Thaioil
Physical Risk Scenario

As of 26 December 2023

Assessment Process & Scenarios

Qualitative Assessment Methodology

Provincial Level Assessment

Baseline Hazard Data

AQUEDUCT

WORLD BANK GROUP

ThinkHazard!

Identify natural hazards in your project area and understand how to reduce their impact

Geospatial Information

1 **Baseline Natural Hazards**

Open Source Datasets

Key Natural Hazards

2 **Climate Change Projections**

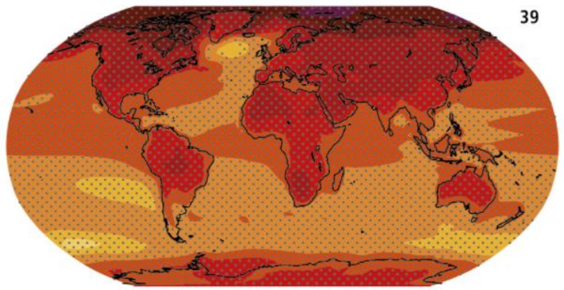
Climate Data CMIP-5 for RCP 2.6 and 8.5 (2030 and 2050)

Data for Key Climate Indices

Qualitative Risk Rating

Geospatial Data

Climate Change Projections



Risk towards water availability is evaluated based on annual rainfall only. Therefore, evaluation of water availability may require further assessment considering local water usage pattern, projected changes in water usage.

