Topic: # Climate change impacts on Quang Ninh province

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Abstract

Quang Ninh is one of Vietnam's coastal provinces that are prone to climate change and highly vulnerable with impacts of sea level rise, torrential rain, storms, and tropical depressions . Impacts of climate change have been observed clearly: In the last 55 years, the average temperature in Quang Ninh has increased 0.7 ^{o}C, variations of rainfall in the province have not been clear, but the highest rainfall in one day once reached 697 mm. The Medium-Low Scenario RCP 4.5 forecasts that in the late 21st century, the average temperature will increase 2.3 ^{o}C annually against the 1986-2005 period and will possibly reach 25.8 ^{o}C; the annual rainfall will increase 29.8% against the 1986-2005 period and is estimated to reach 1,900-3,500 mm; the sea level rise and water level rise due to storms and high tides are likely to increase to 5.7-6.0 m. Climate change is strongly impacting several regions and localities in the province including Quang Yen, Hai Ha, Dam Ha, Tien Yen, Van Don, Hoanh Bo, Ha Long, and Mong Cai; and affecting the province's multiple sectors including water resources, agriculture, industry-energy, construction- urban, tourism and people's lives. Climate change impacts are clearly seen in increasing flooding, flashfloods, landslide, and saline intrusion thus threating Quang Ninh people's lives.

To respond to climate change, the province has worked out several measures with priority given to building early warning systems for landslides and flashfloods, building and duplicating sustainable livelihood models in the context of climate change, upgrading drainage systems, strengthening the plantation and protection of upstream forests and protected forests, consolidating river and sea dykes.

Key words: climate change, Quang Ninh climate, impact,

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PREFACE

Climate change is said to have strong, long-term impact on all socio-economic aspects of many regions, territories and countries including Vietnam and Quang Ninh province in particular.

Quang Ninh province has a natural land area of 6,102 km2 and is the largest province in the Red River Delta. Mountains cover 80% of the province's area. Agricultural land accounts for 75.4% of the total land area but most of the remaining area are covered by mountains, only 50,886 ha (8.3%) are cultivable.

Quang Ninh province has 14 adminstrative units: 10/14 districts, towns and cities are coastal and it is the only province in Vietnam that has 4 cities (Ha Long, Mong Cai, Uong Bi and Cam Pha) and two towns (Quang Yen and Dong Trieu).

Climate in Quang Ninh is generally moderate, favorable for agricultural production and other economic sectors. Due to unusual weather changes caused climate change, it's necessary to make appropriate decisions and solutions to reduce greenhouse gas emission and adapt to climate change. It's necessary to properly evaluate the climate change status in the province, its imminent and potential impacts on local regions, localities, and sectors.

1. Climate change situation in Quang Ninh

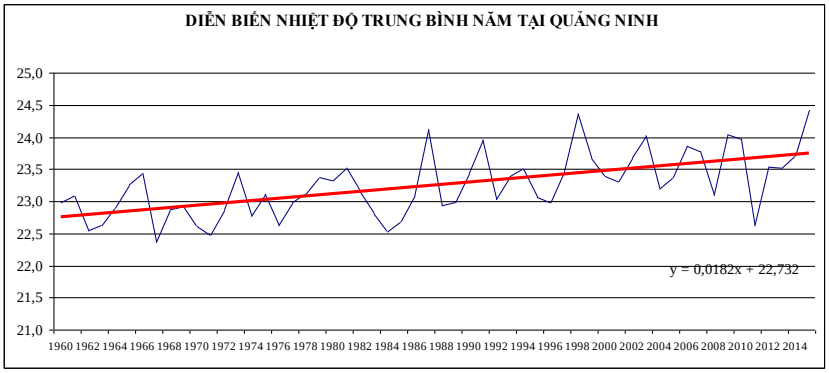
1.1. Temperature changes in Quang Ninh

Average temperatures in Quang Ninh in different periods:

- Annual average temperatures during 1960-1979: 22.2-23.2^{o}C.
- Annual average temperatures during 1980-1999: 22.5-23.5^{o}C.
- Annual average temperatures during 2000-2015: 22.9-23.9^{o}C.

In 55 years, the average temperature in Quang Ninh increased 0.7^{o}C, on average it increased 0.018-0.02 ^{o}C/year.

