

IMPACT ASSESSMENT OF CLIMATE CHANGE ON INDUSTRY AND TRADE IN BINH THUAN PROVINCE

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Abstract: *This paper presents the results of assessing the impacts of climate change (CC) on industry and trade in Binh Thuan province. Assessing the impacts of climate change at the present and in the future. The temperature and rainfall scenarios used are RCP4.5 and RCP8.5. Flooded scenario for both the present and the future is calculated with 20% flood frequency. Evaluation results show that CC impacts on the fields of Industry and Trade as: electricity production, seafood processing, minerals processing, factories, industrial clusters, traditional craft villages, trade centres, supermarkets, markets, petroleum stores, warehouses.*

Keywords: *Climate change impact, industry and trade, Binh Thuan Province.*

1. Introduction

The climate of Binh Thuan province has typical characteristics of the monsoon tropical climate. Binh Thuan is a coastal province with an area of 7,943.9km², a population of 1,230,417 thousand people [7].

The meteorological and hydrological factors change due to the impacts of climate change. Both rainfall and temperature tend to increase compared to previous years. Specifically, in 33 years (1984-2017), the annual average temperature at Phan Thiet station increased by 0.213°C/decade and the annual rainfall increased by 1.6mm/year. According to satellite observation data, in the period of 1993-2013 the sea level tends to increase by 42mm/decade [1].

Based on the results of climate trend assessment and climate change scenarios for Binh Thuan province, this study assesses the impact of climate change on industry and trade in the fields of electricity production, seafood processing, minerals processing, factories,

industrial clusters, traditional craft villages, trade centres, supermarkets, markets, petroleum stores, warehouses. The results of climate change impact assessment would contribute to build action plan to respond to climate change for industry and trade sector in Binh Thuan.

2. Data and methodology

2.1. Data

The temperature and rainfall scenarios are RCP 4.5 and RCP8.5, based on the approach of climate change scenarios of the Ministry of Natural Resources and Environment in 2016. Flooded scenario for both the present and the future is calculated with 20% flood frequency.

Climate change scenarios for Binh Thuan Province are based on results of the completed projects Technical Consultancy for present and future climate data and analyses for water management in Luy River Basin, Bac Binh District, Binh Thuan Province.

The collected map includes: map of Binh Thuan province, industry and trade status in 2016 and development plans for Binh Thuan industry and trade in the period of 2016 - 2020, vision to 2030 [2-3].

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2.2. Methodology

Assessing the impact of climate change on the industry and trade of Binh Thuan province including: qualitative and quantitative

Evaluation based on scenarios of temperature, rainfall, flood calculation according to CC scenarios.

The methods used to assess impacts include:

- Numerical modelling method: using models to predict future impacts through extrapolation of the observed climate factors in the past.

- Extrapolation of historical data: used in statistical research of past data on impacts of climate change on economic and social sectors.

- Expert method: analytical methods on the opinions of experts on the impact of climate change on the object under

consideration, through interviews or conferences and seminars.

- Impact assessment map: overlapping administrative and hydrological maps of VN2000 reference system, results of climate change scenarios of MONRE, flooding scenario of 20%.

3. Results and discussion

3.1. Evaluate the impact of flooding

Overlaying the current flooded map in 2016 (Figure 1) and Binh Thuan province industry and trade status in 2016 map. The results show that the flood area is from 0.1 to 1.3% compared to natural land area. Districts have large flooded areas such as Phan Thiet (14.2%), Bac Binh (3.2%), Ham Tan (2.3%) (Table 1).

