

CHAPTER 6 - CLIMATE AND CLIMATE - RELATED DISASTER PROFILE OF QUANG BINH

Introduction

This chapter provides information on the current climate of Quang Binh, and the history of climate-related hazards and disasters that the province has already faced for many years. It identifies the districts and communes of the province most affected by each type of disaster, and provides details of the type and amount of damages caused. Finally, it recommends priority geographic and thematic areas for Ecosystem based intervention in Disaster Risk Reduction (Eb-DRR) and climate-change adaptation (EbA) based on the analysis provided.

1. Climate of Quang Binh

Quang Binh Province is located in the tropical monsoon zone, but the local climate is complex and differs between locations, strongly influenced by topography. From a temperature perspective the year can be considered as having 2 main seasons, the warm season from April to September with an average temperature of about 35°C and cool season from October to March with an average temperature about 22 - 25°C. Overall annual average temperature is about 24 - 25°C, increasing from North to South and decreasing from East to West. In the mountainous areas, the daytime and night-time temperature differences can be as much as 9 - 10°C in compared with 7 - 8°C in the plains (Nguyen et. Al., 2013) In the warm (dry) season, the south-westerly monsoon wind blows strongly through the Truong Son Mountains, the natural border between Vietnam and Lao, leading to extremely hot and dry weather and known colloquially as the “Lao wind”. Each year there are about 40-48 hot-dry days with temperatures over 35°C. Conversely the north-easterly monsoon brings a mostly cold and dry air mass and temperatures can drop considerable in January and February. Wind speed during rainy season is usually higher than in dry season.

Table 6.1: Monthly average temperature in 2012 (°C)

Month	1	2	3	4	5	6	7	8	9	10	11	12	Mean
Temperature	17.8	18.5	21.4	26.3	29.2	30.1	29.7	29.2	26.8	25.6	24.8	21.5	25.1

Source: Year book Quang Binh province 2013

From the perspective of precipitation, there are two distinct seasons in the Province, i.e., the dry season, which lasts from November to April and the rainy season from May to early November. 80-90% of total annual rainfall occurs in the rainy season. According records from 1961 - 2009, the average annual rainfall is 2,000 - 2,300 mm/year, while the maximum and minimum annual rainfall are 3,092 mm (in 1964) and 1,570 mm (in 1969), respectively (SNREC, 2010) The average annual rainfall has slightly decreased over time, by an average of about 8 mm/year (Nguyen et al. 2013). Average number of rainy

days is about 152 days/year, mostly concentrated during the period from September to November, accounting for 56-65% of the total annual rainfall. Precipitation is not evenly spread across the province. Highest average precipitation occurs in Huong Hoa (2,715mm), while lowest annual precipitation is in mountainous areas and southwestern valleys in Quang Phuc (1,683mm) and Quang Luu (1,892mm), as well as in Ron (1,898mm) and Trooc (<2,000mm). On average, every year Quang Binh encounters five to six storms and/or tropical depressions. From 1955-1984, there were 43 hurricanes directly landing in the province, mostly in August, September and October. Heavy rainfall concentrated in brought by storms combined with the steeply sloping terrain and fast-flowing rivers often results in widespread flooding, especially when combined with periods of high tides (ISPONRE, 2009).

Table 6.2: Monthly average rainfall in 2012 (mm)

Month	1	2	3	4	5	6	7	8	9	10	11	12	Mean
Rainfall	38.3	11.0	17.5	82.2	154.7	82.6	123.2	145.2	547.0	281.9	156.8	103.7	145.3

Table 6.3: Main weather characteristics in three meteorology station in Quang Binh

Type of climate	Tuyen Hoa station	Ba Don station	Dong Hoi station
Average annual temperature	23.8 °C	24.3°C	24.6°C
Lowest temperature	5.9°C (Jan)	7.6°C (Dec)	7.7°C (Jan)
Highest temperature	40.1°C	40.1°C	42.2°C
Average annual rainfall	2,266.5mm	1,932.4mm	2,159.4mm
Annual number of rainy days	159 days	130 days	135 days
Highest daily precipitation	403mm	414mm	415mm
Annual number of low rainfall days	18 (Jan, Feb, Mar)	09.3 (Nov)	17 (Dec)
Average air humidity	84%	84%	83%
Average minimum humidity	66%	67%	68%
Foggy days	47 (Jul, Aug, Sep)	20 (Sep, Oct)	13.8 (Sep, Oct)
Water evaporation	1,031mm	1,035mm	1,222mm
Coordinates			
North latitude	17°50'	17°45'	17°-29'
West longitude	106°08'	106°25'	106°37'
Elevation above sea level	25m	8m	7m
Observed years	1961 - 2000	1960 - 1999	1900 - 2000