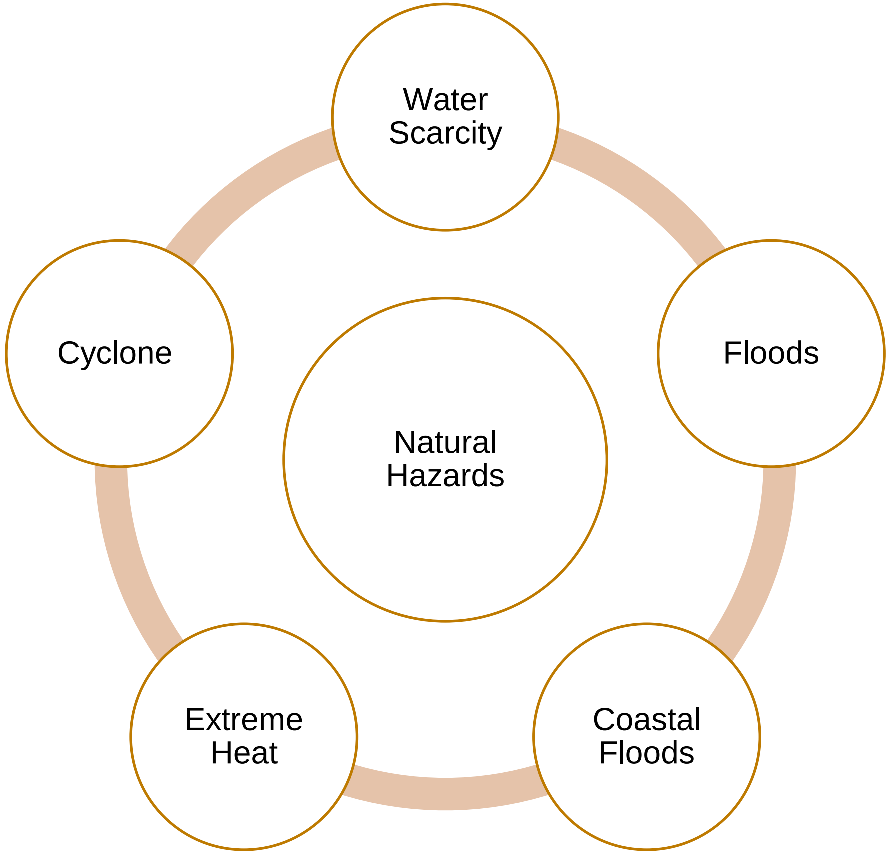
3 **Qualitative Risk (Hazard) Matrix**

RCP2.6	Water Scarcity			Urban Flood			Riverine Flood		
Province	BSL	2030	2050	BSL	2030	2050	BSL	2030	2050
Chiang Mai	1	1	-1	3	-3	-3	3	3	3
Chonburi	1	1	-1	3	-2	-2	3	-1	2
Khon Kaen	1	1	-1	3	-3	-3	3	-2	-1
Nakhon Ratchasima	2	1	-1	3	-3	-2	3	2	3
Nonthaburi	2	1	-1	3	-3	-3	3	2	3
Pathum Thani	2	1	-1	3	-3	-3	3	2	3
Rayong	1	1	-1	3	-1	1	3	3	3
Samut Prakarn	2	1	-1	1	-3	-3	2	2	3
Songkhla	1	1	-1	3	1	2	3	3	3
Ubon Ratchathani	1	1	-1	3	-1	-1	3	-1	3
Bangkok	2	1	-1	2	-3	-3	2	2	3

CMIP-5: Couple Model Intercomparison Project (CMIP) provides a community-based infrastructure in support of climate model diagnosis, validation, intercomparison, documentation and data access. CMIP-5 provides the climate projections data from IPCC Fifth Assessment Report

Representative concentration pathways (RCPs) The word representative signifies that each RCP provides only one of many possible scenarios that would lead to the specific radiative forcing characteristics. The term pathway emphasises that not only the long-term concentration levels are of interest, but also the trajectory taken over time to reach that outcome

Key Climate Physical Risks Under Current Scope of Assessment



Relevance to TCFD

Acute Risks: Risks resulting from extreme weather events, such as cyclones and floods.

Chronic Risks: Risks resulting from comparatively longer term shifts in weather pattern such as sea level rise and desertification

Hazard under Current Assessment	Hazard Type	Corresponding TCFD Recommended Hazard
Water Scarcity/ Water Stress	Acute/ Chronic	Drought, Water Supply/ Water Demand
Inland Floods (Riverine and Urban)	Acute	Floods
Coastal Floods	Acute/ Chronic	Sea Level Rise, Storm Surge
Extreme Heat	Acute/ Chronic	Temperature
Cyclone	Acute	Typhon, Hurricane, Cyclones

Source: TCFD (2017)

Baseline Natural Hazards

Baseline Hazard Categorization (1)

Baseline natural hazards were evaluated based on the review of an online tool (ThinkHazard) developed by the World Bank/Global Facility for Disaster Reduction And Recovery (GFDRR).

Hazard and Description	Baseline Data	Primary Data Source	Secondary Data Source	Categorization Criteria (ThinkHazard)	Hazard Category (ThinkHazard)	Normalized Hazard Category (ERM)
Water Scarcity Hazard is classified based on catchment level Water Stress, which is the ratio of water withdrawal to available renewable water resource	Annual SPEI Drought Index, Historical Reference Period, 1986-2005	-Think Hazard (World Bank Group, 2017) http://thinkhazard.org/en -WRI-Aqueduct Water Risk Atlas	Global Dataset of Water Crowding Index (WCI) (Veldkamp et al., 2015).	Water Availability <500 m3/capita/year at 5 Year Return Period	High	High
				Water Availability <1000 m3/capita/year at 5 Year Return Period	Medium	Medium
				Water Availability <1700 m3/capita/year at 5 Year Return Period	Low	Low
				Intensity not exceeded at the "Low" return period used.	Very Low	
Riverine and Urban Floods River flood and urban flood hazards are classified using a threshold of "area flooded to damaging intensity threshold of 0.5m. The area threshold is 1% of the Administrative (ADM) unit for river flood, and 4% of the ADM unit for urban flood	Average largest 1-Day/5-Day Precipitation, Historical Reference Period, 1986-2005	-Think Hazard (World Bank Group, 2017) http://thinkhazard.org/en/ -The World Bank Data Catalog	SSBN Ltd 90 m global flood hazard maps	Return Period of 10 Years	High	High
				Return Period of 50 Years	Medium	Medium
				Return Period of 10,000 Years	Low	Low
				Intensity not exceeded at the 'low' return period used.	Very Low	

