



TEMPORAL AND SPATIAL TREND OF CLIMATE VARIABILITY IN VIETNAM

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ABSTRACT

Vietnam's long coastline, geographic location, and diverse topography and climates contribute to its being one of the most hazard-prone countries of the Asia-Pacific region. Given that a high proportion of the country's population and economic assets are located in coastal lowlands and deltas, Vietnam has been ranked among the five countries likely to be most affected by global climate change. This paper aims at providing a short overview on the temporal and spatial trends of climate variability in Vietnam which affected by global climate change.

Keywords: Climate change, Climate variability, Temperature, Rainfall, Sea level rise, Vietnam.

Contribution/ Originality

This study documents the temporal and spatial trends of climate variability in Vietnam which affected by global climate change.

1. INTRODUCTION

Vietnam with its geographical coordinates (latitude 16°0'N; longitude 106°0'E) straddles a wide range of latitudes (8-23° north of the equator) and thus experiences a range of climates. The southern regions of the country sit close to the equator, experiencing a tropical climate whilst the northern regions of the country reach into the humid subtropics, where there is greater seasonal variation. The majority of rainfall in Vietnam is caused by monsoon circulations which bring heavy rains in May to October in the north and south, and from September to January in the central regions. The mean monthly rainfall in the wet season is 200-400 mm. The long coastline of Vietnam is also vulnerable to the Pacific tropical cyclones between June and November, which contribute significantly to wet season rainfall total. The northern regions experience more distinct seasonal variations in average temperature than the south. In the northern provinces, the average temperatures drop to 15-20°C in winter from summer temperatures of 22.5 to 27.5°C, whilst in the south the average temperatures drop to 26-27°C from 28-29°C. Inter-annual variations in climate are caused by the El Niño Southern Oscillation. El Niño episodes influence the behaviour of the monsoons in this region, and generally bring warmer and

drier than average winter conditions across Southeast Asia, whilst La Niña episodes bring cooler than average summer [1].