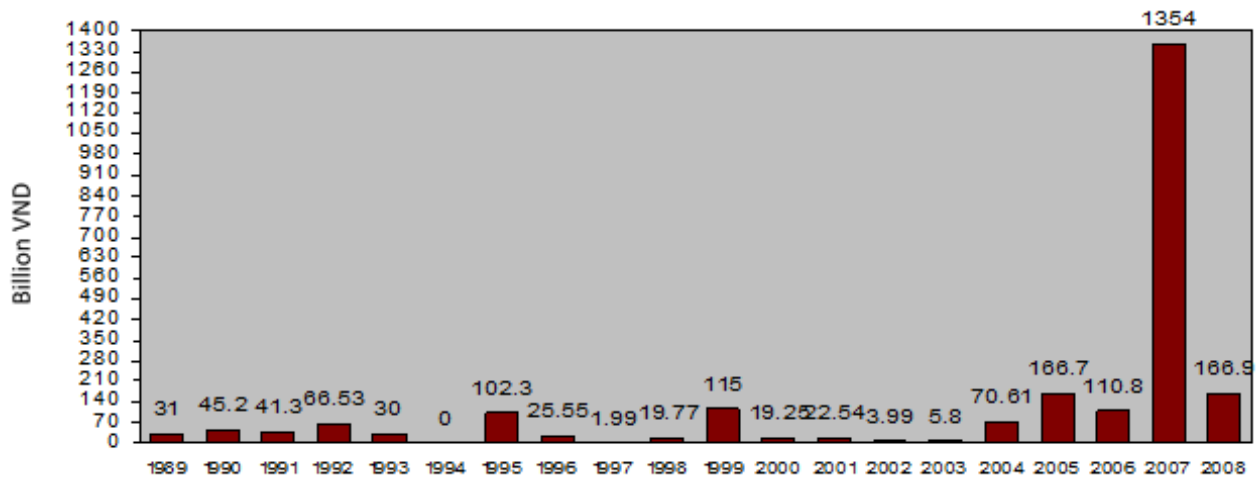
2. Climate Hazards and Economic Costs of Disasters in Quang Binh

Quang Binh is one of the twenty most hazard prone provinces in the country (CCFSC). The province is particularly vulnerable to storms, floods, whirlwinds, river and sea bank erosion and salinity intrusion. During the rainy season, storms and tropical low pressure systems often cause heavy rains and tidal floods, resulting in inundation in lowland regions and flash floods in mountainous and hilly areas. Due to the particular

topography of the province, all the rivers of Quang Binh are relatively short and steep. When storms bring heavy rains, then combined with the nature of the river system this often results in floods with a very rapid onset with high velocity flows and high erosive power. Floods usually occurring from Aug to Oct are considered a normal feature of life in Quang Binh Province. Other types of natural hazard in the Province are early floods, which occur from Apr to Jun, whirlwinds, thunderstorms and salinity intrusion.

The average number of events reported per year (referred to as “data cards”) in Quang Binh is eleven. In most cases when a disaster happened, particularly as a result of storms and typhoons, it affected all seven districts in the province. Heavy rainfall and floods in some cases affected the whole province, while in other cases had more localized impact. These hazards have a significant impact on the province’s economy, natural resources and the lives and livelihoods of the population (see Figure 6.1, and Table 6.4).

Figure **Error! No text of specified style in document.**1: Estimated economic loss due to natural disasters in Quang Binh (1989 - 2008)



Source: Quang Binh Department of Irrigation, Flood and Storm Control

Table 6.4: Statistics of damage caused by natural disasters from 1989 to 2008

Year	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Mortality	5	13	2	39	13	0	35	4	15	23
Injury	6	7	2	7	32	0	12	5	1	2
Loss (billion VND)	31.0	45.2	41.3	66.53	30.0	-	102.3	25.55	1.99	19.77
Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Mortality	33	5	10	5	5	3	17	9	25	12
Injury	12	0	1	0	1	3	8	8	148	46
Loss (billion VND)	115.0	19.25	22.54	3.99	5.8	70.61	166.7	110.8	1354.0	166.9

Source: Quang Binh Department of Irrigation, Flood and Storm Control

3. Overview of disasters and their impact in Quang Binh over the period 1997-2010

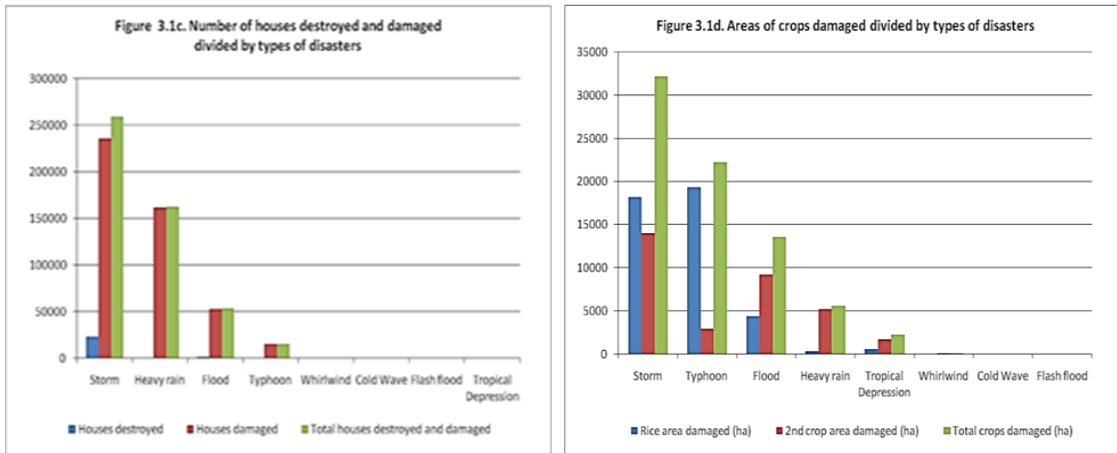
Storm (65 data cards) is the most reported disaster type accounting for 45% of the reported events. Flood (32 data cards, 22%), typhoon (17 data cards, 12%) and heavy rain (15 data cards, 10%) were the next most frequent disasters. Other less frequent disaster types were whirlwind (5%), tropical depression (4%) and cold wave (1%). Taking into account the inconsistent classification of disaster types in Vietnam, if tropical depression, storm and typhoon are combined under one large 'storm' category, this accounts for 61% of all disasters occurrences; combining heavy rain and flood accounts for 32%.