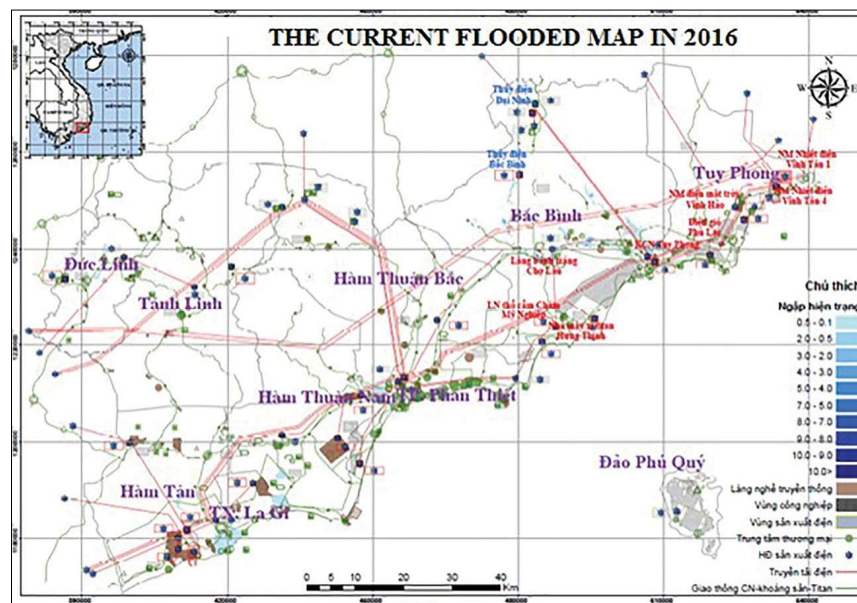


Figure 1. The current flooded map in 2016

Table 1. Total current flooded area in 2016

District	Flooded area (ha)	Natural land area (ha)	Rate (%)
Bac Binh	5,906	186,882	3.2
Tuy Phong	91	79,385	0.1
Duc Linh	649	53,491	1.2
Ham Thuan Bac	1,248	117,442	1.1
Ham Thuan Nam	380	135,044	0.3
La Gi	1,428	106,279	1.3
Phan Thiet	3,010	18,541	14.2
Ham Tan	224	21,168	1.0

Up to 2030, the flood area is up to 1.5%, compared to natural land area. There are

several districts with large flooded areas such as Phan Thiet (14.9%), Bac Binh (3.2%).

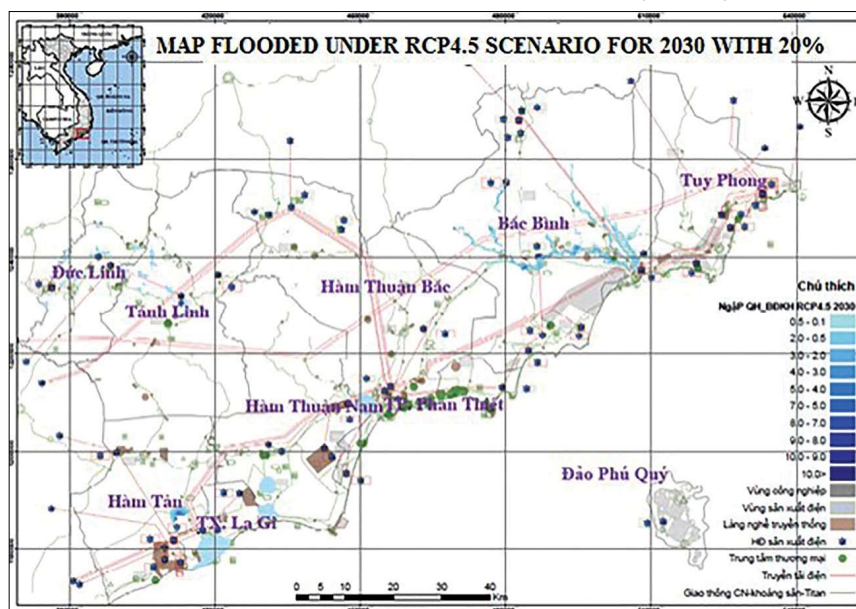


Figure 2. Map flooded under RCP4.5 scenario for 2030 with 20% flood frequency

Table 2. Total flooded area under RCP4.5 scenario for 2030 with 20% flood frequency

District	Flooded area (ha)	Natural land area (ha)	Rate (%)
Bac Binh	4,566	186,882	2.4
Tuy Phong	1	79,386	~0
Duc Linh	802	53,491	1.5
Ham Thuan Bac	856	117,442	0.7
Ham Thuan Nam	409	135,044	0.3
LaGi	1304	106,279	1.2
Phan Thiet	2766	18,541	14.9
Ham Tan	221	21,168	1.0

Overlaying map of flooded under RCP8.5 scenario for 2030 with 20% flood frequency with the planning and development of Binh Thuan province industry and trade in the period of 2016-2020, vision to 2030 (Figure 3). The results show that the flood area is from 0.1 to 1.5% compared to natural land area. Districts have large flooded areas such as Phan Thiet (14.9%), Bac Binh (3.1%) (Table 3).