Figure 1. Changes of average annual temperature in Quang Ninh during 1960-2015



According to the Climate Change, Sea Level Rise Scenario for Vietnam released by the Ministry of Natural Resources and Environment in 2016 (the Medium-Low Scenario RCP 4.5), the annual average temperature in Quang Ninh is likely to increase 2.3^{o}C in the late 21st century (against that of the 1986-2005 period), an increase of 0.02 ^{o}C on average annually. In the late 21st century, the average temperature in Quang Ninh is forecast to increase to 25.8^{o}C. The average temperature tends to increase slightly through time.

Unusual observed changes of temperatures in Quang Ninh:

- In the last 55 years (until 2015), the highest temperature in Quang Ninh was 38.8**^{o}C** (in 1983), the lowest temperature was 0.8^{o}C (in 1999). The difference between the highest and lowest temperatures was 38°C.

- The longest cold spell lasted for 30 days (22/01-20/02/2008) in Quang Ninh making the temperatures in February, 2008 the lowest in history and was 3-4^{o}C lower than the average temperatures of the same period of several years. In February, 2009, there were unusually warm days making the temperature in that month 4-5^{O}C higher than the same period of other several years. From August 23-28, 2016, temperatures in Dong (Bronze) temple in Yen Tu Mountain (Uong Bi city) went down to -5^{o}C; and temperatures in many other localities in the province went down below 5^{o}C.

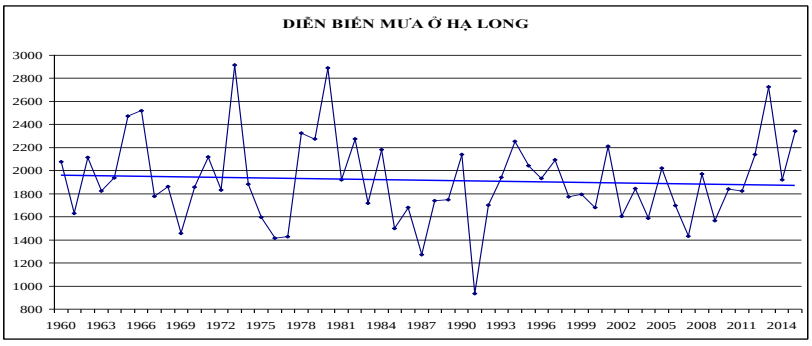
1.2. Variations of rainfall in Quang Ninh

Annual rainfall in Quang Ninh in different periods as follow:

- Annual rainfall during 1960-1979: 1.500-2.600mm.
- Annual rainfall during 1980-1999: 1.500-2.700mm.
- Annual rainfall during 2000-2015: 1.500-2.700mm.

In the last 55 years, the annual rainfall in the eastern coast of Quang Ninh province was 2,200-2,700 mm; in other areas was 1,500-2,000 mm. Rainfall reduced in most areas in the province. In Mong Cai, Hai Ha, Dam Ha, Binh Lieu, the annual rainfall increased, the highest increase was in Co To. In winter, rainfall did not change remarkably. In summer, rainfall changed as annual rainfall.

Figure 2.Changes in annual rainfall in Ha Long-Quang Ninh (1960-2015)



Comparing to previous periods, the annual rainfall in Quang Ninh did not change remarkably, increased in Uong Bi, Bai Chay, Cua Ong, Hai Ha, and Co To and reduced in Tien Yen, Binh Lieu, and Dong Trieu

According to the RCP4.5 scenario, in the late 21st century, rainfall in Quang Ninh province is forecast to increase 29.8% against the 1986-2005 period and reached 1,900-3,500 mm. The increase is relatively high, but the problem is that there will be serious droughts and extreme rains which will cause serious damage to production and life of local people.

Unusual observed changes of rainfall in Quang Ninh:

Maximum and minumum values of rains appear more frequently. There was a heavy rain in late July and early August, 2015 in Quang Ninh causing serious damage to the province. It was heavier than other rains that have been observed in Quang Ninh since 1960. It was unusual, rare weather pattern not only in Quang Ninh but also in Vietnam's northern region.

