International Journal on Emerging Technologies **12**(1): 323-328(2021)

ISSN No. (Print): 0975-8364
ISSN No. (Online): 2249-3255

Flood in the Central Region of Vietnam, Implications in Sustainable Development

Le Canh Tuan and Nguyen Thi Phuong Thanh
Ha noi University of Natural Resources and Enviroment, Vietnam.

(Corresponding author: Le Canh Tuan)*
(Received 02 January 2021, Revised 26 February 2021, Accepted 18 March 2021)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: Every year floods often happening on the rivers of Central Vietnam. Most rivers in the Central region originate from the Truong Son Mountains in the West and flow into the South China Sea. General characteristics, rivers in central Vietnam are often short, the slope changes abruptly, when the rain comes up, the flood usually happening. The question arises: why is Vietnam located close to the East Sea, but the water cannot escape immediately into the sea? October 2020, heavy rains, prolonged rains occurred, and floods reappeared in Central Vietnam. The result is flooding, accompanied by landslides, causing damage to people and the infrastructure. One of the reasons causing the flooding comes from the infrastructure zoning. Analyze documents about topography, geological structure, and rainfall compared with the infrastructure planning.
Especially focus on research in estuarine areas. An analysis of flood drainage capacity of rivers in central Vietnam. At the same time, it gives recommendations to managers that need to consider before approving the plan. That is the construction of the infrastructure along with the central provinces of Vietnam, creating horizontal dams, preventing water from flowing into the East Sea. When planning the infrastructure, it is necessary to do comprehensive and complete geological research.

Keywords: Flooding, River, rainfall, infrastructure, geological structure.

I. INTRODUCTION

The studies on the estuary area of Central Vietnam are of interest to many authors [6], [7], [8], [9]. Every year, when the rainy season comes, the Vietnamese people have to stand up and fight with nature. The study area is the central province of Vietnam. Central Vietnam, including Nghe An provinces, Ha Tinh provinces, Quang Binh provinces, Quang Tri provinces, Thua Thien-Hue provinces, Da Nang provinces, Quang Nam provinces, Quang Ngai provinces (Fig. 1).

Fig. 1. Study area.

Drainage area of the central provinces is the EastSea. All rivers, with flood drainage role into the sea but are all overloaded. The estuary area is many deposited with sediments. Along with the central provinces, many roads are crossing, hindering the ability to drain floodwater. The author analyzes natural factors (topography, geological structure) and human impacts in infrastructure planning (constructions such as roads, urban areas, industrial zones, ...) serves to explain the causes of floods in the central provinces of Vietnam. The rivers surveyed by the author are important rivers of the central provinces. These are Gianh river, Nhat Le (Quang Binh province), Ben Hai river (Quang Tri province), Huong river (Thua Thien-Hue province), Cu De river (Da Nang province), Thu Bon river (Quang Nam province), Tra Khuc River, Thoa River (Quang Ngai).

II. MATERIALS AND METHODS

Materials used in the article include: topographic maps, geological maps at scales of 1/50,000, 1/25,000, satellite images, reports, and projects related to river flood control and drainage in Central Vietnam, Vietnam. The research methods used in the paper are:

- Analysis of satellite images, special attention to downstream areas of rivers, especially the estuarine areas. Estuaries have the interference of river flow with ocean waves and tides, which often form sand bars across estuaries. These are important rivers which are responsible for flood drainage.
- Field survey: check and compare with documents analyzed by satellite images. Study the distribution of infrastructure, population, housing, land use planning in the downstream areas of rivers in Central Vietnam. Investigate flood information of the Central provinces in Vietnam.
- Use drone surveying equipment in flood season or difficult or dangerous areas. The strength of drone helps us to collect images in areas where humans cannot access.

Interviewing technical staff at the Meteorological and Hydrological stations of Quang Binh, Quang Tri, Thua Thien-Hue, and Quang Ngai provinces. Collect data on precipitation associated with floods.

III. RESULTS AND DISCUSSION

The cause of the flooding is related to rain. In normal conditions, when the river bed is obstructions free with low rainfall, and good drainage capacity, a flood will not appear. In the case of heavy rain with high rainfall intensity, flood will occur. The research results show that there are too many "Barriers" in the river to the movement of water to the East Sea. Factors related to flood are divided into the following two groups:

A. Group of natural origin

The group of natural origin is due to topographical characteristics, activities of rain, wind, storm, wave, tide, et cetera. These activities are related to sedimentation and erosion processes along rivers and coasts. Rainfall and its distribution during the year play a very important and decisive role to the possibility of floods. The central region is where there is heavy rainfall. Some areas with heavy rain are Tra My- Ngoc Linh, Ba Na- Bach Ma, et cetera.