Source: ThinkHazard! Hazard Specific Classification Methods

Baseline Hazard Categorization (2)

Hazard and Description	Baseline Data	Primary Data Source	Secondary Data Source	Categorization Criteria (Think Hazard)	Hazard Category (ThinkHazard)	Normalized Hazard Category (ERM)
Landslide Hazards Hazard classified based on the frequency of rainfall-induced landslide events.	Average largest 5-Day Precipitation, Historical Reference Period, 1986-2005	Think Hazard (World Bank Group, 2017) http://thinkhazard.org/en/	SSBN Ltd 90 m global flood hazard maps	Annual frequency >0.00075	High	High
				Annual frequency 0.00032-0.00075	Medium	Medium
				Annual frequency 0.00018-0.00032	Low	Low
				Annual frequency <0.00018	Negligible	No Hazard
Coastal Floods Hazard is classified using a similar rationale to riverine and urban floods.	cm above 2000 CE baseline, 1986-2005	Think Hazard (World Bank Group, 2017) http://thinkhazard.org/en/	A global reanalysis of storm surges and extreme sea levels (Muis et al., 2016)	Return Period of 10 Years	High	High
				Return Period of 50 Years	Medium	Medium
				Return Period of 100 Years	Low	Low

Source: ThinkHazard! Hazard Specific Classification Methods

Baseline Hazard Categorization (3)

Hazard and Description	Baseline Data	Primary Data Source	Secondary Data Source	Categorization Criteria (Think Hazard)	Hazard Category (ThinkHazard)	Normalized Hazard Category (ERM)
Extreme Heat Extreme heat hazard classification is based on heat stress as indicated by daily maximum Wet Bulb Globe Temperatures.	Max Temperature, Historical Reference Period, 1986-2005	Think Hazard (World Bank Group, 2017) http://thinkhazard.org/en/	Wet Bulb Globe Temperature (WBGT) extreme heat dataset developed by VITO	WBGT >32°C at 5 Year Return Period	High	High
				WBGT >28°C at 20 Year Return Period	Medium	Medium
				WBGT >25°C at 100 Year Return Period	Low	Low
				WBGT <25°C	Very Low	
Cyclone Tropical cyclone is classified using wind speed, provided as frequency-severity data. **The damaging intensity threshold is 80km/h.**	Various - based on over 50 studies modelling projected changes in cyclone activity in response to climate change with a 2 degree scenario.	Think Hazard (World Bank Group, 2017) http://thinkhazard.org/en/	UNISDR Global Assessment Report 2015 (GAR15)	Return Period of 50 Years	High	High
				Return Period of 100 Years	Medium	Medium
				Return Period of 1000 Years	Low	Low
				Intensity not exceeded at the "Low" return period used.	Very Low	

Source: ThinkHazard! Hazard Specific Classification Methods

Climate Projection Data

Climate projection data for RCP2.6 and RCP8.5 scenarios.

Hazard	Data (Indicator)	Projection Data Source	Hazard Risk Assessment Method
Water Scarcity	Water Stress (SPEI drought index)	Climate Change Knowledge Portal (World Bank Group, 2021)	Change in annual drought probability
Riverine Floods	5 Day Max Rainfall (mm)	Climate Change Knowledge Portal (World Bank Group, 2021)	Percentage change in rainfall (mm) compared to baseline figures
Landslide	5 Day Max Rainfall (mm)	Climate Change Knowledge Portal (World Bank Group, 2021)	
Urban Floods	1 Day Max Rainfall (mm)	Climate Change Knowledge Portal (World Bank Group, 2021)	
Coastal Floods	Change in Sea Level Rise (cm above 2000 level)	Partnership for Resilience and Preparedness (PREP, 2021)	Change in sea level (cm above 2000 level)
Extreme Heat	Max Temperature (°C)	Climate Change Knowledge Portal (World Bank Group, 2021)	Change in maximum temperature (°C) compared to baseline figures
Cyclones	Change in Sustained Wind Speed (%)	Tropical Cyclones and Climate Change Assessment: Part II: Projected Response to Anthropogenic Warming (Knutson et al., 2020)	Percentage change in sustained wind speed compared to baseline figures