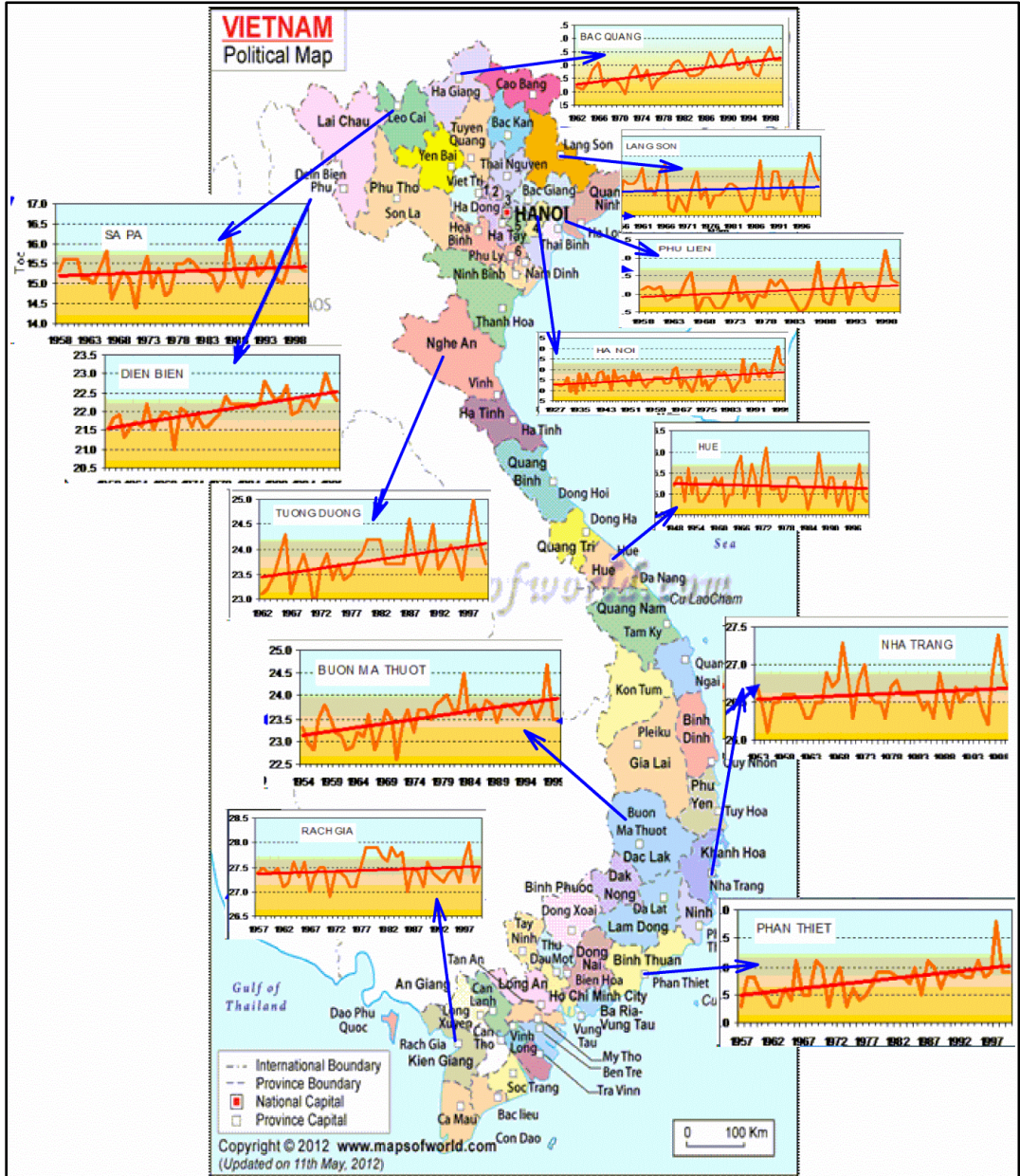
Vietnam's long coastline, geographic location, and diverse topography and climates contribute to its being one of the most hazard-prone countries of the Asia-Pacific region, with storms and flooding, in particular, responsible for economic and human losses. Given that a high proportion of the country's population and economic assets are located in coastal lowlands and deltas, Vietnam has been ranked among the five countries likely to be most affected by global climate change [2]. The country is already experiencing changes in fundamental climatic elements as well as extreme weather phenomena such as storms, heavy rains, and droughts. Over the past 50 years, temperature has increased by 0.5-0.7°C from the South to the North, and the frequency of cold fronts has decreased by 2.45 events. Its coastal areas bear the brunt of tropical storms arising from the East Sea, with an average of almost 7 storms yearly. It has been observed that tropical cyclone frequency has increased by 2.15 events, and the sea level has risen about 20 cm during the past 50 years. The potential impacts of climate change are likely to be most serious in the agricultural and water resources sectors, and that flood inundation and droughts are likely to occur more frequently due to an increase in rainfall intensity and decline in number of rainy days. Large cultivation areas in the Mekong and Red River deltas are likely to be affected by salt water intrusion due to sea level rise (SLR). Climate change is also likely to result in increasing extinction of biodiversity, especially native plant species and economic value species. SLR could result in a decline in mangrove forest area, adversely affect indigo forests and forest planted on the sulfated land in the South of Vietnam, and change boundary distribution of primary and secondary forests [3].

Although there has been significant variability in climate parameters during the past years, in terms of both the temporal and spatial scales, there are few studies on reviewing these trends so far. Therefore, this paper aims at providing a short overview on the temporal and spatial trends of climate variability in Vietnam which affected by global climate change, on the basis of data collected from various sources. In this study, the projections for temporal and spatial trends of climate variability are shown for “*low, medium, and high emission scenarios*”, respectively. These scenarios were developed as explained in details in Thuc [4].

2. TEMPORAL AND SPATIAL TREND OF TEMPERATURE

Over the past 50 years from 1958 to 2007, the annual average temperatures have increased by about 0.5-0.7°C. The minimum temperatures have increased faster than the maximum temperatures. Temperatures for winters and northern climate zones have increased at faster rates compared to summer and southern climate zones, respectively [4, 5] as shown in Fig. 1.

Fig-1. Temporal and spatial trend of temperature



The frequency of hot days and hot nights has increased significantly since 1960 in every season. The average number of ‘hot’ days per year in Vietnam has increased by 29 (an additional 7.8% of days) between 1960 and 2003. The rate of increase is seen most strongly in Sep-Oct-Nov (SON) when the average number of hot SON days has increased by 2.9 days per month (an additional 9.5% of SON days) over this period. The average number of ‘hot’ nights per year increased by 49 (an additional 13.3% of night) between 1960 and 2003. The rate of increase is seen

most strongly in Jun-Jul-Aug (JJA) when the average number of hot JJA nights has increased by 5.1 days per month (an additional 16.3% of JJA nights) over this period [1, 4].