Over the period 1997-2010, 151 people died in Quang Binh due to disasters, making an average of 12 deaths per year. Storm is the most fatal disaster type with over 65 people killed, accounting for 43% of the total number of deaths in the province. Heavy rain was the second most fatal with 58 deaths (38%) and flood the third with 14 deaths (9%). Other disaster types, such as typhoon, tropical depression and whirlwind, caused fewer deaths and combined, account for around 9% of deaths over this period. Flash floods and cold waves did not cause any reported fatalities.

Storm and heavy rains had the highest impacts on houses destroyed or damaged, followed by floods and typhoons. Whirlwinds had negligible impact and cold wave, flash flood and tropical depression do not have any reported impact on housing. Storms, typhoons and floods caused the most damage to rice paddies and other crops.

Heavy rain and tropical depressions also caused damage to agricultural production, while negligible to no damage was caused by whirlwinds, cold waves and flash floods.

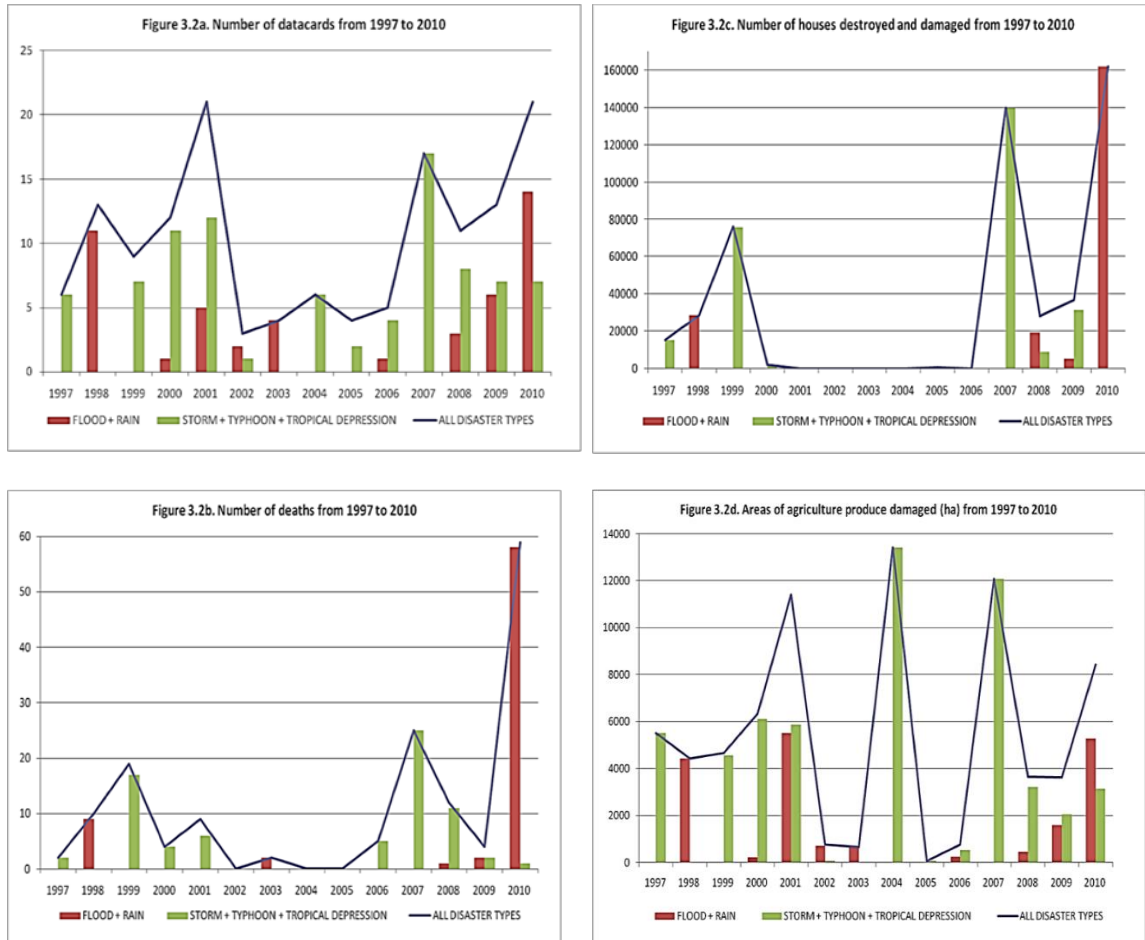
Figure **Error! No text of specified style in document.**2: Houses and crops destroyed/damaged by disasters



Source UNDP, 2012

Examining the trend line for all disaster types, there appears to be an increasing impact on lives, housing and agricultural production over time, although there is a gap in reporting for damage to housing between 2001 and 2004.