Data source sub-national level: Chonburi Province (Si Racha)

Baseline natural hazard and climate change projection

An initial baseline hazard evaluation was conducted for ThaiOil, using data for **Si Racha District**, provided on ThinkHazard and adjusted to be more specific to ThaiOil's context based on ThaiOil's experiences with past hazard events and supporting rationale from various sources.

Hazard	Chonburi (ThinkHazard)	Si Racha (ThinkHazard)	Final Baseline (Source)	Rationale
Water scarcity	1	1	3	Adjusted from ThinkHazard's baseline category of "Low" to "High" based on the **WRI Aqueduct** tool which indicates medium-high drought risk at baseline levels (see slide 25).
River flood	3	1	1	According to the **Country Report Thailand** by the Japanese International Cooperation Agency (JICA), there are no river and urban flood hotspots in Si Racha district.
Urban flood	3	1		
Landslide	2	1	1	Even though the overall landslide risk in Thailand is considered "High", review of provincial and area-specific data indicates that the risk of landslides in Si Racha is "Low".
Coastal flood	3	2	2	According to Muis et al.'s **dataset on coastal flood** presenting the global reanalysis of storm surges and extreme sea levels based on hydrodynamic modelling.
Extreme heat	2	2	2	According to ThinkHazard, baseline category is "Medium" which is consistent with the **Thailand Disaster Management Reference Handbook and heatwaves study** specific to Thailand.
Cyclone	3	3	1	Adjusted from ThinkHazard's baseline category of "High" to "Low" based on UNISDR Global Assessment Report 2015 GAR15 data and there is no cyclone events have occurred at the TOP's asset.

Normalized Hazard Category (refer to slide 7-9 for hazard specific definitions)

High	Medium	Low	No Hazard	Not Applicable
3	2	1	0	N/A

Source: ThinkHazard developed by World Bank/ Global Facility for Disaster Reduction and Recovery (GFDRR)

Climate Change Risk: Results & Trends

Please refer to Appendix 1 for raw and processed data

Hazard	Change in Indicator	Baseline		RCP2.6			RCP8.5		
				2030	2040	2050	2030	2040	2050
Water Scarcity	Water Stress (SPEI drought index)	High	3	1	1	-1	1	-1	-1
Riverine Floods	5 Day Max Rainfall (%)	Low	1	1	-2	2	1	-2	2
Landslide	5 Day Max Rainfall (%)	Low	1	1	1	2	1	2	2
Urban Floods	1 Day Max Rainfall (%)	Low	1	-2	1	-2	-3	2	1
Coastal Floods	Sea Level Rise (cm above 2000 level)	Low	2	1	1	1	1	2	2
Extreme Heat	Max Temperature (°C)	Medium	2	1	1	1	1	1	2
Cyclones	Sustained Wind Speed (%)	Low	1	1	1	1	2	2	3

Legend and Hazard Score:

Category		Drought (Change in annual drought probability	Riverine & Urban Floods (change in 1 day and 5 day maximum rainfall)	Coastal floods and sea level rise	Extreme Heat (Change in annual average maximum temperature)	Cyclone (Change in sustained wind speed
3	Significant Increase	<-1	>10%	>50cm	>2°C	>5%
2	Moderate Increase	<-0.5	>5%	>25cm	>1°C	>2.5%
1	Slight Increase	<0	>0%	>0cm	>0°C	>0%
0	No Change	0	0%	0cm	0°C	0%
-1	Slight Decrease	>0	<0%	<0cm	<0°C	<0%
-2	Moderate Decrease	>0.5	<-5%	<-10cm	<-1°C	<-2.5%
-3	Significant Decrease	>1	<-10%	<-20cm	<-2°C	<-5%

Determining Most Significant Risks:

The most significant risks were determined based on the following criteria:

1. **High baseline** – indicates the hazard that is most likely to happen in the future
2. **High difference between baseline and projection data** – indicates the hazard that ThaiOil is least prepared to face (low likelihood) but may potentially have the largest implications in terms of impact.