The northeast's wind operation is very complex (storm, tropical depression, converging strip…). During this period, it often causes heavy rain for several days, with a total rainfall of 200 to 400mm in a large area, which results in floods. That is the reason why severe floods occur from September to November in the central provinces.

The rainfall distribution of the year plays an essential role in the determination of the possibility of floods. The Central region of Vietnam has heavy rainfall up to 2 800 mm/year (Fig. 2).

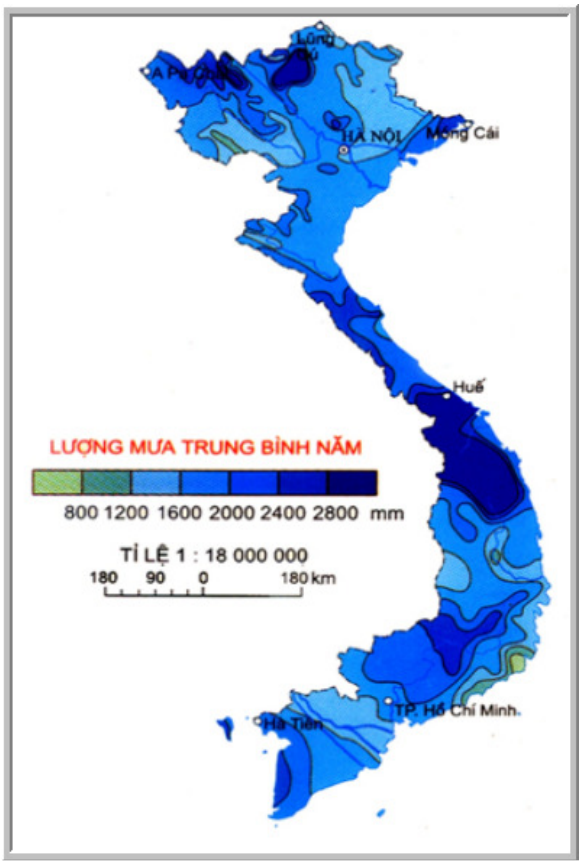

Fig. 2. Average annual rainfall [1].

Fig. 3. Staking to prevent the accumulation of sand from the sea into the Tra Khuc River (Quang Ngai).

In Nam Dong - Bach Ma - Phu Loc, the average annual rainfall is about 3,400-4,000mm, some years exceeding 5,000mm, even up to 8,664mm in Bach Ma (1980). The average rainfall from 1998 to 2000 at an altitude of 1,200 meters on Bach Ma mountain is 9,960mm. The plain of Thua Thien Hue has the least rainfall. The average annual rainfall is about 2,700 - 2,900mm. In rainy years, it can be higher than 3,500mm (in 1999 in Phu Oc 5,006mm, in Hue 5,640mm) [2].

The field survey verified the satellite image analysis results showed that along the coasts of the Central Provinces of Vietnam, estuaries are strongly deposited. Some places that used to be streams or rivers, are now traces of currents. Many rivers have been filled, and their drainage gates are greatly narrowed. In some rivers covered by sand, people have to build sand-blocking embankments (Ben Hai River, Thach Han River - Quang Tri Province) (Fig. 3, Fig. 4, Fig. 5, Fig. 10, Fig. 11), or stake piles for sand retaining walls (Tra Khuc River - Quang Ngai province) (Fig. 4)

Fig. 4. The Ben Hai estuary estuary are strongly accretion.

Fig. 5. The Thach Han estuary estuary are strongly accretion.

Fig. 6. The width of the Gianh river mouth is 253m.

Fig. 7. The width of the Nhat Le river mouth is 127m.

The interaction of rivers with waves and tides causes estuaries to narrow (Fig. 4, 5, 6). In Thua Thien-Hue, strong waves and tides have created sand dikes that run along the coast. The water of Huong River draining to the sea must go through two outlets (the current outlet of Huong River is only 353m wide). Cu De estuary was also strongly sedimented. The width of the river mouth is only 63m (Fig. 4).

Fig. 8. Thu Bon estuary (Quang Nam) is strongly accreted. The width is 710m.

Fig. 9. Tra Khuc estuary (Quang Ngãi) is strongly accreted. The width is 622m wide.

Fig. 10. The Ben Hai estuary is strongly accreted.

Fig. 11. Thach Han estuary is strongly accreted.

The results at the Meteorological stations in the Central region showed that in Quang Binh province, if it rains around 5-7 hours in June-July, with the amount of rainfall of about 300mm, floods will occur in the Gianh River. In Quang Tri, about 70mm of rainfall will generate floods in July and August. In Quang Ngai province, if the amount of rainfall at the beginning and in the middle of the rainy season are 200-300mm and 100-150mm respectively there will be floods [3].

B. Group with Human origin

It originates from the development of the infrastructure (industrial zones, residential areas, roads, et cetera). Vietnam has a river system mainly developing in the Northwest-Southeast direction. Traffic roads have crossed rivers and streams and created dams that prevents drainage to East Sea (Fig.12, fig. 13).

