |
|---|---|---|---|---|
| **Warm Spell Duration Index (day)** | 12 | 32 | 43 | 54 |
| **Maximum Daily Temperature (°C)** | 38.1 | 38.7 | 39.0 | 39.3 |
| **Projection (change compare with BSL)** | | 0.6 | 0.9 | 1.2 |

Source: Climate Change Knowledge Portal

| Category | Change in annual average maximum (°C ) |
|---|---|
| Significant increase | > 2°C |
| Moderate increase | >1°C |
| Slight Increase | > 0°C |
| No Change | 0% |

Source: Climate projection trend legend categorized by ERM

**Note**: There is no available legend for WSDI , we used the same trend for WSDI and Change in Max temperature.

# Extreme Heat: Climate Change SSP5-8.5

- SSP5-8.5 scenario is also conducted based on CMIP6 from Climate Change Knowledge Portal.
- The indicators used are the **"Warm Spell Duration Index (WSDI)" and "Maximum of Daily Max-Temperature"**
- Under SSP5-8.5 scenario, a scenario representing the highest emissions no-policy baseline scenario, the model projected that the
  - Warm Spell Duration Index (WSDI) is likely to be increase up to 35 days, 64 days and 94 days in the 2030s, 2040s and 2050s, respectively, compared to baseline value of 12 days.
  - Maximum of daily Max-Temp also likely to be increase up to 38.7°C, 39.2 °C and 39.8°C in the year 2030s, 2040s and 2050s, respectively, indicating an upsurge by 0.6°C, 1.2°C and 1.7°C from the baseline.
- Hence, under SSP5-8.5 scenario also, the extreme heat hazard is considered to be "High" for all time-horizons.
- The projected rise in temperatures under all scenarios considered may trigger the increased risk to heat stress-related conditions like heat strokes.

| Baseline | 2030 | 2040 | 2050 |
|---|---|---|---|
| High | High | High | High |

**Projection: Extreme heat (SSP5-8.5)**

| Indicator | BSL | 2030 | 2040 | 2050 |
|---|---|---|---|---|
| **Warm Spell Duration Index (day)** | 12 | 35 | 64 | 94 |
| **Maximum Daily Temperature (°C)** | 38.1 | 38.7 | 39.2 | 39.8 |
| **Projection (change compare with BSL)** | | 0.6 | 1.2 | 1.7 |

Source: Climate Change Knowledge Portal

| Category | Change in annual average maximum (°C) |
|---|---|
| Significant increase | > 2°C |
| Moderate increase | >1°C |
| Slight Increase | > 0°C |
| No Change | 0% |

Source: Climate projection trend legend categorized by ERM

**Note**: There is no available legend for WSDI , we used the same trend for WSDI and Change in Max temperature.

# Cyclones: Baseline

| Parameter | Source |
|---|---|
| **Cyclones Tracks**<br>Cyclone tracks data for cyclones since 1980 (modern era of satellite observations) till present. | NOAA-IBTrACS[1] |

- During the period 1980 to 2020, **only one tropical storm (i.e., BulBul-Matmo, 2019)** made landfall in central Vietnam and crossed within the vicinity of 100km from Bangkok. While moving westwards, it weakened into a tropical depression, having a maximum wind speed of 15 knots (7.7 m/sec).
- However, as indicated by a case study of the 2011 floods, the project area is likely to have some indirect impacts from such tropical storms.
- Moreover, during the analysis period, approx. 62 such types of Tropical disturbances occurred within the vicinity of 100km from Thailand (see Fig. 24).
- But considering very less occurrences of such Tropical Storms near the 100km vicinity of Bangkok in the past, the hazard associated with it is considered to be **"Low" for baseline.**

| Baseline | Low |
|---|---|

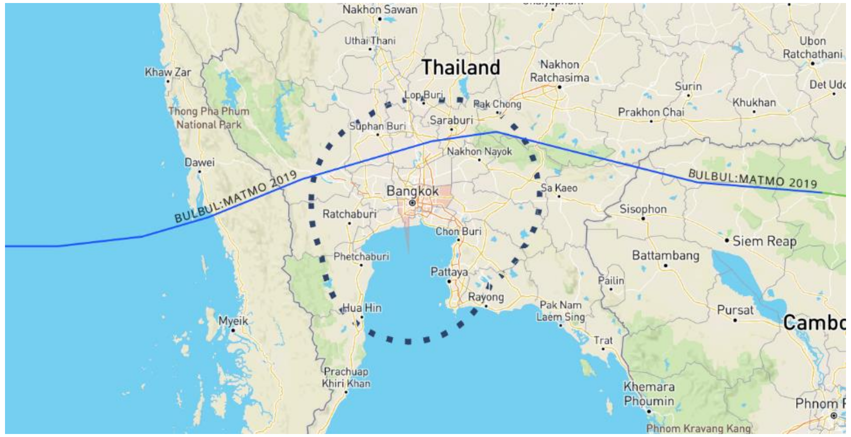



**Figure** 20: Historical Tropical Storms within 100km vicinity of Bangkok during 1980-2020 (NOAA IBTrACS)

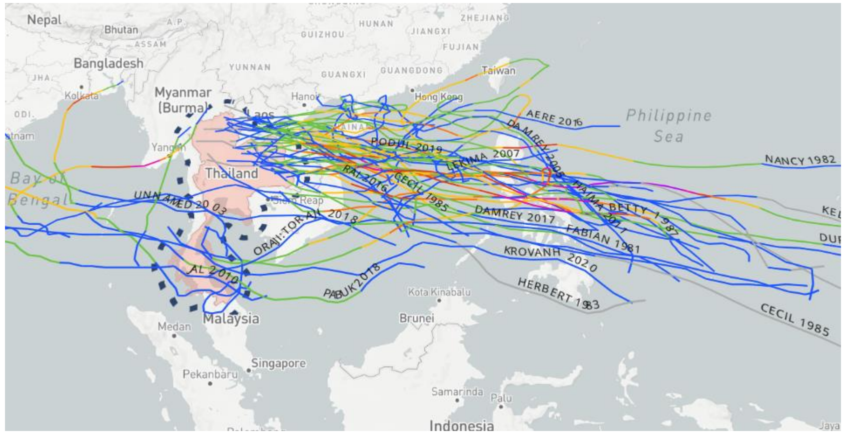



**Figure 2**1: Occurrences of Tropical disturbances within 100km vicinity of Thailand (NOAA IBTrACS)

# Cyclones: Baseline

Historical storms within 100 km from Bangkok

| Storm | Storm Category | Areas that has been affected |
|---|---|---|
| **Vae (1952)** | Tropical Depression | Bangkok, Chonburi, Chantaburi and Samut Prakarn (Central part, Thailand) |
| **ELSIE (1972)** | Tropical Depression | Bangkok and Central part, Thailand |
| **BulBul:Matmo (2019)** | Tropical Depression | Bangkok and Lop Buri ,along with little rain (Central part, Thailand) |

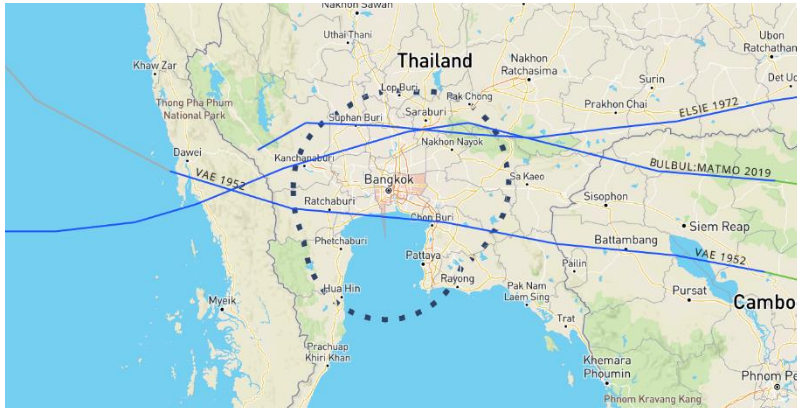



**Figure 22**: Past Tropical storms that crossed within the vicinity of 100km from Bangkok (NOAA IBTrACS)

# Cyclones: Climate Change

**Historical Occurrences of Cyclone or Typhoons[1]**

Tropical cyclones or Typhoons occur in most of the tropical oceans and present significant threat to coastal communities and infrastructure. Every year about 90 cyclones or Typhoons are reported to occur globally. Further, this number is reported to remained pretty constant since the period of geo stationary satellites (1970s). However, changes in inter-annual and multi-decadal frequency within individual ocean basin are reported to be substantial.

**Observed Changes[1]**

Literature review indicated that the detection of trends in cyclone or Typhoons occurrences (frequency and intensity) is a challenge due to: i) Changes in observation technology, ii) variations in protocol for identification of cyclones or Typhoons in different ocean basins, iii) limited availability of homogeneous data (30-40 years).