The frequency of cold days and nights, annually, has decreased significantly since 1960. The average number of 'cold' days per year has decreased by 11 (3.0% of days) between 1960 and 2003. This rate of decrease is most rapid in Dec-Jan-Feb (DJF) when the average number of cold DJF days has decreased by 1.9 days per month (6.0% of DJF days) over this period. The average number of "cold" nights per year has decreased by 35 (9.5% of days). This rate of decrease is most rapid in DJF when the average number of cold DJF nights has decreased by 4 nights per month (12.8% of DJF nights) over this period [1, 4].

The projections for temporal and spatial trends of temperature by the end of the 21st century in Vietnam have been made on the basis of different emissions scenarios [4] as summarized below.

- *Low emission scenario*: The annual average temperature increases 1.6-2.2°C over large parts of the northern territory and under 1.6°C in the majority of the southern areas (from Da Nang southward).
- *Medium emission scenario*: The annual average temperature increases 2-3°C over large parts of the country. For the areas from Ha Tinh to Quang Tri, the average temperature increases faster than elsewhere. The lowest temperature increases from 2.2-3.0°C on average, meanwhile, the highest average temperature increases from 2.0-3.2°C. The number of days with temperatures above 35°C increase 10-20 days on large parts of the country.
- *High emission scenario*: The annual average temperature increases from 2.5-3.7°C in most areas of the country.

3. TEMPORAL AND SPATIAL TREND OF RAINFALL

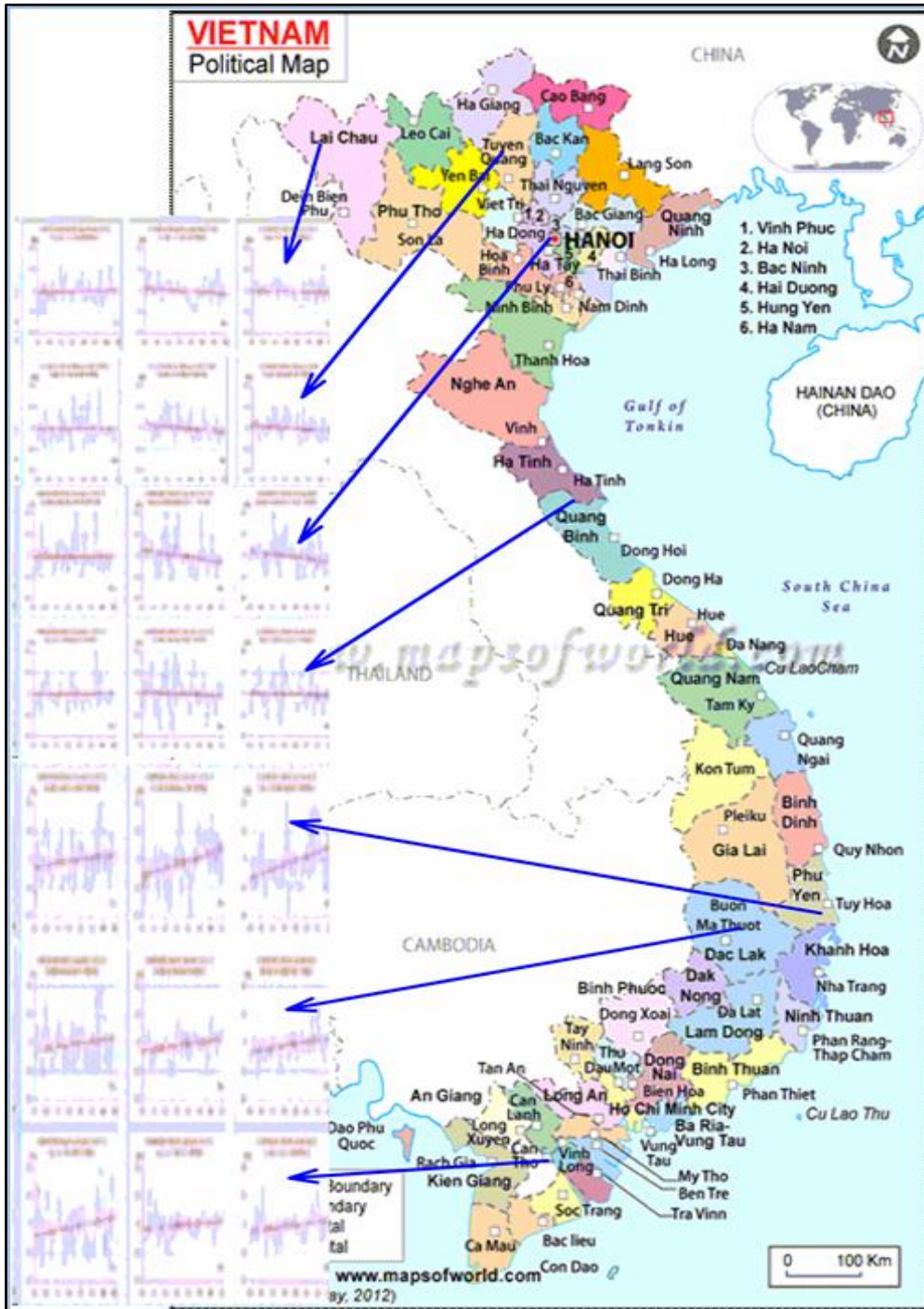
The annual average rainfall over the last nine decades (1911-2000) has not shown a clear trend across regions and time periods. Instead, both upward and downward trends could be seen. The off-season extreme rainfalls have occurred more frequently. The extreme rainfalls have increased, even in areas where total rainfall decreased. Northern climate zones have seen a decrease in annual rainfall, in contrast to southern zones (Fig. 2). On a country wide basis, the average rainfall fell by 2% during the last fifty-year period (1958-2007) [4, 5].

