Sea level rise and flood risk in coastal areas of Vietnam

Tran Viet Khanh
Thai Nguyen University, Vietnam
E.mail: tranvietkhanhsp@yahoo.com

Tran Thi Lan Huong
Student of Advance Education Program, College of Agriculture and Forestry,
Thai Nguyen University, Vietnam
E.mail: lanhuongyenchi@gmail.com

ABSTRACT

In the past 50 years climate has changed rapidly, include warming of the world's ocean. In Vietnam, sea level monitoring data in marine-coastal stations show trend changes in average sea levels are not the same through coastal areas. Most of these stations tend to increasing, however, a few stations did not clearly reflect this trend. Changing tendency average of sea level along the coast Vietnam is about 2.8mm per years.

In this research, we focus on the changing of temperature, rainfall, tropical hurricane, flood and drought in coastal areas of Vietnam. These factors are reasons for rising sea level. Sea level rising in coastal Vietnam affect to human life, social-economic development activities, especially agricultural production. Therefore, the research and forecast sea level rise and identify risk areas for future is essential

Key words: Climate; change; temperature; sea level; rise; risk; Vietnam.

1. INTRODUCTION

According to scientists, the global climate has had complicated changes in the last 50 years, and the biggest changes that need to be mentioned are the warming of the world oceans. The monitoring data shows that the global average sea level has been rising at a rate of 1.8 mm / year: that 0.42 mm/ year due to thermal expansion and approximately 0.70mm/ year due to glacier melting (Intergorvemental Panel on Climate change - IPCC, 2007). In fact, the sea level change is not equal across the world's oceans: Some areas have rising rates that are several times higher than the global average rate, while in some other areas, the sea levels are even lowering. The trend of increasing average water levels appears mostly at monitoring stations around the globe; According to reports of scientists, in the past decade, the highest sea levels are in the Western Pacific and the Eastern Indian Ocean.

The phenomenon of sea level rise leads to the risk of flooding in some localities, especially, in the low-lying coastal areas. This phenomenon impacts all social - economic activities of many countries including Vietnam, thus evaluative research should be carried out to uncover the response and recovery solutions for the phenomenon.

There are two main methods for determining sea level: at oceanographic stations and treatment Satellite data. Method for measuring oceanographic station showed the water level changes compare with the altitude of the station. The tectonic movement influence significantly to results of this method. But the method of data processing satellite measured Earth's mass centre is not affected by the geological movement.

2. RESULTS AND DISCUSSION

2.1. Status of climate change in Vietnam

2.1.1. The change of temperature

In the past 50 years, in Vietnam, the average temperature has risen about 0.5^0 C. But winter's temperature increased faster than that of summer: winter temperature has increased 1.2^0 C within 50 years while summer temperatures increased about 0.3 to 0.5^0 C. In comparison, the temperature in the interior of the region increased faster than the temperature in coastal and island areas. The annual average temperature increase of 0.5-0.6^0 C within 50 years in the Northwest and Northeast but in Centre of Vietnam are lower, Only 0.3^0C within 50 years.

General trend of rising temperatures is in most areas, however, a few of coastal areas in Centre and South of Vietnam such as Thua Thien - Hue, Quang Ngai, Tien Giang tends to decrease. Notably, in these regions, annual rainfall has increased.

2.1.2. The change of rainfall

Precipitation change is not equal, decrease in the North and increased in the South. Rainfall in dry season (from November to April) increased slightly or did not change significantly in the North and strong grow up in the South. Rainfall in wet season (from May to October) decreased from 5% to 10% on most of the North of the country and about 5% to 20% in the South. The trend of annual rainfall similar to the trend of wet season: increase in the South but decrease in the North. South Central Region has rainfall (both dry season and rainy season) increase highest compared to other regions in Vietnam, up to more than 20% in the last 50 years.

2.1.3. Hurricanes and tropical low pressures

Usually, there are about 12 typhoons and tropical cyclones operated a year in East Sea of Vietnam, of which about 45% were born in the East Sea and 55% others come from Pacific Ocean. Hurricanes and tropical low pressures affecting Vietnam at about 7 times per year, and 5 of them are landed or directly impact to the land of Vietnam. The high frequency of operating of hurricanes and tropical low pressures are in the middle in the north part of East Sea.

Area landed of storms and tropical low pressures tend to moving toward to South Vietnam's territory, the number of strong storms tend to increasing, and hurricane season last longer, the impact of the storm in Vietanm tends to strengthen.