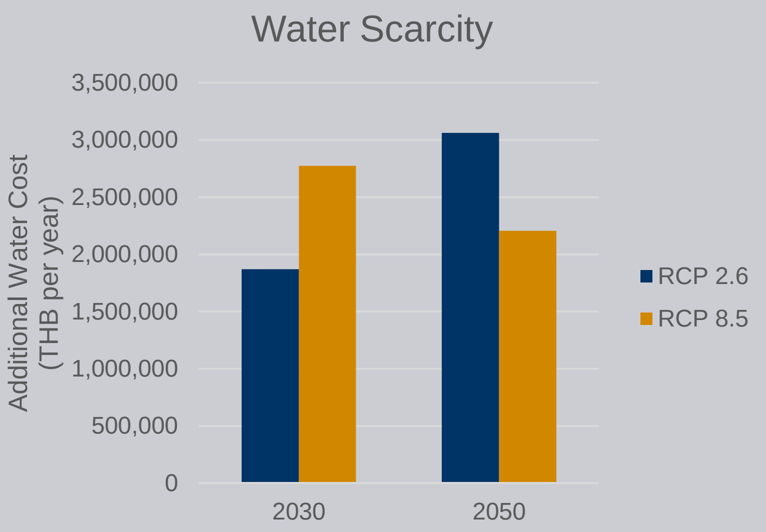
Selecting top two risks

1. **Water Scarcity** was identified as high risk at baseline level. Despite climate projection data indicating a slight decrease in the RCP 2.6 and RCP 8.5 scenarios at 2030 and 2050 timeframes, water availability is crucial to ThaiOil's operations as it directly influences production. Therefore, water scarcity has been selected as one of the most significant risks.

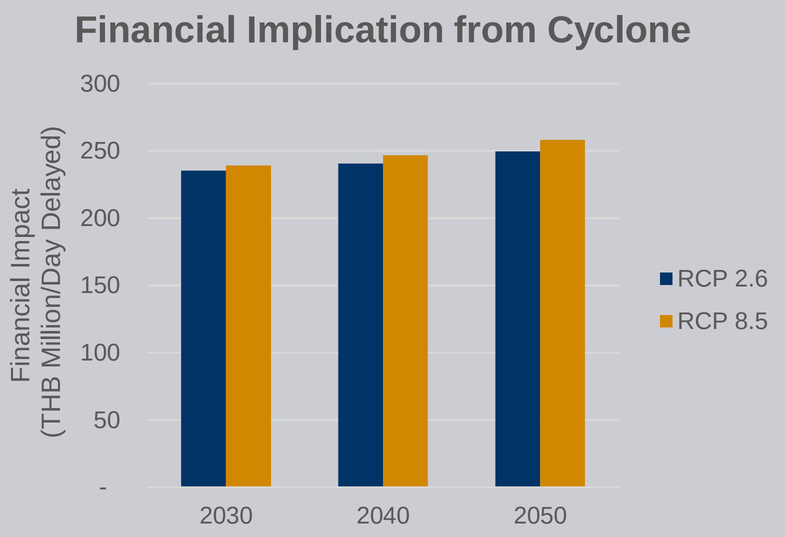
2. **Cyclones** was identified as low risk at baseline level. Projection data indicates a moderate increase in 2030 and significant increase in 2050 under the RCP 8.5 scenario. This demonstrates the highest difference between baseline and project data (low baseline but large increases in projected data risk score), which may cause the highly acute impact. This risk should be taken into considered for the great impact prevention, although it has been considered as very low likelihood and never been impact on business operation in the past. And only offshore cyclone is focused as the historical data.