Rainfall from 24/7 to 05/8/2015 (10 days) in districts, towns, and cities in Dong Trieu-Uong Bi-Quang Yen, Hoanh Bo-Ba Che-Binh Lieu, Tien Yen-Dam Ha reached 500-800 mm, in other coastal districts, towns, and cities: 1,100-1,300 mm, in Cam Pha: 1,600 mm. Rainfall in just 10 days accounted for ¼ to 2/3 of the annual average rainfall in the province, and almost surpassed the total rainfall of 1991.

Increasing rainfall during this period in some areas was higher than observed data in Quang Ninh in the last 55 years; in Cua Ong station it was 436.8 mm (26/7/2015), in Co To station 424.2mm (27/7/2015), in Bai Chay station 386.5mm (28/7/2015). Earlier, historical rainfall in Co To was 322.7mm (22/7/1986) and Bai Chay 350.4mm (21/7/1978).

On 26/9/2008, Tien Yen and Binh Lieu witnessed historical daily rainfall of 502.3mm in Tien Yen and 697.0mm in Binh Lieu. The rain in combination with high tides and water level rise due to effects of storms has caused serious damage to eastern districts and towns of the province.

1.3. Sea level rise situation Quang Ninh

Sea level in Quang Ninh (measured at Bai Chay station) was at 2.06 m on average during 1962-1979, reduced to 2.04 m during 1980-1999 and increased sharply in early years of the 21st century to 2.11m. So, in recent years, sea level rose 7 cm against the figure of the 1980-1999 period.

According to the RCP 4.5 scenario, in the late 21st century, sea level in Quang Ninh will possibly rise 53 cm. It is forecast to reach 2.64 m by 2100, with the highest tide in the province (4.70-4.74m); the highest sea level rise is likely to reach 5.23-5.27 m. However, according to storm risk forecasts by the Ministry of Natural Resources and Environment, water level rise due to storm in coastal areas including Quang Ninh province is likely to reach 4.0 m, and with the combination of high tides, water level can rise to 5.7-6.0m.

Coastal areas are likely to be the most affected: Mong Cai city, Hai Ha district, Dam Ha district, Tien Yen district, Van Don district, Quang Yen town, and Hoanh Bo district.

2. Priority solutions to respond to climate change in Quang Ninh

Climate change has affected all sectors, areas, and localities in Quang Ninh province. Coastal areas are the most vulnerable: Quang Yen, Hai Ha, Dam Ha, Tien Yen, Van Don, Hoanh Bo, Ha Long, and Mong Cai.

Climate change has affected the province's multiple sectors including water resource (increasing risks of pollution in water resources, reservoirs in residential areas, urban areas in 4 major cities in the province: Ha Long, Mong Cai, Cam Pha and Uong Bi, causing flooding in lower areas, areas with ineffective drainage systems, and areas in downstream of Ba Che river and Tien Yen; salinizing and alkalifying underground water, river estuary and coastal ponds, creating a flow of freshwater into saltwater water and brackish waters; aquaculture (mostly in Hai Ha, Van Don, Mong Cai, Quang Yen, Dam Ha and Tien Yen..); affecting agriculture (the province's main agricultural productiona reas include Quang Yen, Hai Ha, Dam Ha, and Dong Trieu; affecting forestry (mangrove forests, mainly in Tien Yen, Quang Yen, Van Don, Co To, affecting upstream protected forests, mainly in Binh Lieu, Ba Che, Tien Yen, Hoanh Bo, Cam Pha and along the Vietnam-China border corridor…); affecting industry and energy; construction-urban, tourism and people's life.

.In the conext of climate change, floods, flashflood, landslide, saltwater intrusion, sweetening saltwater , response capacity and community awareness are identified as urgent problems facing Quang Ninh province. Greenhosue gas emission, drought, freshwater shortage, and biodiversity degradation are issues of great concern of Quang Ninh province.