Global reanalysis of tropical cyclone or Typhoons intensity using homogenous satellite data indicated increasing trend in intensity of cyclones, with a suggestive link between cyclone or Typhoons intensity and climate change. However, these observations based on 30 years period are reported to be insufficient to conclusively provide the evidence for long term trend.

Hence, no hazard due to cyclone is considered for the project area.

**Projected Changes[1]**

Climate change studies suggested likely increase in peak wind intensity and near storm precipitation in future tropical cyclones, and decrease in overall frequency of cyclones. Spatial resolution of some of the earlier models used in AR4 is generally reported to be too coarse to simulate tropical cyclones. The recent advances in downscaling techniques are reported to indicate some level of success in simulating/ reproducing observed tropical cyclone characteristics. However it should be noted that there exists limitations and high uncertainty in simulation of tropical storms.

**Observations in IPCC 1.5°C scenario report[2]**

The report noted similar remarks stating that the limited period of 30-40 years of observations is not enough to conclusively distinguish anthropogenic induced changes with decadal changes in overall cyclone frequencies. Further studies conducted for detection of Category 4 and 5 cyclones over recent decades indicated increasing trend. However, these changes in frequency are reported to vary from one ocean basin to another. Studies conducted with higher degree of warming indicated decreasing trend in total number of tropical cyclones while increase in Category 4-5 cyclones.

# Cyclones: Climate Change

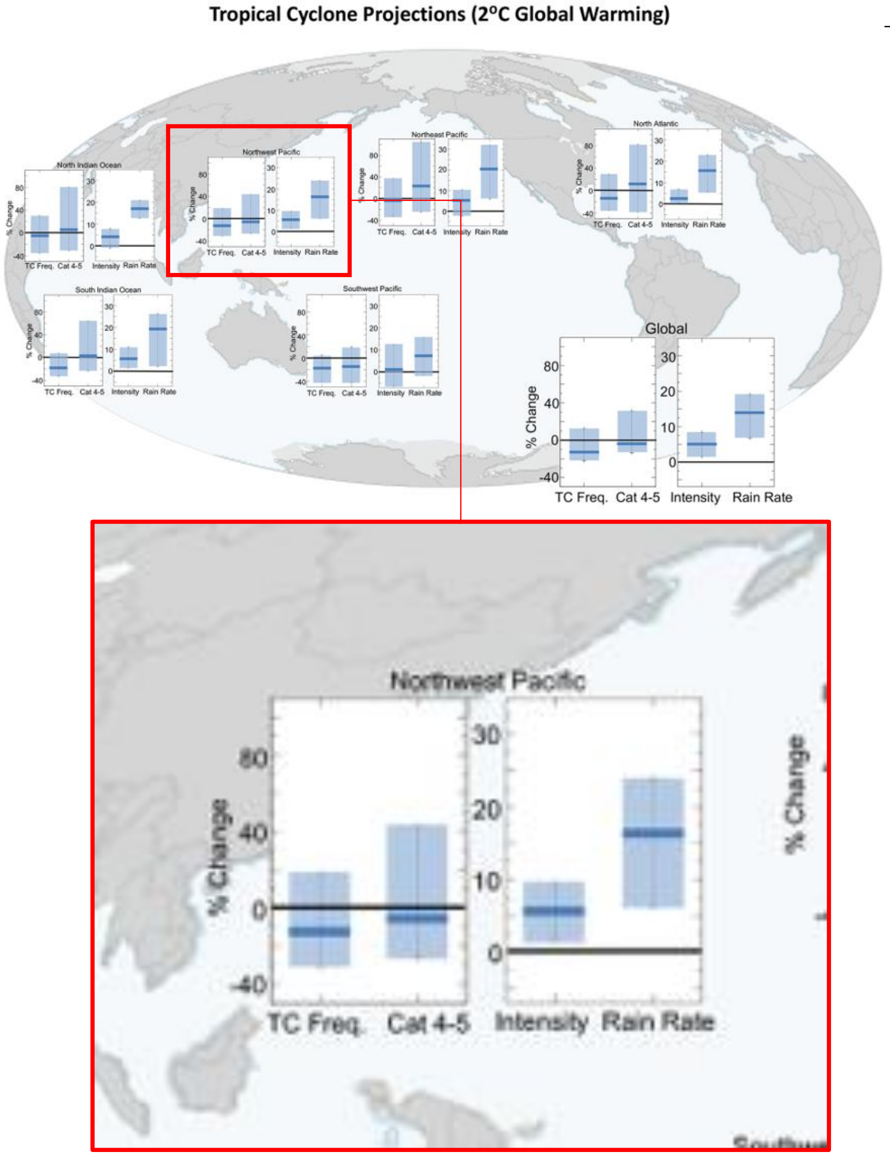
**Projected Changes at Site**

The recent study by Knuston et. al. (2020)[1] indicated a likely changes for occurrences of tropical cyclone over north-west Pacific ocean as following

- Overall frequency of tropical cyclone by -30 to 20% with median change of -12%
- Changes in frequency of category 4-5 cyclone between -25 to 40% with median change of -5%
- However, intensity of cyclone indicated likely increase of 1 to 9% with median of 5% increase
- Increase in precipitation is likely to be in the range of 5-25% with a median of 15% under 2°C scenario by end of century
- Although, the climate change projections for cyclones indicate a likely increase in frequency and intensity, considering no direct impacts at the Project Site, the hazard associated with it is considered to be '**Low**'.

| Baseline | 2030 | 2050 |
|---|---|---|
| Low | Low | Low |

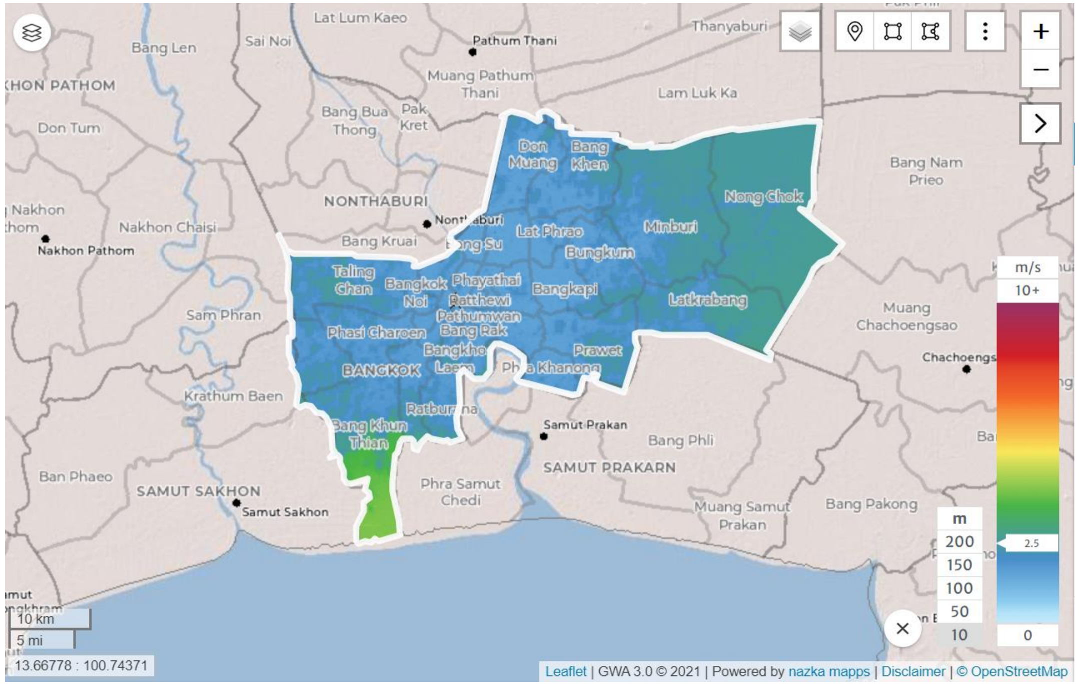
**Figure 23**: Historical Cyclone Tracks