Fig. 12. About 3 km along Tra Khuc river, there are 4 bridges: Railway Bridge, Thach Bich Bridge, Tra Khuc Bridge, and Tra Khuc 2 Bridge.

Fig. 13. A series of piers are obstacles to water, reducing the ability to drain water on Tra Khuc river.

Some of the reasons obstruct water drainage in the central provinces can be illustrated by the construction works shown in Fig. 14.

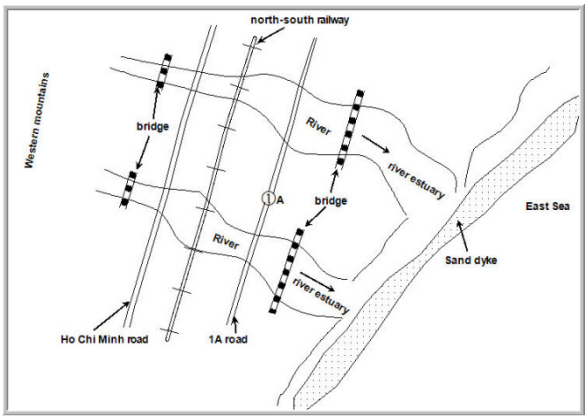

Fig. 14. Illustration of construction works that obstruct water drainage.

IV. DISCUSSION

Vietnamese territory is inclined to the sea. When it rains, the water will escape to East Sea. During the development process, the roads, factories, and residential areas have been increasing. As stated in the results of the study, the cause of the floods in the central provinces of Vietnam, besides natural factors, there are also human factors. Regarding infrastructure planning, the managers have not taken into account all the factors affecting the natural space and environment. Therefore, flooding is inevitable. The following analyzed problems are the cause of the floods:

A. The central provinces of Vietnam are where heavy rainfall occurs

Thua Thien - Hue is one of the provinces with the highest amount of rainfall in Vietnam. The annual average rainfall exceeds 2,600mm.It can be up to 4,000mm in some places. Areas with heavy rainfall are A Luoi - Dong Ngai (altitude 1,774m) with average rainfall/year from 3,400-5,000mm, and South East - Bach Ma - Phu Loc with average rainfall/year from 3,400 - 5,000mm. The delta of Thua Thien - Hue has the lowest amount of rainfall which averages about 2,700 - 2,900mm. The number of rainy days each year are from 200 to 220 in the mountainous regions, and from 150 to 170 in plain areas. In the rainy season, each month has 16-24 rainy days. When rain lasts many days, it often causes huge floods [4]

According to the National Center for Hydrometeorological Forecasting, the total rainfall from October 16 to October 21, 2020, in the provinces of Ha Tinh and Quang Binh, is 500-800mm, and it exceeds 900mm in some places. In the provinces from Da Nang to Phu Yen, it is from 200-300mm and exceeds 3500mm in some places.

B. The Central provinces have a complicated geological structure creating the opposition between upstream and downstream, which is one of the causes of flooding

The morphology of rivers depends on the properties of the bedrock. The geological structure of the Central provinces of Vietnam determines the characteristics of the rivers. These characteristics of the rivers are short and steep. Their slopes change abruptly. It is also one of the reasons for increasing the likelihood of floods.

C. Too much sediment deposits on the riverbed, hindering the drainage of water

On the riverbed, especially in estuarine areas, there are many alluvial flats, typically the Cu De River (Da Nang), Thu Bon River (Quang Nam), Tra Khuc River (Quang Ngai), etc. Some rivers are even blocked by sand bars, thus blocking drainage gates (Phu Trach River, Quang Binh province- Fig. 15, fig. 16)

Fig. 15. Rivers and streams in Phu Trach (Quang Binh) are filled with drainage gates.

Fig. 16. Dinh river (Quang Binh) is filled with drainage gates

D. Construction density is high and land use planning is not reasonable, making the river bed narrow

Building too many structures across the river which obstructs drainage is one of the reasons for increasing flooding levels in the central provinces.

Field investigation results show that the topography of estuaries in Central Vietnam is always changing. There are many sandy beaches on the riverbed, hindering the river's ability to drain floods. The estuarine area was narrowed. The measurement results show that the width of the Thach Han river mouth is only 160m, Gianh river is 253m, Nhat Le river is 127m, etc. The water outlet of many rivers is filled with sand. (Fig. 8, Fig.15, Fig.16, Fig. 19)

Fig.17. Leveling Cu De estuary for construction.

Fig.18. Cua Tung Bridge (Ben Hai River) prevents water from draining into the sea.

E. The impact of waves and tides had created sand bars running along the coast, blocking estuaries. Some estuaries were accreted .