The projections for temporal and spatial trends of rainfall by the end of the 21st century in Vietnam have been made on the basis of different emissions scenarios [4] as summarized below.

- *Low emission scenario*: the rainfall increases about 6% in most part of the country. The rainfall in the Central Highland increases less, only about 2%.
- *Medium emission scenario*: The rainfall increases in most of the territory, common from 2-7%. In the Central Highlands, South Central the rainfall increases less than 3%. The overall trend of rainfall decreases in the dry decreases and increases in the rainy season. The highest daily rainfall increases in the North, North Central and decreases in the South Central, Central Highlands and South of Vietnam.

- *High emission scenario*: The rainfall increases in most of the territory of the country, commonly 2-10%, rainfall in the Central Highlands region increases less, about 1-4%.

Fig-2. Temporal and spatial trend of rainfall



4. SEA LEVEL RISE

Vietnam has been reported to be one of the top five countries in the world that likely to be most affected by SLR with “potentially catastrophic” consequences [6]. Observed SLR data from tidal gauges along the coast of Vietnam [4] as shown in Fig. 3 indicated the rate of SLR about 3mm/year during the period of 1993–2008 which is comparable with the global tendency. In particular, the long term (50 year) data from Hon Dau oceanographic station, North Vietnam indicated a 20 cm SLR [4, 7] as shown in Fig. 4.

Fig-3. Observation of sea level rise from tidal gauges along the coast of Vietnam