***Source**: Knuston et al (2020)*

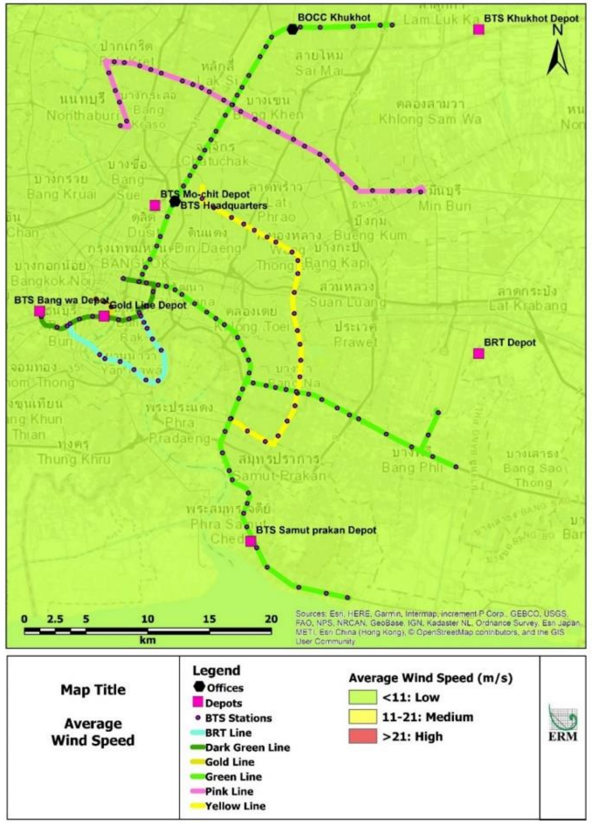
# Wind Speed: Baseline

**Figure 24**: Average Wind Speed




***Source**: Global Wind Atlas*

**Figure 25**: Risk Categorization



# Wind Speed: Baseline

| Parameter | Definition/ Methodology/ Data | Source | Hazard Category | Hazard Criteria |
|---|---|---|---|---|
| Average Wind Speed | Average wind speed data from Global Wind Atlas 2.0, a free, web-based application developed, owned and operated by the Technical University of Denmark (DTU) in partnership with the World Bank Group | Global Wind Atlas[1] | Low | Wind Speed < 11m/s |
| Maximum Near-Surface Wind | Wind variability has a key impact on water cycles, wind energy, and natural hazards such as hurricanes and typhoons. Thus, it is crucial for many socioeconomic and environmental issues, and can cause damage to buildings, infrastructure, and frequency of dust storms. Here daily maximum near-surface wind speed from CMIP6 database is analysed to categorize the hazard associated with it. | CMIP6 | Low | Wind Speed < 11m/s |
| **Overall Hazard** | | | Low | Conservative |

# Wind Speed: Climate Change

- To categorize the hazard associated with wind, the daily Max. near-surface wind from CMIP6 is analysed.
- **Figure 26** shows the change in the annual maximum of near-surface wind speed during the 2030s and 2050s, compared to Baseline, under the Low- and High-end emission scenarios for Thailand.

**Figure 26**:Projected Change in the near-surface wind

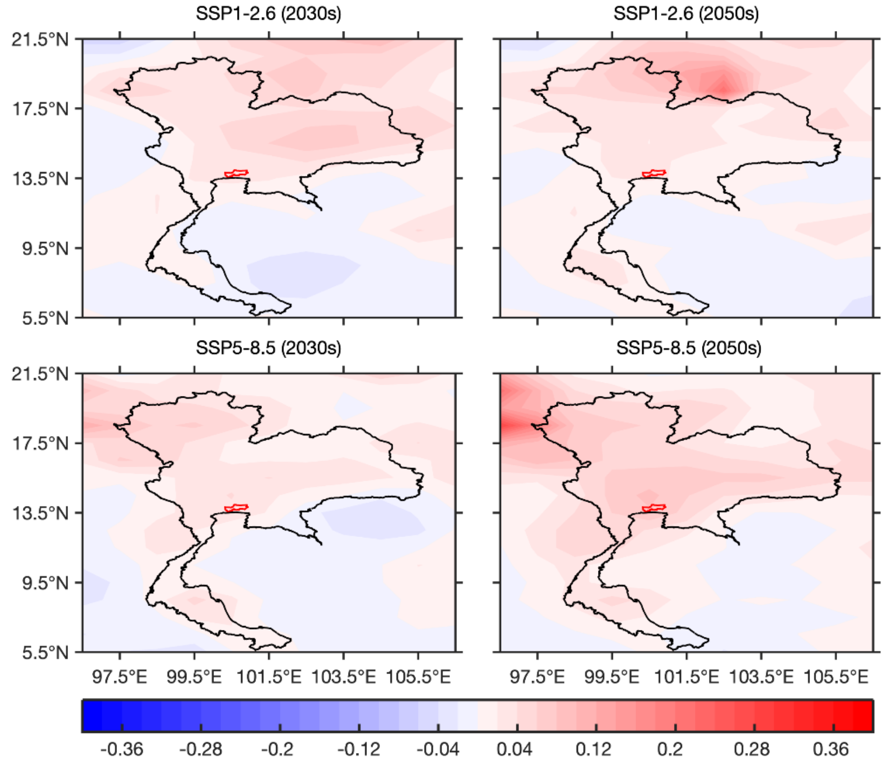
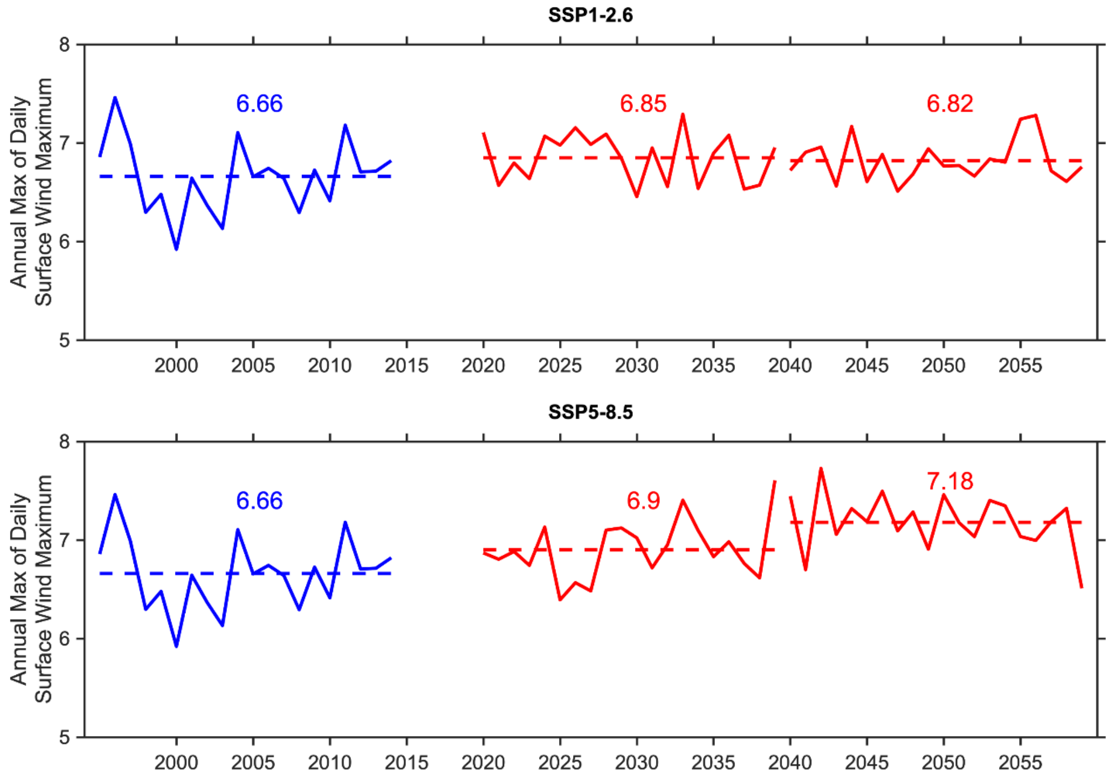



**Figure 27**: Temporal Variation of Annual Maximum near-surface wind for Bangkok (m/s)




- To get further insights into how the annual maximum of near-surface wind speed over Bangkok will change, the time series is plotted for the baseline and future time horizons.

# Wind Speed: Climate Change

- Annual maximum of near-surface wind speed under:
  - **SSP1-2.6 scenario** shows a moderate/sight increase in the 2030s/2050s, i.e., reaching values of 6.85/6.82 m/sec, respectively, compared to the baseline value of 6.6 m/sec.
  - **SSP5-8.5 scenario** illustrates a moderate/significant increase in the 2030s/2050s, i.e., attaining values of 6.9/7.18 m/sec, respectively, compared to the baseline.
- Even though, the annual maximum of near-surface wind shows moderate to significant increase in the 2030s and 2050s, under the scenarios considered, the wind hazard in future time-horizons is still considered to be same as in the baseline, i.e., ‘Low’ as the mean of maximum near-surface wind is well below the threshold value of 11m/s.