In estuarine areas, the impact of waves and tides pushes sand to the West, obstructing the drainage of the river to East Sea (picture 1, picture 2,...), Dinh river, Phu Trach River of Quang Binh Province, Thu Bon River of Quang Nam Province, Huong River of Thua Thien-Hue, Gianh River, Nhat Le River of Quang Binh Province, Ben Hai River, Thach Han River of Quang Tri Province, Tra Khuc River, Han River, Cu De River of Da Nang province, and Thoa river of Quang Ngai province, the drainage gate is filled with sand of only 119m width (Fig.19)

F. Unreasonable land use planning

The alluvial flats in the middle of the river are areas that frequently fluctuate and are not approved for the construction of works. The leveling and encroachment on the flow of building Thuy Tu villas on Han River (Da Nang), the Dao Ngoc project located in the middle of Tra Khuc River in Quang Ngai province, and a residential area in the mouth of the Thoa river (Quang Ngai), etc, are examples of wrong land allocation planning, increased flooding in the downstream area.

Fig.19. Sediment filled the Thoa estuary, Thoa river estuary width was only 119 m.

Fig. 20. The planning perspective of Dao Ngoc Ecological Urban Area proposed by Thai group - Photo: quangngai.gov [5].

Fig. 21. Ground leveling along the Han River for the construction of Thuy Tu villa.

Fig. 22. Too many bridges cross the river.

Field investigation shows that within about 3km along Tra Khuc River, there are four bridges (railway bridge,

Thach Bich bridge, Tra Khuc bridge and Song Tra bridge 2) (picture 5). Within about 7km along Han River, there are five bridges (Fig. 12).

G. Geological structure must be researched before approving projects

All construction (urban areas, bridge systems, roads, industrial zones, et cetera) only consider geotechnical engineering, and not take into account the regional geological structure,especially studying geological activities in the past (old river, geomorphology, geohazard, et cetera) At present, the old river has been filled, leaving only traces of the river bed on the topographic surface.

H. Lack of Ministries coordination

Research results and scientific research are not shared, causing waste. The research results are not applied in practice.

V. CONCLUSION

Flood usually occurs in the Central provinces of Vietnam. Two causes are leading to flooding, which are natural factors and human factors.

When it rains, the role of rivers is to drain water. All of the water outlets of rivers in the Central region have narrowed, hindering drainage to the East Sea. The wave and tidal activities at the coastal zone are very strong, creating sand bars that run along the coast and across estuaries.

In addition to natural causes (heavy rain, long-term rain, effects of the geological structure, wave activity, tides, monsoons), human factors are another crucial reason.. That is inadequate land-use planning. Building too many constructions crossing the river hinders the ability to drain water. The approval of projects has not been thoroughly researched, accompanying with the lack of coordination between related Ministries, leading to errors in the approval of the plan hoạch (The planning perspective of Dao Ngoc Ecological Urban Area proposed by Thai group and the leveling along the Han river to build Thuy Tu villa are examples).

VI. FUTURE SCOPE

Analysis of natural factors and human impact causes. The lesson for the future is must have interdisciplinary coordination overcoming inadequacies in planning the infrastructure in Viet Nam.

REFERENCES

[1]. Atlat Vietnam Geography, (2019). Vietnam Education Publishing House.

[2]. https://www.quangngai.gov.vn/userfiles/

[3]. http://kttvqg.gov.vn/du-bao/

[4]. https://thuathienhue.gov.vn/vi-vn/Thong-tin-du-dia-chi/tid/Mua/

[5]. https://nchmf.gov.vn/Kttvsite/vi-VN/1/)

[6]. Phạm Ba Trung, Le Đinh Mau, (2019). Study erosion –deposition processes at Co Luy- Cua Lo Quang Ngai province. Proceeding the third Natonal scientific conference on Marine Geology Ha Noi, 22-23 October, 2019. Publishing House for Science and Technology.

[7]. Le Canh Tuan, (2015). Calculating sediment volume in coastal river mouths in central Vietnam, serving dredging river bed, mitigating flood events (piloting Cua Dai area, Tra Khuc river, Quang Ngai province). Scientific conference "Connecting basic scientific research with fields of Mining - Geology - Petroleum - Environment". Natural Science Publishing House and National Technology Publishing House, Hanoi.

[8]. Tran Thanh Tung, (2006). Analysis of changes in the morphology of Tra Khuc estuary, Quang Ngai province. *Science and Technology Journal of Water Resources and Environment*, No. 14.

[9]. Phan Thi Tuong Vi, (2012). Study on solutions to stabilize the Tra Khuc river bed from downstream of Thach Nham dam to Cua Dai. Master thesis, archived at Danang University.

How to cite this article: Tuan, L.C. and Thanh, N.T.P. (2021). Flood in the Central Region of Vietnam, Implications in Sustainable Development. *International Journal on Emerging Technologies, 12*(1): 323–328.