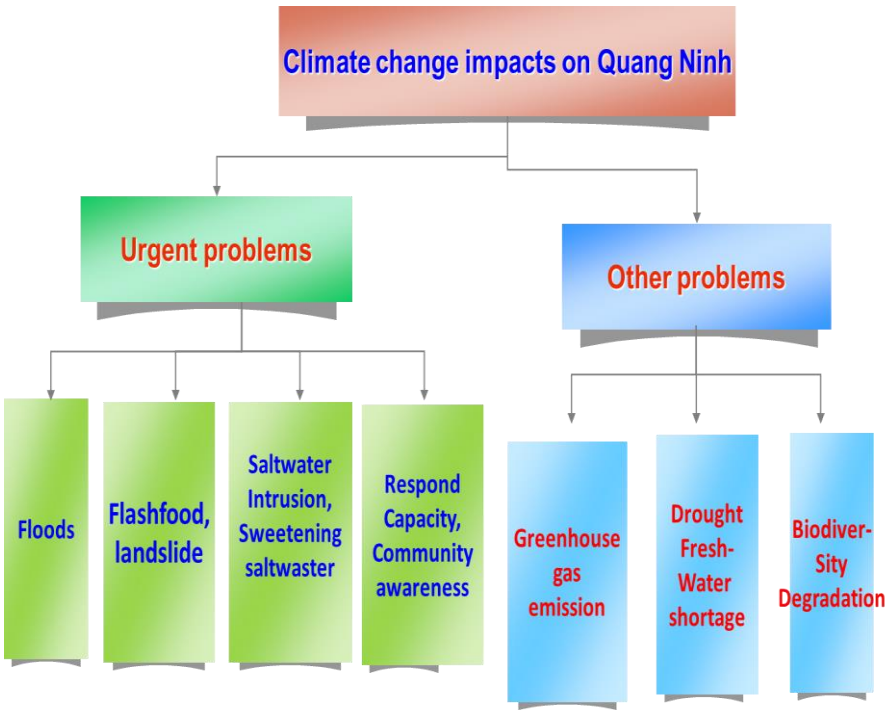


Figure 3. Climate change problems in Quang Ninh

2.1. Flooding, flashflood, and landslide

The main reason behind flooding is extreme rain (unusual heavy rainfall). Flooding is also caused by slow, ineffective drainage (due to increasing deposits in drainage systems, and blocks of water flow), breaks of reservoirs, coal mines, and dykes which strongly affect low-land areas and areas with ineffective drainage systems that are incapable to drain water in partial torrential rains (in the downstream of Ba Che river, Cam Pha, Ha Long, Ban Sen-Van Don, Ha Nam-Quang Yen).

Typically, torrential rain from 24/7 to 05/8/2015 in Quang Ninh caused partial floods in many urban areas in Cao Thang, Cao Xanh, Ha Khanh, Hong Ha, Hong Hai, and Yet Kieu ward in Ha Long city, Quang Hanh ward in Cam Pha city, Ban Sen commune, Van Don district was seriously flooded, Ban Sen commune was completely isolated, many residences were submerged to their roofs. Around 10,000 houses were damaged, 10 households in Mong Duong ward, Cam Pha city were completely submerged under water; 4,285 embankments collapsed, 248 transformers were seriously destroyed.

The historical rain on the night of October 29th and early 30th, 2014 caused flashflood in Quang Lam and Quang An communes, Dam Ha district, driving away most of seasonal dams of the two communes. Huge floods within a short time made water level in Dam Ha Dong reservoir increase suddenly, broke the sub-dyke No 02 and poured millions of cubic meters of water to the downstream, submerging several houses, fields, and fishery ponds.

In Quang Ninh province, 459 areas were blown off and flooded. Risks of landslide at dump and coal mining areas, steep hills, and areas by rivers and streams and low-land areas are high. Due to climate change, especially extreme rain, life and safety of local people are threatened by landslide and floods.

2.2. Saltwater intrusion and freshwater

Saltwater intrusion in rivers acidifies and salinize underground water and aquaculture ponds in coastal areas: Hai Dong, Hai Xuan, Van Ninh commune (Mong Cai); Dong Ngu, Dong Hai, Hai Lang commune (Tien Yen); Dam Ha, Bai Dinh, Tan Lap, and Tan Binh commune (Dam Ha); Quang Minh, Phu Hai commune (Hai Ha); Ha An commune and Ha Nam island with 4 communes: Nam Hoa, Yen Hai, Phong Coc, and Phong Hai and 4 communes of Cam La, Lien Hoa, Lien Vi, Tien Phong (Quang Yen town). It's estimated that the area affected by saltwater intrusion covers 1,800 ha and total damage was about 30 billion VND.