The area is severely affected by flooding: Vinh Tan (Tuy Phong), Bac Binh hydropower, Song Luy hydropower, Hoa Minh wind power, Hoa Thang wind power and Phan Ri Thanh wind power. Plants that are not affected by flooding are: Dai Ninh hydropower, Phu Lac wind power,

Phong Dien 1.

Main roads through Tuy Phong industrial park; Cham brocade weaving village in Phan Thanh, Binh Duc pottery village in Phan Hiep commune, rice paper village of Lau market will be deeply inundated.

3.2. Evaluate the impact of temperature variation

Under RCP4.5 scenario, the results predict that the annual average temperature of Binh Thuan province will increase from 0.6 to 0.8°C in the early 21st century (2016-2035) in comparison with the base period (1986-2005) (Table 4).

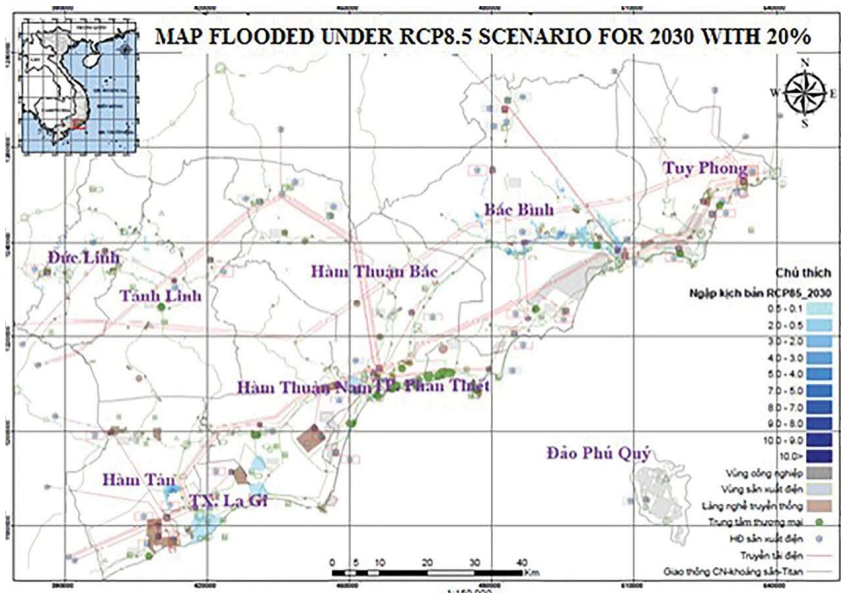


Figure 3. Map flooded under RCP8.5 for 2030 with 20% frequency

Table 3. Total flooded area under RCP8.5 for 2030 with 20% frequency

District	Flooded area (ha)	Natural land area (ha)	Rate (%)
Bac Binh	5,798	186,882	3.1
Tuy Phong	69	79,386	0.1
Duc Linh	802	53,491	1.5
Ham Thuan Bac	418	135,044	0.3
Ham Thuan Nam	1,314	106.279	1.24
La Gi	2,776	18.541	15
Phan Thiet	222	21.168	1
Ham Tan	824	75.309	1