Figure **Error! No text of specified style in document.**3: Temporal trends in number of events reported, number of deaths, houses destroyed and damaged, and agricultural produce houses destroyed and damaged



Source: UNDP, 2012

Districts in the central and south of the province have reported more disasters than districts in the north. The most southern district, Le Thuy, has been impacted by most events - 26. Quang Ninh and Bo Trach districts follow closely, with 24 and 21 respectively. Dong Hoi City in the center of the province is the least affected by disasters with only 17 reported events.

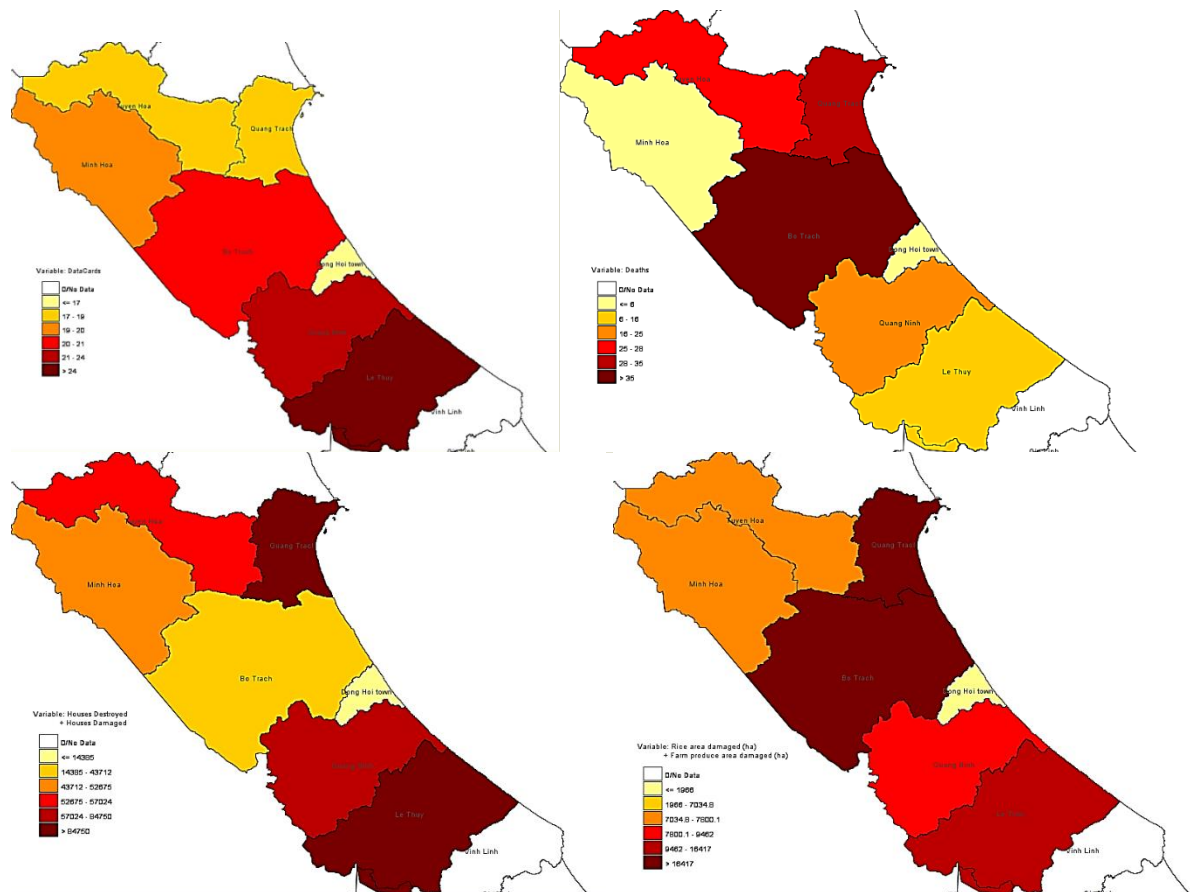
Examining fatalities over this same period, Bo Trach is the most affected district with 37 deaths, followed by Quang Trach, Tuyen Hoa and Quang Ninh with 35, 28 and 25 deaths respectively. Dong Hoi and Minh Hoa have the least number of deaths with 6 deaths in each district.

On the other hand, Le Thuy and Quang Trach experienced the most damage and destruction to housing over the period, with over 100,000 houses damaged or

destroyed. Quang Ninh district follows with almost 85,000 damaged and destroyed houses. Tuyen Hoa and Minh Hoa also each have more than 50,000 houses destroyed and damaged over the same period. Dong Hoi is the least affected with approximately 14,000 houses affected by disasters.