2.1.4. Drought

Drought tends to increasing, but with uneven levels among each region. The phenomenon of broiling sun increases in many regions, especially in Centre and South of Vietnam.

2.1.5. Risks of coastal areas

Coastal areas at about one metre of elevation constitute much of Vietnam's coastline. Sea level rise presents a serious threat to these coastal areas in particular, to the two low-lying deltaic areas of the North and South. Even a limited rise in sea level over coming decades could seriously affect the people and nation of Vietnam. Sea level rise will result in:

- loss of land;
- increased vulnerability to flooding, including storm events;
- accelerated erosion along the coasts and in river mouths;
- increased salinization; and
- changes in the physical characteristics of tidal rivers.

The most fertile agricultural lands, together with 50% of the population, are centred on the low-lying Red River and the Mekong delta regions. Sea level rise could have drastic consequences for the livelihoods and socio-economic well-being of the inhabitants of these areas. It is likely that valuable arable land would be lost.

The biophysical characteristics of neighbouring regions not permanently inundated by sea water could be affected and this may render these areas unsuitable for agriculture.

For example, the irrigation of paddy rice may be seriously affected as a result of the increased intrusion of saline or brackish water. Estuarine and riverine areas could be affected by changes in the tidal regime and in river currents.

Biological resources in coastal areas provide an important base for socio-economic development. They are significant for the ecological balance and for scientific research and provide an important service of coastal protection.

Vietnam's rich diversity of coastal flora and fauna might be substantially reduced and unique habitats may disappear. Mangrove and cajeput forests - important ecosystems in low-lying areas - may be reduced in extent or lost completely.
Marshy areas in river estuaries are habitats and resting places for birds and these will be threatened by sea level rise. Likewise, sandy stretches where sea turtles lay their eggs may be flooded. The development of coral reefs could be affected.
Research currently being undertaken in Vietnam indicates that significant impacts due to sea level rise may already be occurring.
Data from the past decade show that, in the Cau Mau coastal region, more than 600 hectares of land has been eroded.
Observations also indicate that increased salt intrusion is causing a gradual change in species distribution in the mangrove forests. The more that the mangrove forest area is reduced, the greater the impact from salt water intrusion and erosion on the neighbouring land and the greater the vulnerability to storm-induced flooding.
The social and economic consequences of sea level rise could well be wide-ranging. Port facilities may have to be re-engineered. Coastal industries may be lost. Transportation will be disrupted. The provision of drinking water may be affected as saline water penetrates aquifers.

2.2. Forecast the impact of sea level rise to coastal areas of Vietnam

2.2.1. Forecast the affected areas as sea level rise

The method is applied to build sea-level rise scenarios include detailed method to statistics (MAGICC, SIMCLIM, SLRPP) and product applications of numerical models.
On a global scale, Rahmstorf (2007) developed statistical and empirical methods to measure the rising of sea level. This method is based on the relationship between average temperature and global sea level in the past to estimate the future. Calculation results are compared with measured data. In general, sea-level rise scenarios are set up for small areas. The researchers often use local factors such as speed of water level changes in the past and the shift of regional geology to adjust sea level rise scenario at global scale.

Base on these analyses, Ministry of Natural Resource- Enviroment set up sea-level rise scenario for Vietnam. This scenario identifies different areas of coastal sea level. Measured data of sea level at the oceanographic stations, monitoring data from satellites and calculate results from the numerical model for coastal Vietnam is used to determine the coastal areas of the most trend sea level change in the past and predict the future. The research results showed that 7 coastal regions consistent with the trend of sea level change as follows:
1) North region of coastern Tonkin Gulf, from Mong Cai to Hon Dau (including the northern province of Quang Ninh and Hai Phong city);

2) Coastal Region of Red River Delta and North Centre, from Hon Dau to Deo Ngang (including South of Hai Phong, Thai Binh, Nam Dinh, Ninh Binh, Thanh Hoa, Nghe An and Ha Tinh);
3) The coastal area in the south of the Gulf of Tonkin, from Deo Ngang to Hai Van (including Quang Binh, Quang Tri and Thua Thien - Hue);
4) The northern coastal area of South Centre, from Hai Van to Dai Lanh cape (including Da Nang, Quang Nam, Quang Ngai, Binh Dinh and Phu Yen);
5) The southern coastal area of South Centre, from Dai Lanh cape to Ke Ga cape (including Khanh Hoa, Ninh Thuan and North of Binh Thuan);
6) Area Southeast coast, from Ke Ga cape to Ca Mau cape (including southern Binh Thuan, Ba Ria - Vung Tau, Ho Chi Minh City, Tien Giang, Tra Vinh, Ben Tre, Soc Trang, Dong Bac Lieu and Ca Mau);
7) The area on the west coast, from Ca Mau cape to Ha Tien (including west of Ca Mau and Kien Giang).