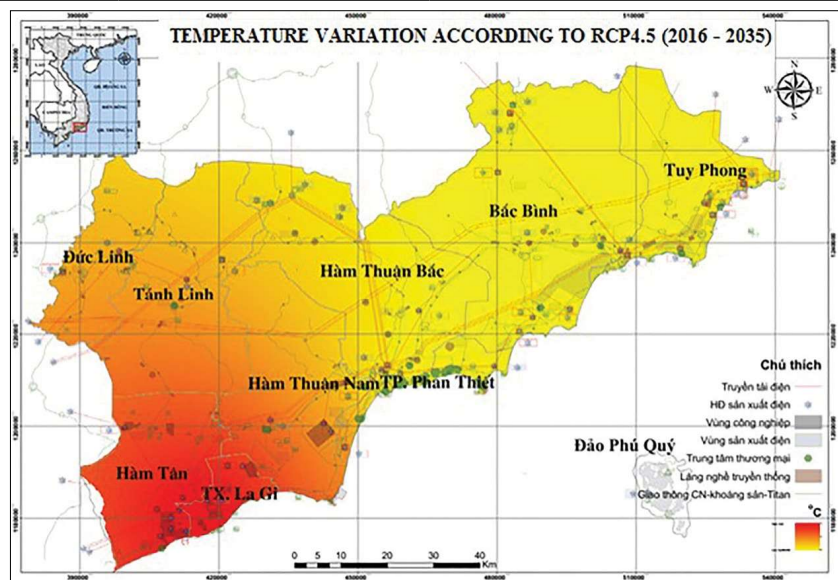


Figure 4. Map of temperature variation according to RCP4.5 scenario in the beginning of the century (2016-2035)

Table 4. Temperature variation according to RCP4.5 scenario in the beginning of the century (2016-2035)

District	Temperature variation (°C)
Phan Thiet	0.7
La Gi	0.6
Tuy Phong	0.6
Bac Binh	0.6
Ham Thuan Bac	0.6
Ham Thuan Nam	0.6
Tanh Linh	0.7
Ham Tan	0.8
Duc Linh	0.6

Under RCP8.5 scenario, the annual average temperature of Binh Thuan province will increase from 0.7 to 0.8°C in the early 21st

century (2016-2035), compared to the base period (1986-2005) (Table 5).

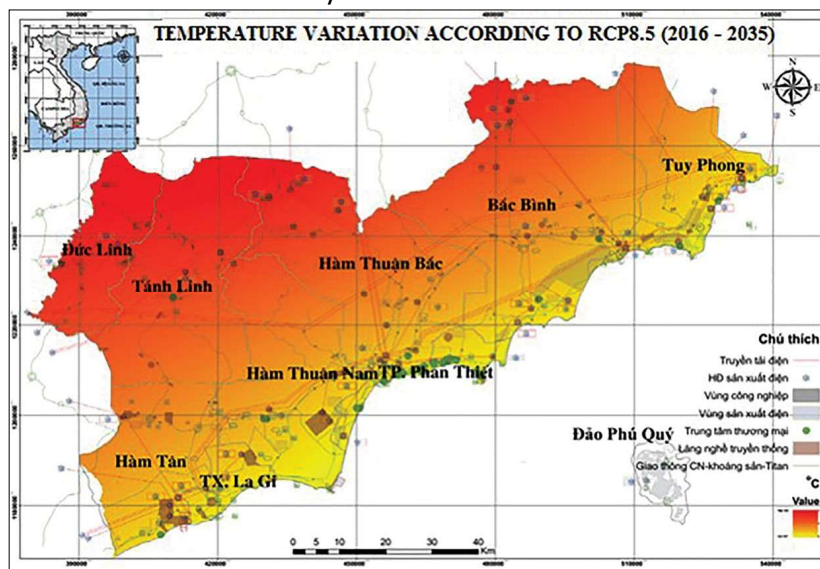


Figure 5. Map of temperature variation according to RCP8.5 scenario in the beginning of the century (2016-2035)

Table 5. Temperature variation according to RCP8.5 scenario in the beginning of the century (2016-2035)

District	Temperature variation (°C)
Phan Thiet	0.7
La Gi	0.6
Tuy Phong	0.6
Bac Binh	0.6
Ham Thuan Bac	0.6
Ham Thuan Nam	0.6
Tanh Linh	0.7
Ham Tan	0.8
Duc Linh	0.6

The annual average temperature in the region such as Tanh Linh, Duc Linh, Ham Thuan Bac, Bac Binh and Tuy Phong quickly increased. These areas concentrated factories, substations, power stations, power transmission lines and auxiliary works of the electricity projects of Binh Thuan province. Hence, increasing temperature will reduce the efficiency of electricity generation, leading to a decrease in power output. Adverse effect on the cooling system of thermal power plants and the range of cooling water quality standards. The increase in temperature accompanied by increased evaporation leads to changes in water reserves and flow into hydroelectric reservoirs. Rising temperatures also reduce the steam turbine thermal cycle performance, causing fuel waste.