Bo Trach and Quang Trach districts are where agriculture is the most impacted, closely followed by Le Thuy. All three districts lost more than 16,000ha of rice and other produce over the period. Again, for agricultural impact, Dong Hoi is the least affected as its economy is much less focused on agriculture compared with other districts.

Figure **Error! No text of specified style in document.**4: Spatial distribution of (a) all reported events (b) deaths (c) houses destroyed and damaged and (d) agriculture produce damaged or all disaster types



Source UNDP, 2012

Seven districts in Quang Binh are prone to direct impacts of storms, namely Le Thuy, Quang Ninh, Quang Trach, Bo Trach, Dong Hoi City, Truong Xuan and Truong Son. Residential and seafood processing areas are concentrated along the coastline and in river mouths. These areas are directly affected by many storms, some with wind speeds of over 30m/s. Fishing during the storm seasons is usually dangerous for fishermen as

storms and tropical depressions are happening with stronger and harder to predict intensity. The highest recorded damage was in 1995 inflicted by the 11th hurricane with total of 564 vessels sunk or damaged. Heavy rain, hurricane and cyclones also affect the economics of the seaport. In June 2009, there was a level 7-8 cyclone in the vicinity of Hon La port that snapped anchor chains and capsized 10 berthed ships.

Six communes in the lowland areas of Quang Ninh district are seriously affected by flash floods: Tan Ninh, An Ninh, Hien Ninh, Xuan Ninh, Van Ninh, Duy Ninh, and Ham Ninh. These areas are surrounded by dykes therefore water cannot escape when flooding occurs. Flooding usually happens 3-4 times every year, blocking transport in the district. After each flood season, diseases like pinkeye epidemic, dengue, or diarrhea affect public health.

4. *Details of specific climate-related disaster events*

1) STORMS

In Quang Binh, storms normally occur from July to September causing damage to property, crops, and loss of life. Statistics from 1989 to 2008 showed that 13 major storms hit Quang Binh with an average of 0.7 storms per year. Some years have no storm, but other years may have 2 or 3 consecutive storms. The severe impact caused by storms including whirlwinds typically lasts 2-5 days with heavy rain causing serious flooding problems. The total rainfall volume contributed by storms and low pressure cyclones accounts for approximately 40-50% of the total rainfall during the rainy season.

According to observed data between 1999 and 2008, the province was attacked by 8 storms and 36 tropical low pressure cyclones (an average of about 4 storms/cyclones per year). In recent years, there has been an increase in the number of storms and the degree of dangerous levels. It appears that predictions about directions of storm tracks are often unreliable thereby creating difficulties for flood and storm protection preparations.

In November 1999, a large flood resulting from storm Eve (#9) at the end of October, resulted in 19 deaths and 79,000 houses damaged or destroyed. This event was reported under the 'storm' category.

In 2001, tropical storm Trami (#5) in mid-July and a flood caused by a tropical depression mid- October, resulted in a considerable damage to agricultural produce.

In June 2004, although not resulting in a large number of deaths or major damage to housing, storm Chanthu (#2) did cause serious damage to rice and other crops (13,500 ha).

In 2006, storms #5, and #6 caused 5 heavy floods, killing 9 people, with a total estimated economic damage of VND 111 billion.

In 2007 Storm #2 in Aug (internationally classified as a tropical depression rather than a storm) and Storm #5 (Lekima), caused heavy rain in the Gianh River Basin, leading to a historic flood of 9.47m in Mai Hoa commune. Storms #2 and #5 combined killed 25 people and injured 148 others, damaged 139,000 houses (7,692 seriously) including 270 houses that collapsed or were swept away. The storms also sank 22 ships, destroyed 560 hectares of vegetables and flooded 2,420ha of rice and other crops, as well as 51 hectares of aquaculture. In addition, 305 electricity poles, 129 bridges and culverts, 140 classrooms, 160 clinics and healthcare centers were heavily damaged. Many rubber tree plantations were devastated by powerful winds, inflicting serious damage to the rubber sector of the province. A massive amount of water inundated the lower Gianh River for an extended duration. Amongst other things this also caused the death of mangrove trees in the estuary and damaged the aquaculture sector. Total estimated economic damage was almost VND 1.4 trillion.

In September 2008, storm #7 (Higos) swept across Quang Binh with strong winds of level 9 and 10 and gusts of level 11. The storm killed 12 people and injured 46 people. 8,221 houses were damaged with lost roofs, 52 houses collapsed or were swept away, 01.8 hectares of rice, 859 hectares of other crops, 826 hectares of industrial and fruit trees, 3,061 hectares of forest, 748 hectares of aquaculture, 28 ships, 260 classrooms, 82 healthcare facilities, 252 welfare centers, 85 community culture houses and 398 electricity poles were destroyed. The total loss was more than 167 billion VND.

In 2009, storm #9 and the floods and tornados it caused killed 4, injured 13, and knocked down 31 houses, with a total estimated economic damage of 135 billion.