2.2.2. Using flood risk maps to evaluate the effect of rising of sea level in Vietnam

Flood risk maps based on the sea level rise is built to show the risk areas which directly affected by sea level rise. Each map to a region is based on a single value of sea level. Basically, this method is "upward surface water," according to a selected value. This approach is most commonly used in mapping flood risk due to sea level rise. The layers information is entered into the GIS system, showing flood risk maps and presented in accordance with the thematic maps. The accuracy of flood hazard maps depending on the accuracy of topographic maps. In the process of building flood risk maps the risk of flooding only use data base of sea level rise, other factors such as tectonic, dynamic factors (tides, waves, storm surges) are not been considered. The results of analyzing flood risk maps in areas inundated by the rising sea levels show that: if sea level upward 1 meter, about 39% of the Mekong Delta, more than 10% of the Red River Delta, 2.5% of the area of the central coastal provinces are at risk of flooding. Results of calculating on the basis of traffic data show that if the sea level upward 1 meter, there are about 4% on the rail system, the 9% national highway system and about 12% of the provincial road system will be influenced. System traffic in Mekong Delta was the highest affected with about 28% highway and 27% of provincial roads; In central coastal region, nearly 4% of national highways, 5% provincial roads and 4 % rail system are affected. The area of Red River Delta, nearly 5% highway, 6% provincial roads and 4% railways are affected. According to population data of GSO (2010), if sea level upward 1meter almost 35% of the population in the Mekong Delta, 9% of the population in the Red River Delta are directly affected; In Ho Chi Minh city about 7% and in the central coastal provinces nearly 9% of the population are affected.

3. CONCLUSION

The change of climate, mainly due to increasing temperature and rainfall will cause sea level rise and flooding in some coastal areas of Vietnam. Depending on the extent of change of temperature and precipitation trends that sea level rise could reach different values.

Communities living in coastal areas vulnerable to increased flooding may have to be relocated. This would increase pressure on the remaining land and exacerbate problems associated with forest destruction and ecosystem degradation as new agricultural tracts are created. Biodiversity would be degraded, land erosion would increase and flooding may worsen as a result.

In response to the impact of sea level rise, increased expenditure will be necessary on flood protection and the planning and zoning of activities in coastal areas, including agriculture, industry, transportation and tourism, may have to be rethought.

Sea level rise will have significant implications for all activities in low- lying areas. Given the planning timescales involved, it is important that serious and prompt consideration be given to suitable responses in relevant policy areas such as coastal protection, agriculture, industry and land use zoning.

Climate change, rising of sea levels will cause many flood areas, shrinking living space, causing significant impact to human life, affecting agricultural production, changing the method cultivation thus devising solutions to cope with climate change for everyone and all the countries world-wide.

4. REFERENCES

1. Ministry of Natural Resources and Environment (2012), climate change scenarios and sea level rise for Vietnam, Hanoi.
2. Ministry of Natural Resources and Environment (2010), Report of the Second National Vietnam to the United Nations Framework Convention on Climate Change, Hanoi.
3. Ministry of Natural Resources and Environment (2008), National Target Programme to respond to climate change, Hanoi.
4. Nguyen Duy Chinh (2006), inventory and resource assessment of climate Vietnam, Final Report of the Ministry of Science and Technology theme, Hanoi.
5. Hoang Duc Cuong (2008), study the construction of climate change scenarios for the Red River basin from 2010 to 2100 and the initial stage impact assessment of surface water resources, agricultural production, Report Thread NCCB, Hanoi.
6. Nguyen Xuan Hien, Tran Thuc, Le Quoc Huy (2010), Research trends change sea level, and the South China Sea Vietnam coastal areas from satellite data, Meteorology and Hydrology, No. 592.

7. Nguyen Trong Hieu et al (2009), Climate change in Vietnam, Institute of Policy and Strategy for Environment, Hanoi.
8. Tran Viet Lieu (2000), The impact of climate change and sea level rise on coastal Vietnam, Agriculture Publishing House, Hanoi.
9. Nguyen Duc Ngu (2002), Impact of ENSO to climate, environment and socio-economic, Report on the State-level science subjects.
10. IPCC (2007), The Physical Science Basis, Cambridge University Press.