| Baseline | 2030 | 2050 |
|---|---|---|
| Low | Low | Low |

**Projection: Annual Maximum of near-surface wind**

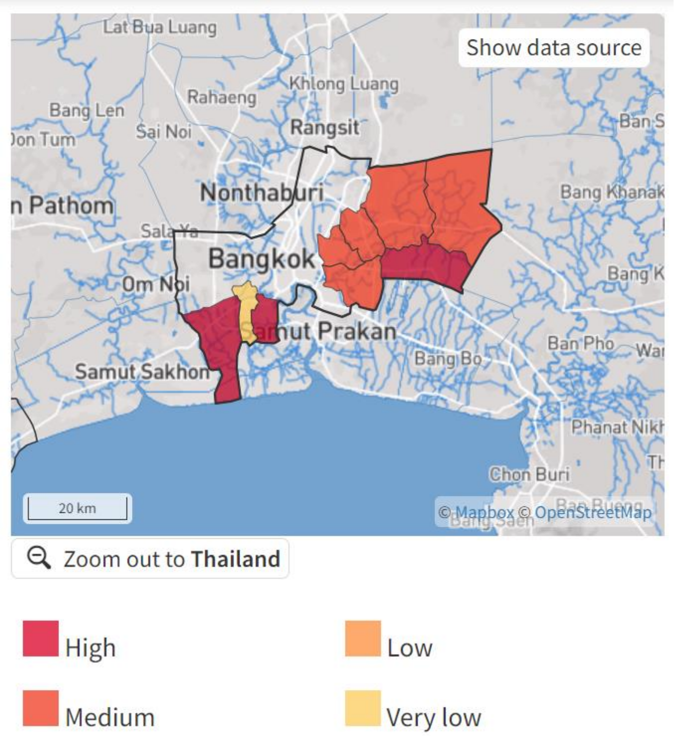
| Scenario | BSL (m/s) | 2030 (m/s) | 2040 (m/s) | 2050 (m/s) |
|---|---|---|---|---|
| **SSP1-2.6** | 6.66 | 6.85 | 6.83 | 6.82 |
| **SSP5-8.5** | 6.66 | 6.90 | 6.70 | 7.18 |

# Coastal Flood: Baseline

| Parameter | Definition/ Methodology/ Data | Source | Hazard Category | Hazard Criteria |
|---|---|---|---|---|
| Flood likelihood | Describes expected frequency of flood damage. The classification uses simulated flood depth data and expert guidance. Coastal flood describes onshore flooding due to high tides, storm surge (due to high winds and low pressure), and wave set-up (energy transfer from offshore waves to the coast). | Think Hazard[1] | Medium-High | Potentially-damaging waves are expected to flood the coast at least once in the next 10 years |
| Flood Inundation Depth | To estimate coastal hazard, the Global Tide and Surge Reanalysis (GTSR) dataset (Muis et al. 2016) is used as a database of extreme water levels. GTSR is a global dataset of daily sea levels (due to tide and storm surge) for 1979–2014, based on the hydrodynamic Global Tide and Surge Model (GTSM). | WRI-Aqueduct Floods[2] | Medium | Depth of inundation 0.15-0.6 m |
| **Overall Hazard** | | | High | Conservative |

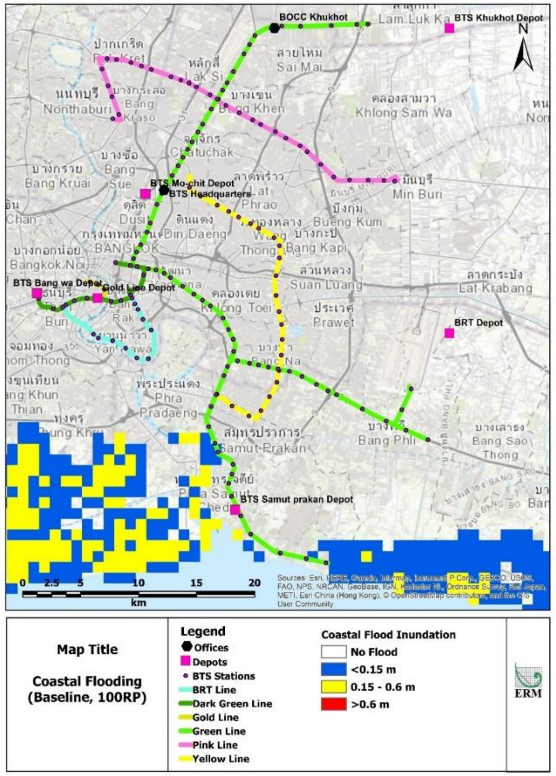
# Coastal Flood: Baseline

**Figure 28**: Coastal Flood Likelihood Map




*__Source__: Think Hazard*

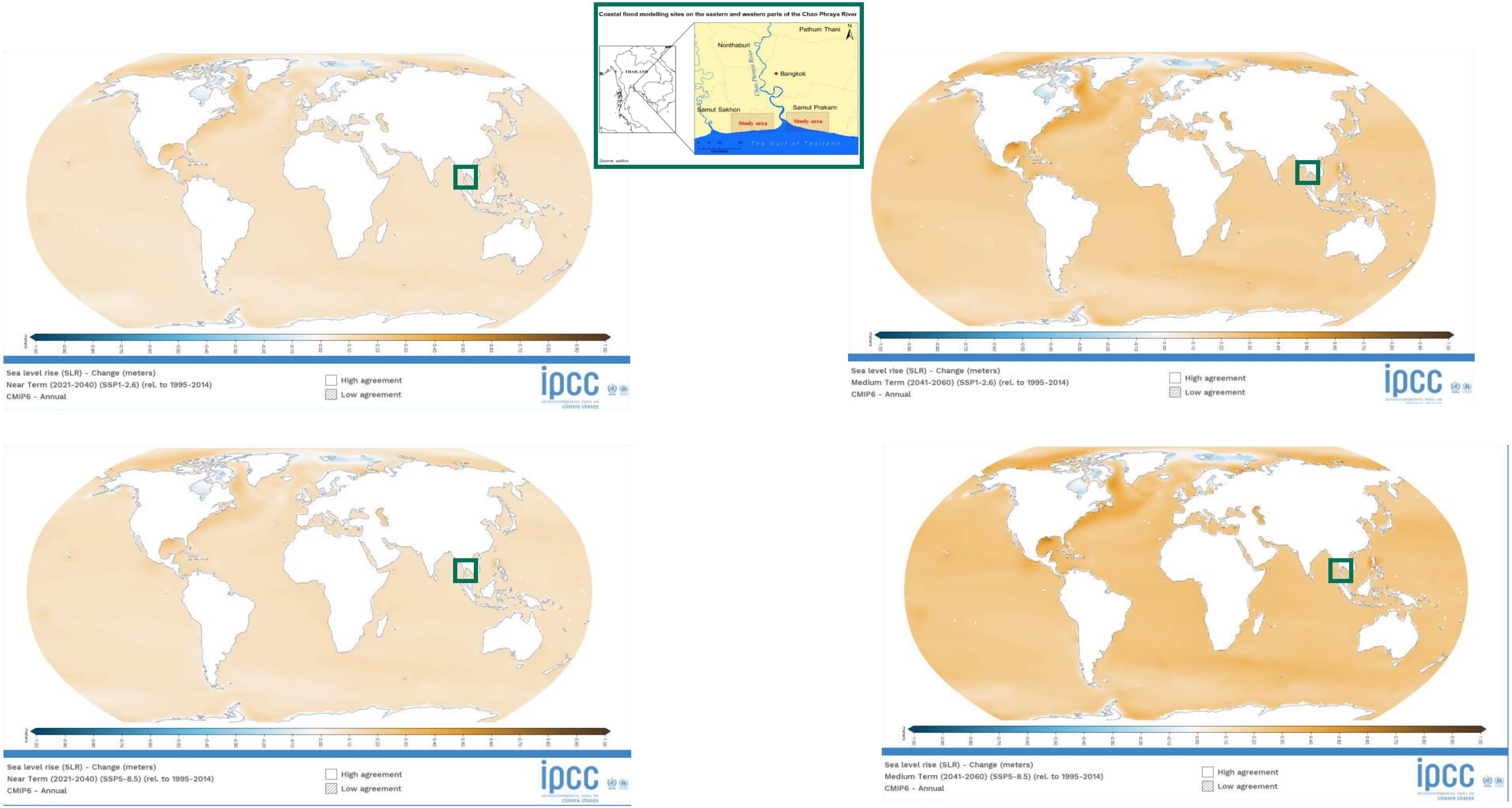
**Figure 29**: Coastal Flood Inundation Map