In 2013 Typhoon Wutip, a category 2 typhoon hit Dong Hoi on 30 September leaving 5 dead and estimated damages over VND 4,000 billion.

II) **FLOODS**

A total of 23 flood events (an average of 3.1/year) happened in the period 1979-2010. Historically, major floods happened in 1985, 1992, 1993, 1996 and 2005. In the last 10 years, major floods have happened in 2006, 2007, 2008, 2010, and 2013 with severe impacts including loss of life, damage to property and economic losses of billions of Vietnamese Dong. Floods appear to be happening more unexpectedly, and particularly the 2007 and 2010 floods have significantly damaged summer-autumn crops and seasonal rice. Four significant and prolonged floods during the 2006-2010 period are described as follows:

1. In 2006 Quang Binh was attacked by some storms and tropical low pressure cyclones, resulting in 5 floods, of which 3 reached warning levels II and III in the Gianh River, Kien Giang River and Dai Giang River. The massive rainfall had caused deep inundation over the Province. Water levels in the Gianh River were above the warning level II, and water levels in the Kien Giang River in Phan Xa Commune were measured at 13,32m, 0.32m higher than the warning level III.

Total economic losses caused by these 5 floods were more than 110 billion VND. In total 9 people died, 8 were injured, 13,829 houses were flooded, and 21 boats were destroyed.

2. The historical flood in August 2007 was caused by a tropical low pressure cyclone with prolonged and heavy rain. This was the biggest flood recorded in the Province, whose water level exceeded the historical flood level recorded in 1993 (64cm). It was reported that 16 people were killed, 78 people were injured, 68 towns and 95,009 households were flooded (8,278 and 8,870 households were flooded under 2m and 4m, respectively); 3,655 households collapsed, were swept away, or completely destroyed; 6,002ha of rice were lost; and 122,024 poultry animals were killed. Infrastructure and business assets were severely damaged. The total loss exceeded 810 billion VND.
3. In 2008, Quang Binh Province experienced three consecutive floods. The first one was from 29-30 Sep, caused by moderate to heavy rainfall, which ranged from 130mm to 375mm. The second storm occurred from 18-20 Oct, caused by heavy rain patterns throughout the Province. The third storm happened during 28-30 October with strong winds and rainfall. All the rivers in the Province were flooded. Water levels exceeded warning level III. These storms and flooding events destroyed 19,356 houses. The total loss was more than 55.9 billion VND.
4. In 2010, a historic flood happened in Oct, killing 59 people and injured 239 others, inundating 106 communes in 6 districts, washing away 419 houses and thousands of hectares of rice and crops, and killing many cattle and poultry. 35,000 houses were flooded, many to a depth of 1-2m. Total estimated economic damage to the province was over 2,734 bn. The floods drove up the water level in the Son River to a record high, causing the Centre for Eco and Social Tourism at Phong Nha Ke Bang to be submerged under 5-7m of water - all the equipment for tourism activities was destroyed and swept away, the two river banks were severely eroded, and the boat landing damaged. The strong current in the Phong Nha cave cracked some stalactites and stalagmites, and part of the cave collapsed. The tourism infrastructure at Thien Duong cave (a newly discovered cave recently opened for tourism) was similarly severely impacted, and investors suffered losses estimated to be hundreds of millions of Vietnamese dong. This disaster was recorded in the database as 'heavy rain' rather than flood.

During the rainy seasons the mountainous areas of the province such as Truong Xuan and Truong Son communes in Quang Ninh District are usually exposed to flash floods causing damage to life, crops and property. Flood in 1992 wiped out Tan Son village in Truong Son. In the 2007 flood many villages in Truong Son were completely isolated. In addition, flooding usually occurs with serious impacts on communes along the Giang River including Van Hoa, Chau Hoa, Thanh Hoa, High Quang, and Tien Hoa. Along the

river banks, severe erosion up to 50 - 70 cm p.a. can occur and families residing along the riverbank are forced to relocate.

Many transport routes have been severely eroded and damaged by floods. Routes that run through mountainous communes have been particularly affected by ferocious flash floods, including route 20 and 12A heading to the Cha Lo international border crossing; route 559 and routes leading to villages in Thuong Ha commune (Minh Hoa district). Serious landslides often happen in Da Deo pass, north of U Bo Pass, Khu Dang Pass, in Tan Ap commune (in Minh Hoa); Tan Trach (in Bo Trach); Truong Son (in Quang Ninh); as well as in Lang Cat and Lang Ho (in Le Thuy). In the rainy season of 2010 alone, the Ho Chi Minh Road experienced serious landslides at 10 different places blocking transport in the mountainous areas, while in lower lying areas the Ho Chi Minh Road and National Road 1A had sections which were inundated to a level of over 1 meter for several kilometers along their length.

There are 172km of railway lines and 19 stations in Quang Binh, including the main one at Dong Hoi. Due to harsh weather conditions, many railroad sections running through Quang Binh are already in a degraded condition. Every year, the system of waterway transportation also suffers damage in the flooding season. Many ferries, boats and vessels have been swept away. When road traffic is cut off in many areas, residents must use small and often unsafe boats to travel around. Nearly every year during the flood season, there are accidents with boats capsizing and human casualties.