Typically, in Hai Dong commune (Mong Cai) and Dong Hai commune (Tien Yen), each commune has more than 50 ha of vegetable crops and aquaculture production being affected by saltwater intrusion caused by sea level rise and high tides (in recent 10 years), and being deserted.

In addition to saltwater intrusion in the mainland and underground water, sweetening in brackish water and saltwater areas has affected Quang Ninh province. Around 300 ha of saltwater aquaculture were damaged due to fresh water intrusion caused by the historical flooding from July 25th to August 5th, 2015 (saltwater level reduced from 21‰ 8‰, even with the sample taken at the depth of 3-4m).

Due to climate change, natural disasters and extreme weather have caused serious losses for Quang Ninh province over the past years:

Table 1. Total loss caused by natural disasters and extreme weather in Quang Ninh

Year	Death	Missing people	Property losses (billion dong)
2012	02	01	65
2013	04		228
2014			173,5
2015	17		2.700
2016	02		54,3

3. Priority solutions and tasks to respond to climate change in Quang Ninh province

Based on the climate change situation and impact forecast, vulnerability and risks, the province has worked out a number of priority solutions and projects until 2020:

1. Developing hydro-power and hydro-meteorology models to support anti-floods efforts in Quang Ninh province.

2. Developing flood and landslide monitoring and early warning systems in Quang Ninh.

3. Strengthening capacity in co-management and building sustainable livelihood models in combination with conserving mangrove forest biodiversity in Dong Rui commune, Tien Yen district.

4. Providing technical support, human resource training in climate change response and improving public awareness and response to climate change.

5. Piloting climate change adaptive sustainable aquaculture livelihood model in Tien Yen district, Quang Ninh, withdrawing experience and duplicating the models in 5 coastal provinces in the Red River Delta.

6. Inspecting the safety of dams in medium and large reservoirs in Quang Ninh.

7. Building, upgrading drainage systems in Ha Nam island area, Quang Yen town.

8. Upgrading, consolidating, building embankment along Tien Yen river, Quang Ninh province.

9. Improving awareness and understanding for students about climate change through extra-curriculum activities and integrating climate change in school curriculum at all school levels in Quang Ninh province.

10. Installing flood early warning system and cameras to monitor water levels in major canals of medium and large reservoirs in Quang Ninh.

11. Minimizing flooding risks in Cam Pha city

12. Zoning the protected areas and recovering the coral reef ecology, and mangrove forests in Ha Long Bay.

13. Devising detailed plans on areas to evacuate people from landslide affected and dangerous flooding areas at the foot of dump areas and coal mining areas in Quang Ninh province.

14. Evaluating greenhouse gas and measurement, review, and verification system in Quang Ninh.

15. Inspecting, consolidating river and dyke system in combination with growing mangrove forests in Ha Nam, Quang Yen town.

16. Developing a database on hydro-meteorology and disseminate information on law, and information on hydro-meteorology in Quang Ninh province.

17. Upgrading drainage systems in some urban areas that are regularly prone to floods in Cam Pha city, Quang Ninh province.

18. Devising sea level rise action plan for cultural, natural heritage sites, key maritime tourist spots in Quang Ninh province.

19. Building dams to protect residential areas in island villages in Thanh Lan commune, Co To district, Quang Ninh province.

20. Inspecting, consolidating dams of the saltwater-prevention dykes and sea dykes in Dong Rui commune, Tien Yen district, Quang Ninh province.

21. Building dykes for Sen river, drainage system and waste treatment systems in the north and south of Sen bridge, Uong Bi city.

22. Research, updating the database of biodiversity values of Ha Long Bay World Natural Heritage Site and developing response measures against climate change and sea level rise.

CONCLUSION

Climate change is affecting all sectors, areas, and localities in Quang Ninh province. Responding to impacts of climate change is necessary and urgent in the current context. Quang Ninh province has identified its fundamental solutions to respond to climate change which include priority solutions to respond to natural disasters caused by lcimate change and protect the environment of each sector, solutions to mitigate climate change, particularly in the energy sector that needs great attention to reduce greenhouse gas emission.

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