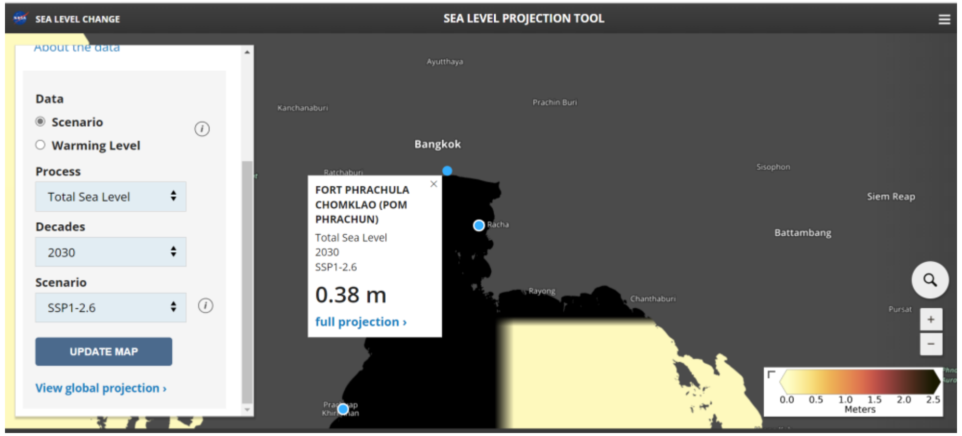

*__Source__: WRI-Aqueduct Flood*

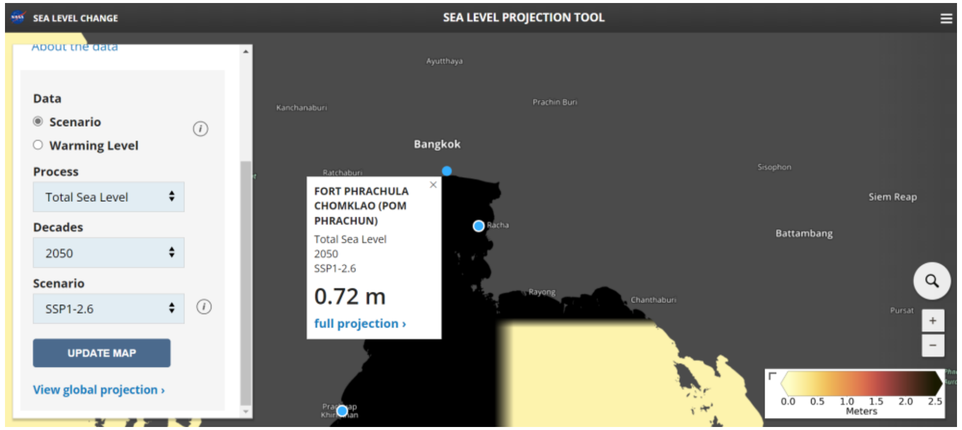
| | ThinkHazard | WRI-Aqueduct | Overall |
|---|---|---|---|
| **Baseline** | Medium-High | Medium | High |

# **Figure 30**: Sea Level Rise under SSP1-2.6 & SSP5-8.5



# Coastal Flood: Climate Change SSP1-2.6




[Source: IPCC 2021: https://sealevel.nasa.gov/data_tools/17](https://sealevel.nasa.gov/data_tools/17)

**Projection: Coastal Flood (SSP 1-2.6)**

| Indicator | 2030 (cm) | 2040 (cm) | 2050 (cm) |
|---|---|---|---|
| **Sea-level Rise** | 38 | 55 | 72 |

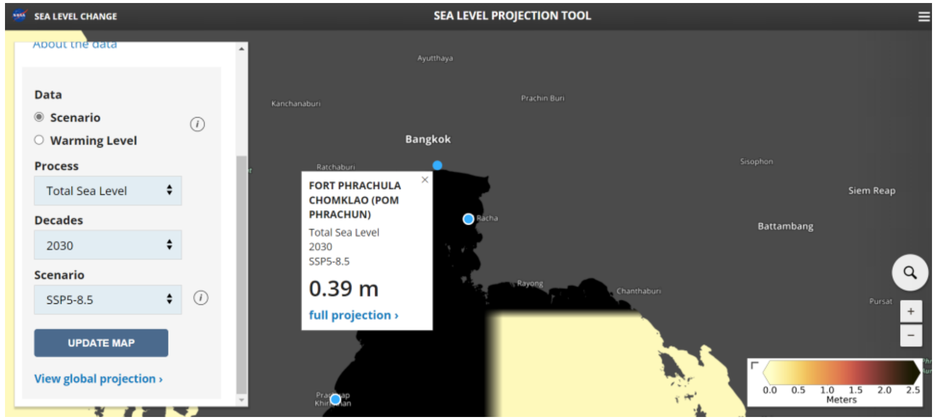
- The low-end emission scenario reveals a slight increase in sea level rise in the 2030s, 2040s and 2050s compared to the baseline. Hence the coastal flood risk is likely to be projected as **'High'** for both time horizons.

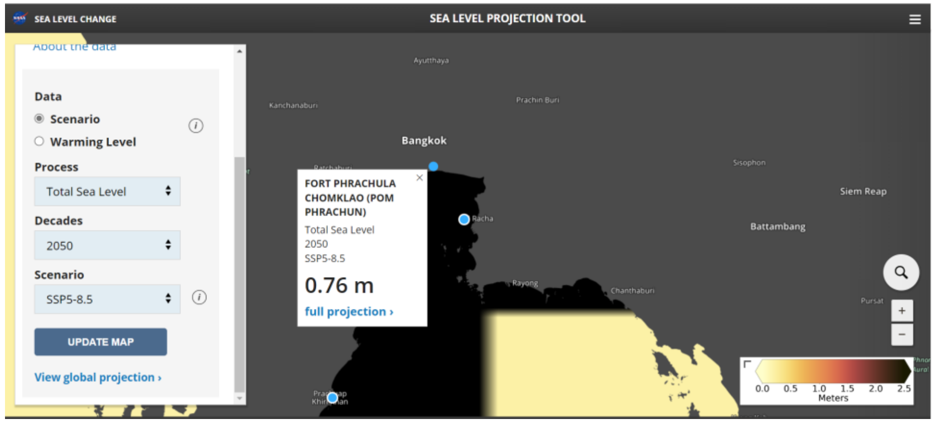
| Category | Sea-level rise (cm.) |
|---|---|
| Significant increase | > 50 cm. |
| Moderate increase | > 25 cm. |
| Slight Increase | >0 cm. |
| No Change | 0% |

Source: Climate projection trend legend categorized by ERM

| Baseline | 2030 | 2040 | 2050 |
|---|---|---|---|
| High | High | High | High |

# Coastal Flood: Climate Change SSP5-8.5




Source: IPCC 2021: https://sealevel.nasa.gov/data_tools/17

**Projection: Coastal Flood (SSP 5-8.5)**

| Indicator | 2030 (cm) | 2040 (cm) | 2050 (cm) |
|---|---|---|---|
| **Sea-level Rise** | 39 | 58 | 76 |

- The high-end emission scenario reveals a significant increase in sea level rise in the 2030s, 2040s and 2050s compared to the baseline. Hence the coastal flood risk is likely to be projected as **'High'** for both time horizons.

| Category | Sea-level rise (cm.) |
|---|---|
| Significant increase | > 50 cm. |
| Moderate increase | > 25 cm. |
| Slight Increase | >0 cm. |
| No Change | 0% |

Source: Climate projection trend legend categorized by ERM

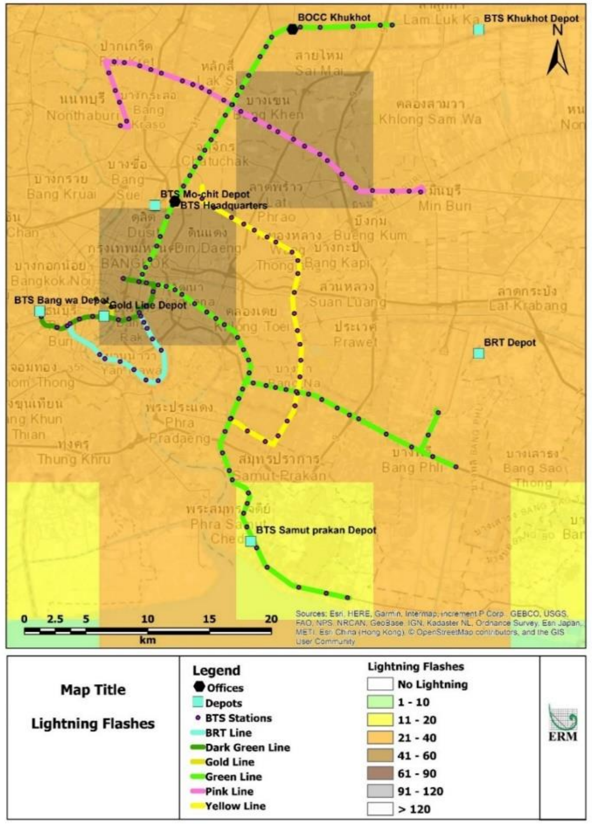
| Baseline | 2030 | 2040 | 2050 |
|---|---|---|---|
| High | High | High | High |

# Lightning: Baseline

| Parameter | Definition | Source |
|---|---|---|
| Lightning Flash Density | Average number of lightning flashes per year per km$^2$ recorded during 1998-2013 | NASA- Global Hydrology Resource Centre |

- Lightning flash density map indicates the density of lightning flashes to be between 20-60 flashes/km$^2$/year during the period 1998- 2013 in the region.