Binh Thuan province has fishing centres including: Phan Thiet, La Gi, Phan Ri; in which Phan Ri and Phan Thiet fishing port area under the scenarios of temperature change are strongly influenced by rising temperatures. The change in temperature also affects aquaculture areas, impacts on marine ecosystems, changes in species and marine fish resources.

Titanium mineral processing area in Luong Son, Bac Binh district will be affected by rising temperatures and drought. Increased temperatures, prolonged drought increase cooling costs for processing plants and processing lines.

Vinh Tan thermo-power, Song Binh, Thang Hai 3, Dong Ha and Nam Ha industrial complexes are strongly affected by temperature rise. Increasing temperature also reduces the quality of life of workers, fire, equipment and equipment to reduce quality and longevity.

3.3. Rainfall impact

Under RCP4.5 scenario, the average annual rainfall of Binh Thuan province, except Bac Binh and Ham Thuan Bac districts, will increase from 0.7 to 15% in the early 21st century, compared to the base period (1986-2005) (Table 6).

Under RCP8.5 scenario, the average annual rainfall of Binh Thuan province, except Ham Thuan Bac district, will increase from 2 to 13% in the early 21st century compared to the base period (1986-2005) (Table 7).

Hydropower plants (Dan Sach, Kao Et, Thac Ba, Dan Sach 2, 3, Bom Bi, Song Dinh, Ham Thuan, Da Mi, La Ngau) in the southern districts such as Duc Linh, Tanh Linh, Ham Thuan Bac and Ham Thuan Nam will be affected by rainfall increase. Cost of repair, maintenance, inspection due to prolonged heavy rains cause rust, degradation, flooding is likely raised.

In Ham Thuan Bac district, heavy rainfall combined with flooding of Quao River cause local flooding in Ham Thang, Ham Chinh, Thuan Hoa, Ham Liem and Ham Tri communes which lead to seafood processing damage. In the context of climate change, many extreme phenomena occur such as heavy rain, storms, the exploitation of seafood, especially the offshore fishing is extremely dangerous and difficult. Increasing labour cost, repairing ships, fuel costs, equipment, and difficulties in transportation. Increased rainfall, sudden change in salt concentration caused the death of many species of shellfish and shrimp in Binh Thuan province.

In Suoi Nhum titanium exploiting mine, the collapse of mining pits due to heavy rain has frequently happened. If the waste water treatment system in the mines of inferior titanium mining is polluted in excess of the permissible level, it will be mixed with rainwater flowing into the river, dispersing radioactive substances in the waste water of mining. The impact on the environment is huge.

The main roads through large industrial zones such as Tuy Phong, Bac Binh 1, La Gi, Tan Binh 1, Nam Cang, Phu Hai, Mui Ne, Sung Nhon, Hong Liem Nghia Hoa, Tan Lap, heavy rain will flood deeply, causing damage. Increasing rainfall is the cause of food production. Wet conditions make it harder to store ingredients as food. Plants must increase costs in protection, build stormwater drainage systems.

4. Conclusion

Based on above mentioned data and approach on climate change scenarios for Binh Thuan Province as well as provincial planning of industry and trade, there are some conclusions about the impact of climate change on the fields of Industry and Trade, as follows:

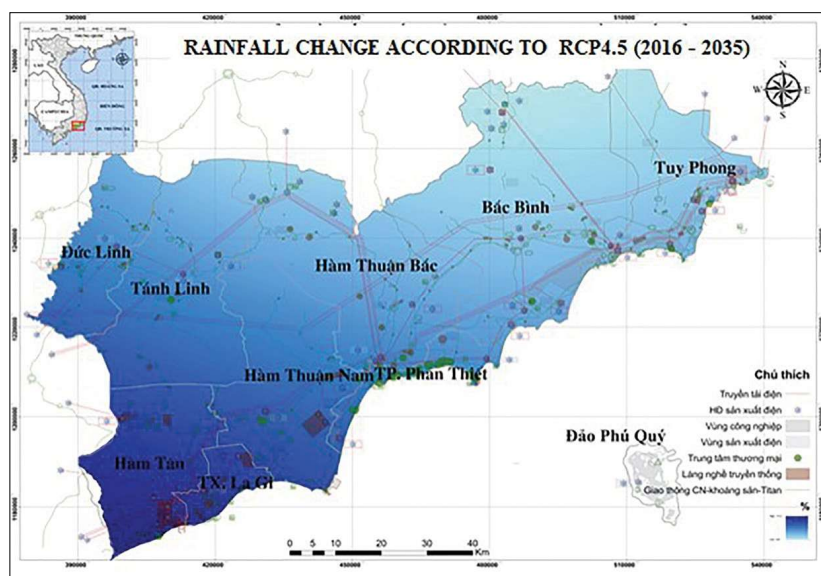


Figure 6. Rainfall change under RCP4.5 scenario for the period 2016-2035

Table 6. Rainfall change under RCP4.5 scenario for the period 2016-2035

District	Rainfall change (%)
Phan Thiet	10.7
La Gi	6.5
Tuy Phong	2.7
Bac Binh	-1.7
Ham Thuan Bac	-1.9
Ham Thuan Nam	0.7
Tanh Linh	2.2
Ham Tan	15.6
Duc Linh	2.6

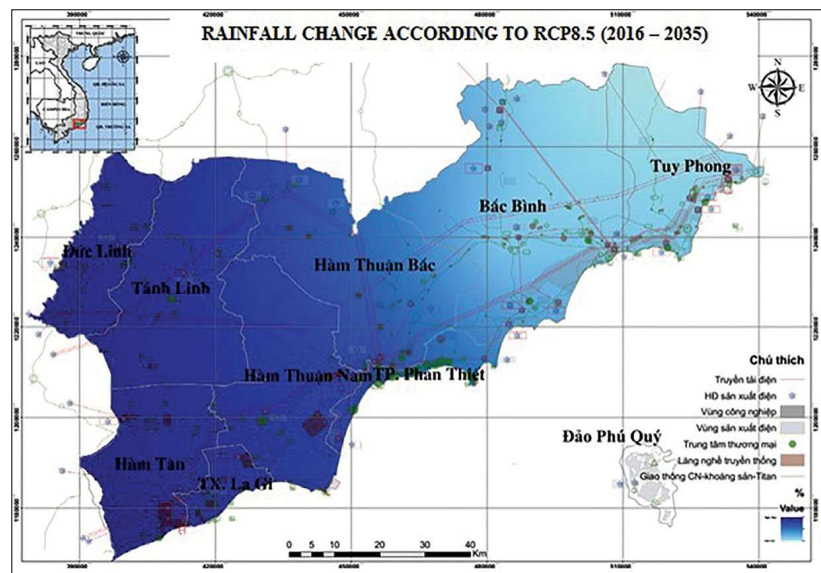


Table 7. Precipitation variation according to RCP8.5 scenario for the period 2016-2035

Table 7. Precipitation variation according to RCP8.5 scenario for the period 2016-2035

District	Rainfall change (%)
Phan Thiet	10.3
La Gi	6.2
Tuy Phong	6.0
Bac Binh	0.0
Ham Thuan Bac	-0.5
Ham Thuan Nam	2.0
Tanh Linh	3.1
Ham Tan	13.3
Duc Linh	2.6

Power production: climate change may lead to increase costs for power production activities during operation, cooling and maintenance. In addition, electric poles, transformer stations, power transmission lines, etc. are overloaded, degraded, damaged due to rising temperatures, rain, extreme climate; prolonged flooding can be dangerous due to electrical leakage.

Seafood processing: changes in temperature and precipitation would impacts on marine ecosystems, loss of diversity and reduction of seafood exploited for processing.

Mineral exploitation and processing: Heavy rain can cause underground mines of titanium to be flooded, makes the equipment damaged.

Heavy rain also is likely to break pits, spill ore and make environmental incidents.

Factories, industrial clusters, traditional craft villages: Roads may be flooded due to heavy and prolonged rain. Heavy rain and prolonged heat could affect the manual production of traditional villages and reduce the number of tourists coming here. Temperature increases, prolonged heat is likely to make fire risk.

Trade centres, supermarkets, markets, petroleum stores, warehouses: Increasing temperature negatively tends to affects the sustainability of buildings, increase electricity consumption and raise cooling costs in trade centres, supermarkets and markets, respectively. The rise in temperature may increases the risk of fire in petroleum stores and warehouses.

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