Physical Risk Implications

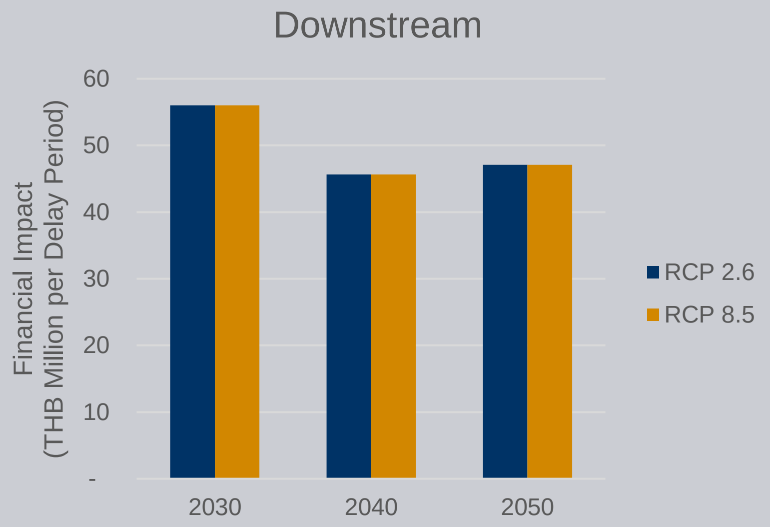
Physical Risk Implications (Chronic Impact)

Identified Risk	Possible Risk Implication	Financial Impacts
Water Scarcity (Own Operation)	• Operational cost increasing due to investment in mitigation measure for water scarcity when 10% shortage of water from the existing sources (i.e. Royal Irrigation Department and the Eastern Water Resources Development and Management Public Company Limited) under crisis conditions	Thaioil Group have quantified the potential financial implications which may affect us from investment in mitigation measure for water scarcity as follows:  Assumptions : • Assumed reductions under the RCP 2.6 and RCP 8.5 scenarios for 2030 and 2050 timeframes based on water stress data from WRI Aqueduct

Physical Risk Implications (Acute Impact 1/2)

Identified Risk	Possible Risk Implication	Financial Impacts
Offshore Cyclone (Own Operation)	• Revenue loss due to preventive measure will be considered as plant shutdown prior to cyclone impact and checking of refinery for damages post cyclone event (i.e. wind speed from offshore cyclone)	The evaluation of financial implications from cyclones aim to estimate potential impacts from refinery shutdowns due to high wind speeds from offshore cyclone as follows:  Assumptions : • Taking into account plant shutdown prior to cyclone impact (preventative measure) and checking of refinery for damages post cyclone event, the estimated total shutdown duration is 2 days. • This duration does not include further shutdowns from secondary impacts (e.g. flooding from intense rain, damages to plant infrastructure, etc.)

Physical Risk Implications (Acute Impact 2/2)

Identified Risk	Possible Risk Implication	Financial Impacts
Offshore Cyclone (Downstream)	• Revenue loss due to the product cannot export to oversea customer by marine transportation	The evaluation of financial implications of Thaioil's downstream customers being impacted by natural hazards. Consequently, Thaioil cannot export their oil products to customers resulting in revenue loss as follows:  Assumptions : • Cyclone activity is a cause of port disruption. As there was only Typhoon Gay that affected Gulf of Thailand in 1989, its period from formation of typhoon until the end is around 3 days starting from South China Sea to Gulf of Thailand. According to Knutson et al. (2020), the change in cyclone intensity as indicated by change in wind speed between RCP 2.6 and RCP 8.5 is 5.81% which is considered not significant enough to influence cyclone duration. Therefore, the cyclone duration (i.e. number of shipment days delayed) is the same across both RCP 2.6 and RCP 8.5.