**Figure 31**: Historical Lightning Flashes

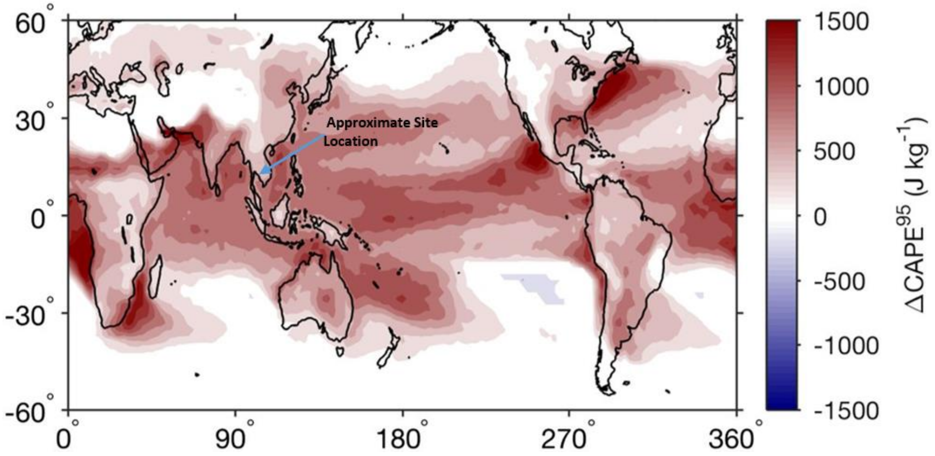



***Source**: NASA-GHRC*

# Lightning: Climate Change

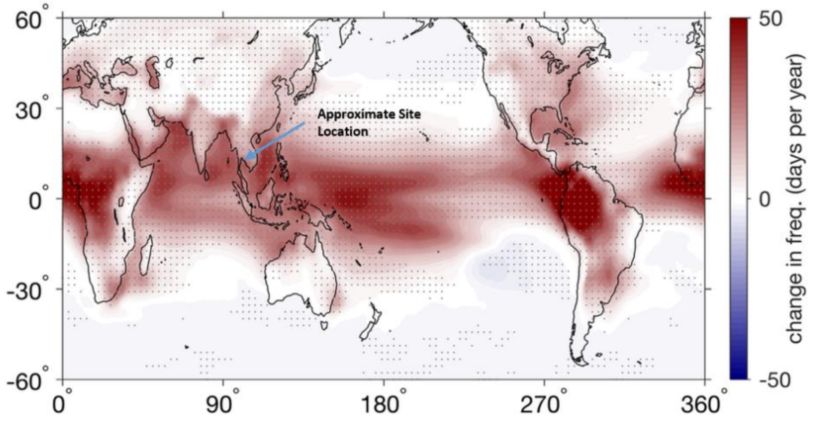
- **There are no direct projections available for lightning**. However, as lightning usually occurs during thunder storms, any changes in occurrences of thunder storm are considered as measure for changes in lightning in future.
- Literature review indicate that predicting changes in thunderstorm directly is difficult task, and hence generally changes in frequency  of large scale environmental conditions conducive to thunderstorms are used as an indirect measure. One such factor is <u>Convective Available Potential Energy</u> (CAPE), which is a measure of maximum kinetic energy obtainable by an air parcel lifted adiabatically from near surface. CAPE is also reported to be important large scale indicator for the potential lightning.
- Literature review indicates tropical and subtropical CAPE extremes increasing sharply with warming across ensembles of GCMs participating in CMIP5. In general, the studies indicate an increase in potential for intense thunder storms in warming atmosphere.
- Accordingly, the increase in number of favourable days (frequency) at Site are likely to be 0-10 days/year. Assuming the linear change in the increase the change in **2030** and 2050 is likely to be 0-5 more days.

**Figure 32**: Projected Change in CAPE




***Source**: Kulp, S.A., and Strauss, B.H (2019)*

**Figure 33:** Projected Change in Number of Days with Conditions Conducive to Thunder Storms




***Source**: martin Singh (2017)*

# Summary of Future Projections for Key Climate Variables RCP 2.6 / SSP1-2.6 and RCP 8.5 / SSP5-8.5

| Climate Index | Baseline | RCP2.6/SSP1-2.6 Scenario | | | RCP8.5/SSP5-8.5 Scenario | | |
|---|---|---|---|---|---|---|---|
| | | 2030 | 2040 | 2050 | 2030 | 2040 | 2050 |
| **Water Availability** | High | High (-0.04) | High (0.07) | High (0.08) | High (0.03) | High (0.07) | High (0.2) |
| **Floods:** | Medium-High | High (236.7mm.) | High (243.2 mm.) | High (249.6 mm.) | High (238.2 mm) | High (253.5 mm) | High (268.9 mm.) |
| **Extreme heat:** | High | High (38.7 ° C) | High (39° C) | High (39.3 ° C) | High (38.7 ° C) | High (39.2 ° C) | High (39.8 ° C) |
| **Cyclone** | Low | Low | Low | Low | Low | Low | Low |
| **Wind speed** | Low | Low (6.85 m/s) | Low (6.83 m/s) | Low (6.82 m/s) | Low (6.90 m/s) | Low (6.70 m/s) | Low (7.18m/s) |
| **Sea-level rise** | High | High (0.38 m.) | High (0.55 m.) | High (0.72 m.) | High (0.39 m.) | High (0.58 m.) | High (0.76 m.) |
| **Lightning** | No classification (use 2021 information) | | | | | | |

# Qualitative Physical Climate Risks Ratings
# Baseline


**Legend**

No Classification | No Hazard | Low | Medium | Medium-High | High

# Qualitative Physical Climate Risks Ratings
# RCP2.6/SSP1-2.6


**Legend** No Classification | No Hazard | Low | Medium | Medium-High | High

# Qualitative Physical Climate Risks Ratings RCP8.5/SSP5-8.5


**Legend**

No Classifi cation | No Hazard | Low | Medium | Medium -High | High

# Future Projections for Key Climate Variables RCP 2.6 / SSP1-2.6 and RCP 8.5 / SSP5-8.5

| Climate Index | Baseline | RCP2.6/SSP1-2.6 Scenario | | | RCP8.5/SSP5-8.5 Scenario | | |
|---|---|---|---|---|---|---|---|
| | | 2030 | 2040 | 2050 | 2030 | 2040 | 2050 |
| **Water Availability** | High | High (-0.04) | High (0.07) | High (0.08) | High (0.03) | High (0.07) | High (0.2) |
| **Floods:** | Medium-High | High (236.7mm.) | High (243.2 mm.) | High (249.6 mm.) | High (238.2 mm) | High (253.5 mm) | High (268.9 mm.) |
| **Extreme heat:** | High | High (38.7 ° C) | High (39° C) | High (39.3 ° C) | High (38.7 ° C) | High (39.2 ° C) | High (39.8 ° C) |
| **Cyclone** | Low | Low | Low | Low | Low | Low | Low |
| **Wind speed** | Low | Low (6.85 m/s) | Low (6.83 m/s) | Low (6.82 m/s) | Low (6.90 m/s) | Low (6.70 m/s) | Low (7.18m/s) |
| **Sea-level rise** | High | High (0.38 m.) | High (0.55 m.) | High (0.72 m.) | High (0.39 m.) | High (0.58 m.) | High (0.76 m.) |
| **Lightning** | No classification (use 2021 information) | | | | | | |

# Physical Risks and Adaptation Plans

Time frame = 5 years 2027*

| Physical Risk | | |
|---|---|---|
| **Risk** | **Impact for BTS** | **Adaptation plan to be completed within 2027** |
| **Water Stress** | • Reduced customer and employee water access for drinking, sanitation and maintenance.<br>• Increased cost of water sourcing and treatment. | • Water risk assessment and water auditing<br>• Explore opportunities for rainwater harvesting<br>• Water savings fixtures to be installed.<br>• Opportunities for use of recycled water to be explored. |
| **Extreme Heat** | • Service disruption due to infrastructure damage: Twisting of tracks and derailment of trains, softening of roads<br>• Increased power demand for cooling.<br>• Health and safety of staff/ employees due to heat stress / related illness | • Develop action plan to operate trains under extreme temperature conditions.<br>• Provide training to employees to identify symptoms of heat stress and provide first aid.<br>• Ensure appropriate mix design for construction of asphalt/ bitumen pavements to mitigate the risk of melting/ softening. |
| **Floods & Coastal Floods** | • Stations, offices, and depots may become inaccessible<br>• Debris on road / damage to road surface may disrupt buses<br>• Damage to supporting infrastructure<br>• Failure of track circuit or detection of presence/ absence of train on track.<br>• Endanger structural safety of lines | • Provide regular capacity training to relevant employees in response to flooding which is estimated to be addressed before the 2027<br>• Design and implement suitable mitigation measures such as increasing capacity of storm water drainage or pumping system.<br>• Sufficient drainage system for the viaducts of the Sky Rail to avoid inundation on elevated sections<br>• Sufficient camber and storm water drainage capacity ensured for the roads carrying bus/BRT transport.<br>• Prepare plan to operate metro rail at lower speed during rainfall intensity. |
| **Wind Speed & Cyclone** | • Reduced customer comfort and safety<br>• Damage/ disruption of assets<br>• Safety of construction/ maintenance workers | • Consider wind hazard in emergency response plan and develop action plan identifying steps to be taken if wind speed exceeds certain threshold value.<br>• Install anemometers to monitor wind speeds<br>• Compliance with national or international best practices for wind load for design and construction of all structures. |

# Financial Impact

BTS Group Holdings Public Company Limited

# Identify Financial Impact from Flooding Risk

**The most significant risk and methods used to manage:**

- **Flooding Risk**: High Level flooding which causes water breaching inside the workshop in the depot halting all maintenance of trains. Trains will not be able to undergo maintenance in the case of train malfunction or engine failure etc. therefore concrete walls must be set up as well as stop log distributed at important locations.
- We have evaluated financial risks related to climate-related physical risks around our rail systems (sky train) that operates in Thailand. The risks from delay service and service disruption was estimated to be around 33,679,452 THB. We assumed disruption from climate-related physical impacts would be around 1 days per year. As of 31 March 2023, end of the FY, **total revenue of MOVE business is 12,293,000,000 THB/year** which equal to 33,679,452 THB/day financial implications for cost of disruption is approximately **33,679,452 THB**.