Flood events not only cause huge life and property damages, but also serious environmental pollution in inundated areas with serious public health consequences. Faeces, garbage, waste water, effluents from livestock pens, dead bodies of some animals, and industrial wastes may all end up in the flood waters. Trees and crops also die killed from prolonged immersion in water. According to reports from the Steering Committee for Storm and Flood Prevention of Quang Binh, 108,472 household wells were submerged during the 2010 flood season, including 32,000 in Quang Trach, 27,500 in Le Thuy, 16,500 in Quang Ninh, 15,977 in Bo Trach, 8,977 in Tuyen Hoa, 3,939 in Dong Hoi city, and 3,579 in Minh Hoa. Wells were polluted with microbial organisms, causing subsequent health problems.

III) SEA LEVEL RISE, COASTAL EROSION AND SALINIZATION

Historically sea level has been rising at an average rate of about 3mm/year over the last two decades. Several parts of the coastline are already severely eroded. For example in parts of Nhan Trach commune in Bo Trach District, the sea encroaches 30-40cm every year causing many houses to crack and collapse. Many hectares of crops and home gardens have been lost and residents have had to migrate further inland.

Rising tides in conjunction with the North East monsoon push salt water further up rivers and into the mainland. Saline water can seep under the bases of dykes and into agricultural fields.

In-field salinization of Quang Binh's coastal plains is already a problem. Increased salinity has damaged agricultural production. Saltwater causes productivity to drop significantly, especially for the Winter-Spring crops.

IV) EXTREME COLD

Cold weather typically occurs from late January to the end of February. In 2008, cold weather winds decreased temperature to a very low level over the entire province. This prolonged and extreme cold weather event caused serious damages to livestock, killing 1,742 buffalos, 3,037 cows and 1,334 goats. Temperature reduction in recent winters and springs has led to severe frosts which have harmed local rice varieties (mainly HT6, HT1, SH2, TBR1, hybrid rice).

V) WHIRLWINDS, TORNADOS AND BLOWING SAND

Whirlwinds often occur during the transition period between dry and wet season (March-April). For instance, on March 18, 2008, a whirlwind occurred in Kim Hoa and Le Hoa communes, in Tuyen Hoa district, with gusts above level 8. The whirlwind was accompanied with hail, which had a diameter of 1.0 to 2.0 cm, and damaged 9 classrooms, 131 houses and 15 hectares of maize. Tornados often blow the roofs off houses in Duy Ninh and Hien Ninh communes, also damaging rice and other crops. Tornados and thunderstorms have been more unpredictable in recent years.

Vo Ninh and Gia Ninh communes in Quang Ninh district are seriously affected by blowing sand. So is Hai Ninh Commune, with over 100ha of coastal sand dunes without windbreak trees, causing serious problems affecting many residents in coastal villages including Tan Hai, Tan Dinh and Xuan Hai. During storm seasons, yards and gardens and even houses are covered with sand. Many families have to evacuate or relocate themselves, but some 100 households are still living with blowing sand and flowing sand. Many roads connecting villages are covered by sand, restricting accessibility.

In Hong Thuy, Thanh Thuy, Cam Thuy, Hung Thuy, Sen Thuy communes of Le Thuy district near National Road 1A, rain with even relatively light intensity can already fill streams with water and cause sand to flow at high speed and cover arable land. It is estimated that each commune loses 2 ha p.a. on average. The three coastal communes of Ngu Thuy Bac, Ngu Thuy Trung and Nguy Thuy Nam are less affected. As a result of the 2010 flood in Le Thuy, many areas suffered sand deposited up to 1.5m high, and people had to abandon their fields which were no longer arable. Many parts of concrete roads along the coastline were cracked and damaged by these unexpected streams.

Coastal residents were also caught by surprise by the formation of streams on sand dunes and suffered significant damage when floods occurred.

1. DROUGHT AND HOT DRY WINDS (LAOS WIND)

Some 30-40 communes in Quang Binh are regularly affected by drought and water shortages. In addition, Quang Binh is also impacted by hot dry winds, the so-called "Laos wind", that occurs from January to August, but mainly from Apr to Jul. The hot wind accelerates the evaporation rate and reduces both humidity and soil moisture, adding to the severity of any drought and water shortages.

In 1998, 2002, 2003 and again in 2005, low rainfall and hot dry winds limited the water supply available for domestic uses and irrigation. The water level in many reservoirs such as Phu Vinh, An Ma, Tien Lang, Cam Ly, Vuc Sanh, Dong Ran, and Be, was very low due to a combination of reduced rainfall inflow and increased evaporation, and was unable to supply irrigation needs. Additionally, saltwater intrusion deepened the problems during the drought period, intensifying the damage to agricultural production.

The 1998 drought was the most severe in 30 years. 312,000 people (38.8% of the provincial population) in 65 out of 148 communes had restricted use of clean water. This drought severely affected 25,600ha of rice during the winter-spring season. It was estimated 9,700ha of rice, 436 hectares of sugarcane, 280ha of rubber trees, and many hectares of coffee plants were destroyed. Many parts of Kien Giang River dried out. Approximately 150 meters of the river bank were severely eroded, and many houses and roads were destroyed, resulting in a total loss of about 193 billion VND.