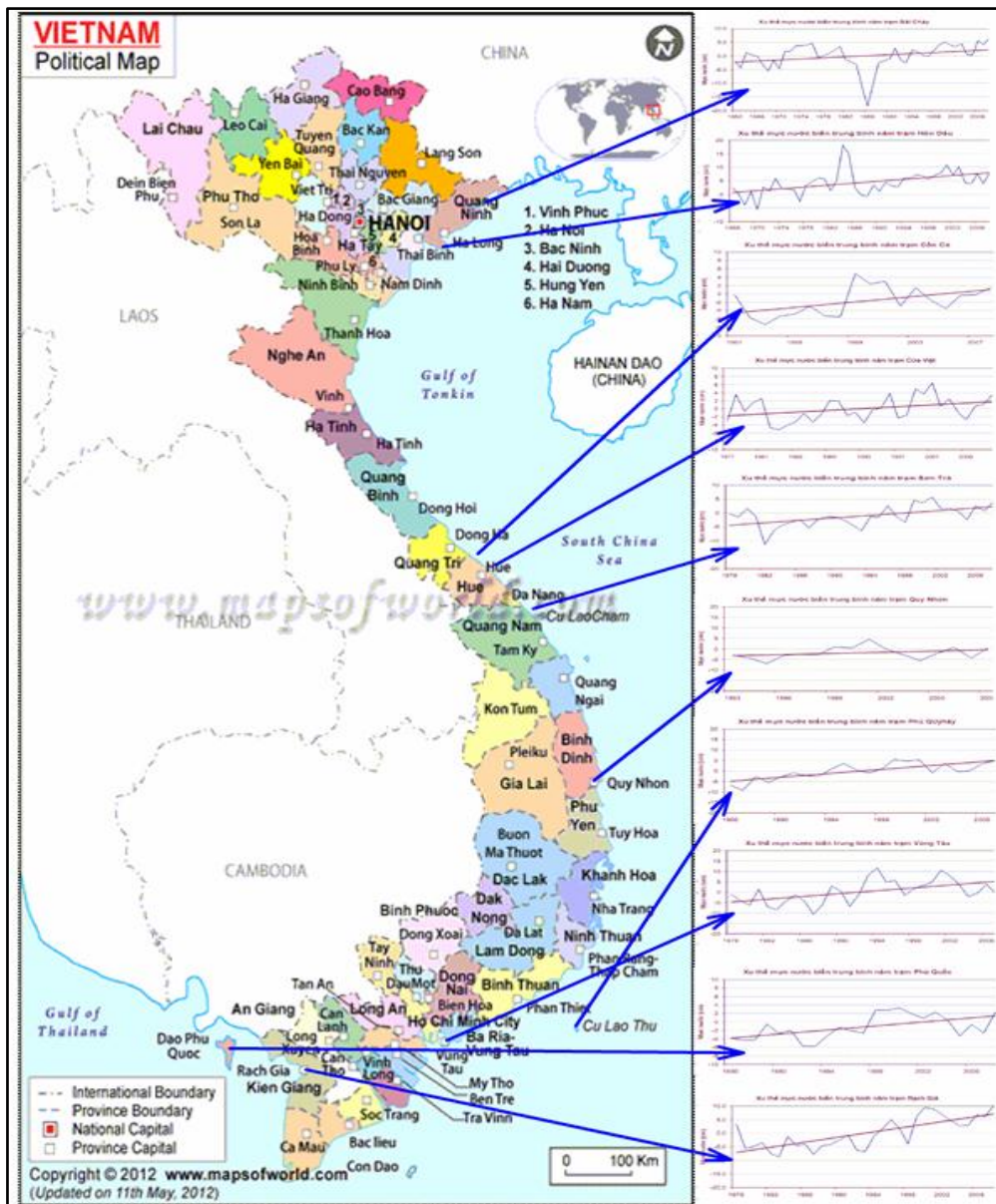
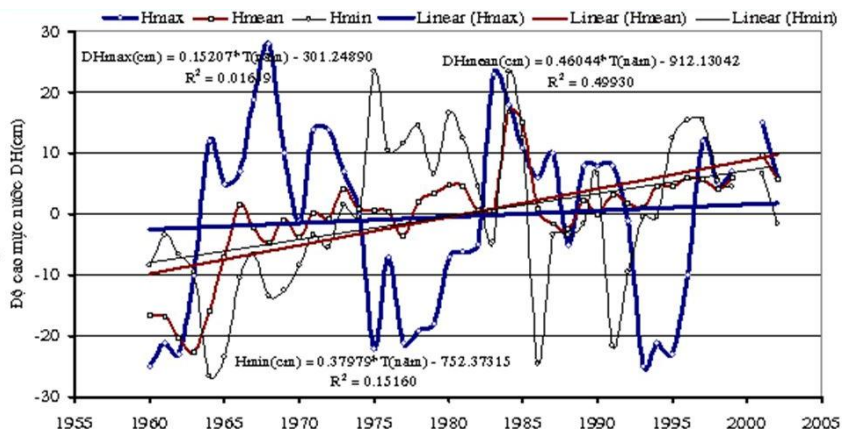


Fig-4. Changes in sea level during the past 50 years at Hon Dau oceanographical station, North Vietnam



The National Meteorology and Hydrology Centre has made the SLR scenarios for Vietnam [7] on the basis of different emissions scenarios recommended by IPCC [8] as summarized in Table 1. However, it is cautioned that there are high uncertainties contained in those results due to the possible reasons such as the low confidence level of emission scenarios, certain errors of models in simulating for the long periods, certain errors in the statistical downscaling method based on the global and regional data, and large differences of climatic factors by locations. As an effort for addressing these uncertainties, SLR scenarios for Vietnam are currently being updated as planned in the National Target Program to Respond to Climate Change.