- Determined %change of rainfall intensity of RCP 2.6 in 2030, 2040 and 2050 from climate change projection
  - 7% in 2030
  - 1.10% in 2040
  - 13% in 2050

- Estimated the disruption days by using the assumption

"The disruption days in 2030 and 2050 are assumed based on the %change of rainfall intensity of RCP 2.6 with the 1-day disruption baseline in 2022"

  - 7% of 1 day disruption = 1.07 days
  - 1.10% of 1 day disruption = 1.10 days
  - 13% of 1 day disruption = 1.13 days

- Determined %change of rainfall intensity of RCP 8.5 in 2030, 2040 and 2050 from climate change projection
  - 8% in 2030
  - 1.14% in2040
  - 21% in 2050

- Estimated the disruption days by using the assumption

"The disruption days in 2030 and 2050 are assumed based on the %change of rainfall intensity of RCP 8.5 with  the 1-day disruption baseline in 2022"

  - 8% of 1 day disruption = 1.08 days
  - 1.14% of 1 day disruption = 1.14 days
  - 21% of 1 day disruption = 1.21 days



Key Financial Data | BTS Group Holdings

# Summary Financial Impact from Flooding Risk 2030s,2040s and 2050s Scenarios

## Baseline

Estimated Financial Implications :
- **33,679,452 THB**

Average estimated time frame (in number of years) for financial implications of this risk: 1
- **1 Year**

Estimated cost of these actions:
- **1,038,525 THB**

## RCP 2.6

- Financial disruption
  - In 2030: **33,679,452THB/day x 1.07 days = 36,037,014 THB**
  - In 2040: **33,679,452THB/day x 1.10 days = 37,047,397 THB**
  - In 2050: **33,679,452THB/day x 1.13 days = 38,057,781 THB**

## RCP 8.5

- Financial disruption
  - In 2030: **33,679,452THB/day x 1.08 days = 36,373,808 THB**
  - In 2040: **33,679,452THB/day x 1.14 days = 38,394,575 THB**
  - In 2050: **33,679,452THB/day x 1.21 days = 40,752,137 THB**

# Transition Risk

BTS Group Holdings Public Company Limited

# Methodology

## Transition Risk & Opportunity Assessment (Qualitative)

| Methodology Overview | |
|---|---|
| 1. | **Identify impact drivers**: The factors or the events that put pressure on companies to respond to low-carbon economy transition |
| 2. | **Assess potential impacts of each driver:** Analysis of risks & opportunities for BTS Group as a result of each impact driver |
| 3. | **Develop scoring criteria for potential impacts:** Based on specified parameters which relate to the potential impacts and adapted from BTS risk scoring criteria |
| 4. | **Define two future scenarios for low carbon transition**: Analysis of impacts is conducted according to two scenarios. 2030 and 2040 timescale is selected due to information availability. |
| 5. | **Conduct Transition Risk & Opportunity Assessment:** Qualitative analysis of each impact driver, for the two scenarios, according to scoring criteria. |

# BTS Impact Drivers & Opportunities

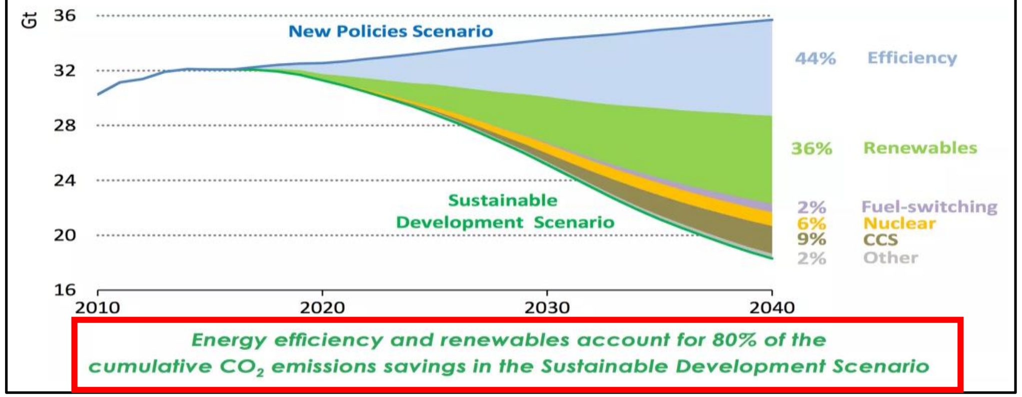
| | Impact Drivers | Opportunities |
|---|---|---|
| **Market** | • Demand for low-carbon transportation services that are more energy efficient and/ or use renewable energy | • Support transition to low-carbon transport system in Thailand:<br>➢ Investment into rail as GHG efficient transportation option (vs private vehicle and air)<br>➢ Electric trains and buses |
| **Technology** | • Technological advances enabling a reduction in the cost of renewable energy sources (e.g. PV) and/or the development of new technologies (e.g. hydrogen) | • Adoption of cost effective renewable energy technology for bus and train<br>• R&D into hydrogen technology suitability for low-medium speed train |
| **Reputation** | • Increased stakeholder concern and expectation on corporate climate action and negative perceptions towards businesses use of fossil fuels. | • Improve company profile amongst key stakeholders<br>• Attract investment |
| **Policy and Legal** | • Change of vehicle excise tax structure (based on the amount of GHG emission)<br>• Thailand's New Nationally Determined Contribution (NDC) to UNFCCC (Updated Oct 2020)<br>• Development of carbon pricing policies in Thailand | • Shift NGV buses to electric buses to avoid extra cost for new car excise taxes<br>• Carbon pricing policies may incentivize customers to switch to low-carbon transportation modes |

# Two Scenarios for Low Carbon Transition

Analysis of impacts is conducted according to two scenarios. 2030 and 2040 timescale is selected due to the limitation of available information.

**Scenarios**

**Stated Policies Scenario**
Holds up a mirror to today's stated policies and illustrates their consequences.




**Overview**

- The **Stated Policies Scenario (STEPS)** is designed to give feedback to decision makers about the course that they are on today, based on stated policy ambitions. This scenario assumes that the pandemic is brought under control over the course of 2021. It incorporates our assessment of stated policy ambitions, including the energy components of announced stimulus or recovery packages (as of mid-2020) and the Nationally Determined Contributions under the Paris Agreement.

Source: Click here

- The **Sustainable Development Scenario (SDS)** is designed to meet the energy-related United Nations Sustainable Development Goals to achieve: universal access to affordable, reliable and modern energy services by 2030; a substantial reduction in air pollution, and effective action to combat climate change. The SDS is fully aligned with the Paris Agreement to hold the rise in global average temperature to "well below 2 °C and pursuing efforts to limit to 1.5 °C".

Source: Click here

**Alignment with TCFD**

- The events in the scenario should be possible and the narrative credible (i.e. the descriptions of what happened, and why and how it happened, should be believable
- The goal of scenario analysis is to explore the way that factors interact, and each action should have a reaction.
- Each scenario, and the set of scenarios taken as a whole, should contribute specific insights into the future that relate to strategic and/or financial implications of climate-related risks and opportunities.
- Scenarios should try to explore alternatives that will significantly alter the basis for business-as-usual assumptions

# Scoring Criteria

| | Impact Drivers | Low | Medium | High | Very high |
|---|---|---|---|---|---|
| **Market** | Demand for low-carbon transportation services that are more energy efficient and/ or use renewable energy | A few complaints received | Multiple complaints received | Repeated or high rate of complaints. | Protest of a group of complaints |
| **Technology** | Technological advances enabling a reduction in the cost of renewable energy sources (e.g. PV) and/or the development of new technologies (e.g. hydrogen) | Low impact to BTS operations | Medium impact to BTS operations | High impact to BTS operations | Critical impact to BTS operations |
| **Reputation** | Increased stakeholder concern and expectation on corporate climate action and negative perceptions towards businesses use of fossil fuels | Very low impact on image/ reputation | Potential minor impact on image/ reputation | Image/ reputation will be affected in the short term | Serious diminution in image /reputation with adverse publicity. |
| **Policy and Legal** | Change of vehicle excise tax structure (based on the amount of GHG emission) | Impact can be readily absorbed through normal activity | An adverse event which can be absorbed with some management effort | Serious event which requires additional management effort | Critical event which requires extraordinary management effort |
| | Thailand's New Nationally Determined Contribution (NDC) to UNFCCC (Updated Oct 2020) | Low impact to BTS operation | Medium impact to BTS operation | High impact to BTS operation | Critical impact to BTS operation |
| | Development of carbon pricing policies in Thailand | low impact to BTS operation | Medium impact to BTS operation | High impact to BTS operation | Critical impact to BTS operation |