In 2003, the drought diminished production yield by 18,547 tons of rice, 270 tons of green beans, and 12,960 tons of sugarcane. The total losses exceeded 32 billion VND.

In 2005, water levels in reservoirs declined so severely there was not enough water for production, leading to serious crop failure and damages: 3,745ha of rice and 1,048ha of other crops were lost, while an additional 5,064ha suffered yields reduced by at least 30%. Total damages were VND 58bn.

Water supply facilities are still scarce scene in mountainous areas. Tuyen Hoa and Minh Hoa are the two mountainous districts most seriously affected by droughts. During severe dry seasons, irrigation facilities can sometimes be left with no water. In 2010, by June, none of the reservoirs in Minh Hoa could be used for irrigation. Minh Hoa district had 50 out of 460ha of paddy fields and 100 and of 844ha of maize fields of the winter-spring crop completely destroyed due to drought and insects, mostly in Dong Hoa, Yen Hoa, and Trong Hoa. Drought decreased the productivity of the remaining winter-spring crop by about 15-20%. Tuyen Hoa also suffered from serious water shortage causing tremendous hardship to farmers.

In Quang Trach District 4,800 out of 5,550ha of cultivated land of summer-autumn crops was left without sufficient water, and Quang Ninh completely lost 60ha of maize and a large area of paddy fields due to early drought. Land was cracked dry and abandoned as it was no longer arable. Similar situations happened in many places in Bo Trach, Nam Thien and Le Thuy. In all, thousands of hectares of the summer - autumn crops were lost. The Gianh River, the biggest and deepest river in Quang Binh, ran dry, exposing its riverbed.

In Minh Hoa the when the drought was followed by sudden rains Rice leaf folder and Sheath Blight outbreaks appeared in many places such as Quy Dat, Hoa Hop, Quy Hoa, Xuan Hoa, Yen Hoa, which prevented large areas of rice in the flowering stage from generating grains.

Summary and Conclusion

Storms (45%) together with heavy rains and floods (32%) are the most frequent sources of climate-related disaster events in Quang Binh. Storms, heavy rains and floods together account for 90% of all fatalities associated with disasters, most of the damage to housing and agricultural fields, and a high proportion of the economic losses caused by disasters.

The central and southern parts of the province are more heavily affected by disasters than the northern parts. Le Thuy District has the highest number of recorded disaster events overall, and also suffers the most damage to housing. Hong Thuy, Thanh Thuy, Cam Thuy, Hung Thuy, Sen Thuy communes of Le Thuy district also suffer from blowing and flowing sand that degrades agricultural land. Bo Trach has the most deaths caused by disasters and the most damage to agricultural fields overall. Quang Ninh and Quang Trach are the third and fourth most heavily impacted districts. Agricultural production in Le Thuy, Bo Trach, Quang Ninh and Quang Trach has all also been significantly impacted by droughts.

The least affected areas in terms of total damages and loss of life are Dong Hoi city, followed by Minh Hoa and Tuyen Hoa, the two mountainous and least populated districts of the province, (explaining the smaller impact on housing and agricultural production). However, Tuyen Hoa district has the third largest number of deaths in the province, occurring mainly during Storm Lekima in October 2007 and the historical floods of October 2010. Tuyen Hoa and Minh Hoa are also affected by droughts, and Kim Hoa and Le Hoa communes in Tuyen Hoa have been severely impacted by whirlwinds and hail storms.

The time series of comparable data available is not yet sufficient to conduct robust statistical analysis, to suggest whether or not the number of disaster events and their intensity are showing clear trends. What clearly stands out however, is that the recorded total economic damage caused by disasters has increased dramatically over

a 25-year period (see Table 6.5, below). Again it is not possible to say definitively how much of this increase in recorded losses is due to actual increases in damage caused by disasters; how much is due to higher monetary values being assigned to each instance of damage; and how much is due to improved data collection and reporting about damages.

Table 6.5: Summary of climate-related disaster information 1989-2013

Time Period	Total # disasters recorded	Loss of Life	Total Economic damage
1989-1993	N/A	72	214 billion VND
1994-1998	N/A	77	150 billion VND
1999-2003	47	58	166 billion VND
2004-2008	40	66	1.9 trillion VND
3009-2013	34 (2009 +2010 data only)	68	6.7 trillion VND (2009, 2010, 2013 data only)

Source: Compiled from information from Quang Binh Department of irrigations, Flood and Storm Control, and UNDP 2012

In conclusion, highest priority should be given to ecosystem-based disaster risk reduction and ecosystem-based climate change adaptation in Bo Trach, Le Thuy, Quang Ninh and Quang Trach; followed by Truong Xuan, Truong Son, Tuyen Hoa, and Minh Hoa. The primary emphasis should be on addressing impacts of storms and floods on human life, housing and agricultural fields. A secondary emphasis should be on addressing impacts of drought, and of blowing and flowing sand in affected lowland communes.

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