Table-1. Projected sea level rise (cm) relative to the baseline period of 1980-1999 in Vietnam

Scenarios	Decades in the 21 th century								
	2020	2030	2040	2050	2060	2070	2080	2090	2100
Low emission scenario	11	17	23	28	35	42	50	57	65
Medium emission scenario	12	17	23	30	37	46	54	64	75
High emission scenario	12	17	24	33	44	57	71	86	100

With respect to the impact of SLR, the projection for the inundated areas in Vietnam corresponding to different SLR are summarized in Table 2.

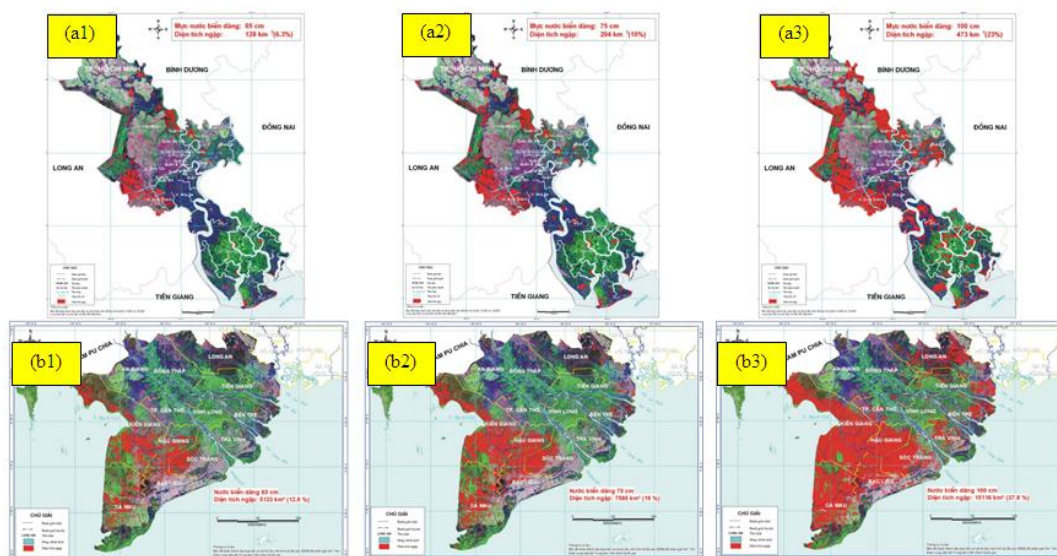
The most vulnerable areas of Vietnam to SLR are the Red River Delta, Ho Chi Minh City, and especially the Mekong River Delta [9]. In particular, the projection for the inundated areas of Ho Chi Minh City and Mekong River Delta, South Vietnam from different SLR scenarios [7] is shown in Fig. 5.

Table-2. Projection for the inundated areas in Vietnam corresponding to different SLR

SLR (m)	Inundated areas (%)			
	Red River Delta	Central Coastal Areas	Ho Chi Minh City	Mekong River Delta
0.5	4.1	0.7	13.3	5.4
0.6	5.3	0.9	14.6	9.8
0.7	6.3	1.2	15.8	15.8
0.8	8.0	1.6	17.2	22.4
0.9	9.2	2.1	18.6	29.8
1.0	10.5	2.5	20.1	39.0
1.2	13.9	3.6	23.2	58.8
1.5	19.7	5.3	28.1	78.5
2.0	29.8	7.9	36.2	92.1

Fig-5. Inundated areas of Ho Chi Minh City and Mekong River Delta, South Vietnam from different SLR scenarios:

- Ho Chi Minh City: (a1) - SLR 65 cm, inundated area 6.3%; (a2) - SLR 75 cm, inundated area 10%; (a3) - SLR 100 cm, inundated area 23%
- Mekong River Delta: (b1) - SLR 65 cm, inundated area 12.8%; (b2) - SLR 75 cm, inundated area 19%; (b3) - SLR 100 cm, inundated area 37.8%



5. SUMMARY

This study has given a short overview on the temporal and spatial trends of climate variability in Vietnam which affected by global climate change. It is shown that during the past 50 years, the annual average temperatures have increased about 0.5-0.7 °C with the faster rates for winters and northern climate zones than those of summer and southern climate zones, respectively. Meanwhile, the long-term data on annual average rainfall has not shown a clear trend across regions and time

periods. With respect to SLR, the sea level has risen at the rate of about 3mm/year during the period of 1993-2008 which is comparable with the global tendency.

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