# Transition Risks (and Opportunities)

## Summary of Results

**Time frame = 6 years**

| Transition Risks & Opportunity | | | |
|---|---|---|---|
| | **Risk** | **Opportunity** | **Impact for BTS** |
| **Market** | Demand for low-carbon transportation services that are more energy efficient and/ or use renewable energy. | Support transition to low-carbon transport system in Thailand. | • New ‘white-space’ market opportunities<br>• Increased operating cost if renewable energy has not reached grid parity.<br>• Potential impact to the BTS future portfolio strategy. |
| **Technology** | Technological advances enabling a reduction in the cost of renewable energy sources and/or the development of new technologies | R&D and adoption of renewable energy / hydrogen technology. | • Reduced operating costs as price of renewable energy decreases<br>• New technologies requiring new operation patterns or train specification<br>• Sensitivity to future price change of renewable energy technology |
| **Reputation** | Increased stakeholder concern and expectation on corporate climate action and negative perceptions towards businesses use of fossil fuels. | Improve company profile amongst key stakeholders and attract investment | • Increased revenues<br>• Availability of investment |
| **Policy & Legal** | Change of vehicle excise tax structure based on the amount of GHG emission.<br>Thailand's new Nationally Determined Contribution to UNFCCC requirements for transport sector.<br>Development of carbon pricing policies in Thailand | Incentives for investment into low emission transportation. | • New infrastructures and sources for supporting new operation systems<br>• Increased investment into GHG reduction actions from transportation sector. |

# Transition Risk & Opportunity Assessment

## Scenario 1: Stated Policies Scenario (1)

| Impact Drivers | | Point of Discussion | 2030 BTS Assessment | Point of Discussion | 2040 BTS Assessment |
|---|---|---|---|---|---|
| **Market** | Demand for low-carbon transportation services that are more energy efficient and/ or use renewable energy | No or very low requests on green travelling choices. Limited low carbon transition from other transportation companies e.g. Electric rail, buses and ferries. | Medium | Higher numbers of customers ask for low carbon transportation options. Other transportation companies e.g. buses and ferries have started launching green travelling options. | High |
| **Technology** | Technological advances enabling a reduction in the cost of renewable energy sources (e.g. PV) and/or development of new technologies (e.g. hydrogen) | BTS will slightly shift some of their operation to green technology e.g. Shifting NGV busses to EV buses | Medium | BTS train operation system including offices and depots will input renewable energy electricity. BTS Sky Train operation will increase the share of renewable energy electricity . | High |
| **Reputation** | Increased stakeholder concern and expectation on corporate climate action and negative perceptions towards businesses use of fossil fuels | Investors have only minor focus on BTS climate strategy | High | Thai and International investors will ask for the company's climate mitigation and adaptation actions | High |

# Transition Risk & Opportunity Assessment

## Scenario 1: Stated Policies Scenario (2)

| Impact Drivers | | Point of Discussion | 2030 BTS Assessment | Point of Discussion | 2040 BTS Assessment |
|---|---|---|---|---|---|
| Policy and Legal | Change of vehicle excise tax structure (based on the amount of GHG emission) | Combustion engine cars tax (higher). Electric car (lower). BTS may need to shift BRT buses from combustion engine to electric buses to reduce the cost from increasing tax. | High | Combustion engines tax will continue to increase annually. If BRT operations are not able to shift into low carbon technology such as electric busses, BTS will shoulder more financial costs. | High |
| | Thailand's New Nationally Determined Contribution (NDC) to UNFCCC (Oct 2020) | In 2030, GHG reduction in the transport sector needs to contribute about 36.3% of Thailand's NDC Roadmap. | High | Increasing ambition of GHG reduction in Thailand's updated NDC will require more GHG reduction from transportation sector. | High |
| | Development of carbon pricing policies in Thailand | Thai Government work with IEA and TGO on emission trading systems, such as cap-and-trade, and carbon taxes, and aim to start using in 2022. | Medium | Thai cap and trade regulation introduced, mainly affecting energy sector. BTS needs improvement of new infrastructure (affects BRT operation and Scope 1 emissions). | Medium |

# Transition Risk & Opportunity Assessment

## Scenario 2: Sustainable Development Scenario(1)

| Impact Drivers | | Point of Discussion | 2030<br>BTS Assessment | Point of Discussion | 2040<br>BTS Assessment |
|---|---|---|---|---|---|
| **Market** | Demand for low-carbon transportation services that are more energy efficient and/ or use renewable energy | Higher number of customer start to ask for green travelling choices. Other transportation companies e.g. buses and ferries have started launching green travelling. | Medium | More people/customers start to request Carbon Footprint of BTS transportation and protest the high GHG emissions. Other transportation companies e.g. buses and ferries have launched low carbon travelling choices. | Medium |
| **Technology** | Technological advances enabling a reduction in the cost of renewable energy sources (e.g. PV) and/or development of new technologies (e.g. hydrogen) | BTS may need to adopt green hydrogen train technology earlier. The new depots and maintenance teams for green hydrogen technology will be established earlier as well. | Medium | BTS may fully adopt green hydrogen train technology faster leading BTS to face new operation pattern and change the specification of the train and maintenance. | Medium |
| **Reputation** | Increased stakeholder concern and expectation on corporate climate action and negative perceptions towards businesses use of fossil fuels | Thai investors will give more focus to company's climate mitigation strategies. Investor will look for the companies that partner with UNPRI or Climate Action 100 | High | Thai and International investors will require comprehensive climate strategies, targets and actions. Carbon offset and buying I-REC may be unacceptable | High |

# Transition Risk & Opportunity Assessment

## Scenario 2: Sustainable Development Scenario(2)

| Impact Drivers | | Point of Discussion | 2030 BTS Assessment | Point of Discussion | 2040 BTS Assessment |
|---|---|---|---|---|---|
| Policy and Legal | Change of vehicle excise tax structure (based on the amount of GHG emission) | Combustion engines tax will continue to increase annually. If BRT operations are not able to shift into low carbon technology such as electric busses, BTS will shoulder more financial costs | High | Combustion engines tax will continue to increase annually. If BRT operations are not able to shift into low carbon technology such as electric busses, BTS will shoulder more financial costs | High |
| | Thailand's New Nationally Determined Contribution (NDC) to UNFCCC (Oct 2020) | In SDS scenario, Thailand may set NDC target at higher than current NDC leading BTS to contribute more GHG reduction commitment | Medium | To keep the world temperature rises below 1.5 C. Being carbon neutral company is not sufficient to reach the target. BTS need to be carbon negative company before by 2040 | High |
| | Development of carbon pricing policies in Thailand | Thai regulation will introduce cap and trade. However, it mainly affect energy sector. BTS needs the improvement of new infrastructures ( Affect mainly on BRT operation and Scope 1 emission). | Medium | Thai regulation will introduce cap and trade. However, it mainly affect energy sector. BTS needs the improvement of new infrastructures ( Affect mainly on BRT operation and Scope 1 emission). | Medium |

# Summary: Transition Risks & Opportunities

| | Market | Technology | Reputation | Policy and Legal |
|---|---|---|---|---|
| **Impact Drivers** | • Demand for low-carbon transportation services that are more energy efficient and/ or use renewable energy | • Technological advances enabling a reduction in the cost of renewable energy sources (e.g. PV) and/or the development of new technologies (e.g. hydrogen) | • Increased stakeholder concern and expectation on corporate climate action and negative perceptions towards businesses use of fossil fuels. | • Change of vehicle excise tax structure (based on the amount of GHG emission)<br>• Thailand's New Nationally Determined Contribution (NDC) to UNFCCC (Updated Oct 2020)<br>• Development of carbon pricing policies in Thailand |
| **Opportunities** | • Support transition to low-carbon transport system in Thailand:<br>➢ Investment into rail as GHG efficient transportation option (vs private vehicle and air)<br>➢ Electric trains and buses | • Adoption of cost effective renewable energy technology for bus and train<br>• R&D into hydrogen technology suitability for low-medium speed train | • Improve company profile amongst key stakeholders<br>• Attract investment | • Shift NGV buses to electric buses to avoid extra cost for new car excise taxes<br>• Carbon pricing policies may incentivize customers to switch to low-carbon transportation modes |
| **Potential impacts** | • New 'white-space' market opportunities<br>• Increased operating cost if renewable energy has not reached grid parity.<br>• Potential impact to the BTS future portfolio strategy. | • Reduced operating costs as price of renewable energy decreases<br>• New technologies requiring new operation patterns or train specification<br>• Sensitivity to future price change of renewable energy technology | • Increased revenues<br>• Availability of investment | • New infrastructures and sources for supporting new operation systems<br>• Increased investment into GHG reduction actions from transportation sector. |

# Thank You

BTS Group Holdings Public Company Limited