

Landslides in the Mekong Delta: Situation, causes and response measures

10/05/2017

Located at the end of the Mekong River, the Mekong Delta (Mekong Delta) is known as one of the most heavily affected areas of hydropower and water transfer projects being implemented upstream. The impact of reservoir projects on the mainstream, along with the extreme weather effects caused by climate change, has created a "double threat" that challenges the survival of the Mekong Delta, the richest area of agricultural production in Southeast Asia.

The long-term catastrophe of the "double threat", as warned by scientists and experts, is the delta's collapse due to the large amount of sediment deposited annually and the rise in sea level. . The immediate development of the disintegration process is the landslides which is increasing in scope and intensity. Before 2015, serious landslides were reflected mainly in the coastal areas around the peninsula of Ca Mau, Ben Tre and some places with busy sand mining activities such as An Giang and Can Tho. ... then now, the extent of the landslide has penetrated deep inland, on the rivers and confluence areas with increasing frequency. The Vam Nao river erosion, which engulfed more than 70m of the riverbank and 16 solid houses in Cho Moi District - An Giang at the end of April, is an alarming sign of the current disintegration process.

Since the Vam Nao River landslide incident, many environmental experts have explained the causes, all agreeing that excessive sand mining is considered the most direct cause. However, in order to have a broad and multi-dimensional view of landslides in the Mekong Delta, this paper takes an interdisciplinary perspective to first describe the actual situation of landslides in the region, thereby identifying and evaluating direct and indirect causes, both objective and subjective, to explain the landslide process that are increasingly popular in many localities.

Then, based on the analyzed reasons, the article gives some risk forecasts and response measures.

Situation of "double" landslides in the Mekong Delta

In the previous highschool Geography textbook, it was recorded that: Each year, the Mekong Delta, especially Ca Mau Cape, encroaches on the sea for over 100m. This, for many generations of people in the Cape, has become familiar because the expansion of the mudflats full of fish here can be felt every day. But since the late 2000s, storm surges accompanied by frequent high waves have created the opposite reality: Every year, the Ca Mau Cape is swept by an average of 5-8 km of the coastline, covered with numerous patches of forest cover (mangroves, black tiger, parrots ...), which are considered as the pioneer species to open the land and reclaim the sea. swallow "hundreds of hectares every year. The landslide situation in the Ca Mau Cape in particular and the Ca Mau peninsula in general is so serious that experts warn that the area will lose 56% of its land area in 80-90 years if it is not improved. [1]

Currently, the most dangerous landslides on Ca Mau Peninsula belong to the coastal communes of Khanh Tien (U Minh district), Khanh Binh Tay (Tran Van Thoi district), Tan Hai (Phu Tan district), Dat Mui (Ngoc Hien district), Tan Thuan (Dam Doi district) of Ca Mau province with a total length of over 14 km. In Bac Lieu, because the coast is oriented nearly perpendicular to the Southeast monsoon ("monsoon winds" - the monsoon winds blowing in the opposite direction of the Tien and Hau rivers), it is strongly influenced by the waves and tidal currents along the coast create at least 30 points of erosion, landslides and landslides on a large scale and regularly such as Nha Mat, Vinh Hau A, Dien Hai, Long Dien Tay and Ganh Hao with a total length of over 18km.

Throughout the coastal line of nearly 200 km through Soc Trang, Tra Vinh, Ben Tre to Tien Giang, although near the mouths of Hau and Tien rivers, the advantage of accumulating alluvium to form many islets and coastal sand dunes is now also severe erosion and landslide. In particular, the most serious in the coast through the provinces of Bien Tre, Tra Vinh and Go Cong Dong district (Tien Giang province) - where dozens of kilometers of sea dykes were washed away

and on average each year the waves continued to invade land about 160-200m on the total length of landslides more than 18km.

While dozens of km of sea dykes and protective forest patches are defending and withdrawing from the violent invasion of the rising sea effect, the Mekong Delta faces severe erosion when hundreds of landslides identified with a total length of tens of kilometers. Particularly, according to the survey results in Dong Thap province, there are 34 points of river bank erosion scattered throughout 9/12 district towns in the province with a total length of over 5.5 km. In particular, some river sections belong to Long Thuan, Long Khanh A communes (Hong Ngu district), Tan Binh, An Phong, Binh Thanh (Thanh Binh district), Tan Thuan Dong, Tinh Thoi (Cao Lanh city), My An Hung B (Lap Vo district), An Hiep (Chau Thanh district) and Tan Khanh Dong (Sa Dec city), were eroded dozens of meters deep into the shore, some places reached nearly 40m.

Another upstream province in the Mekong Delta, An Giang, is in the same situation: more than 40 serious landslides have been identified across the districts bordering the Tien and Hau rivers. Can Tho City is the next victim of river erosion. Most districts along the Hau River in Can Tho face landslides, including Tan Loc dune area (Thot Not District), Can Tho River (Ninh Kieu District) and Cai Rang District are hot spots on river bank erosion. Soc Trang and Tien Giang are the upstream provinces that are affected by coastal erosion and landslides on canals. In Soc Trang, Cu Lao Dung, Long Phu, Ke Sach areas... are the most frequently eroded areas. Meanwhile, the authorities have identified 15 dangerous landslides on the Tien River that flow through the territory of Tien Giang province and many creeks in the province. The total length of these landslides is nearly 3 km, mainly located in densely populated areas.

As a result of land loss from landslides, not only houses or river sections are "swallowed" into the whirlpool, some fertile dunes on the Hau River have also become memories before the invasion. The most typical is Ca Doi dune filled with Hau river alluvium with a length of over 4km and a width of over 20ha. But since the 1990s, the area of alcohol quickly shrunk to 6 hectares and by the mid-2000s, Ca Doi was completely gone.

Thus, it can be seen that the landslide situation in the Mekong Delta is very complicated; Erosion occurs in most inland and coastal provinces. Many landslides occur slowly, but the number of unexpected landslides causing great damage appears with increasing frequency. This shows that the erosion trend will continue to expand and evolve complicatedly, especially in the context of weather changes and hydrological regime changes increasingly in the near future.

Cause and warning

In order to assess erosion trends and future risks of landslides in the Mekong Delta, it is important to identify the underlying causes of erosion under a multidisciplinary approach lens. Because coastal and riverine erosion are the result of many different impacts, from geological, geomorphological, hydrological and climatic factors to human factors. From this perspective, several key causes are identified as follows:

Geological - geomorphological factors

The Mekong Delta is one of the youngest alluvial plains in the world. Based on the history of the formation of the world's continental plates, it can be seen that this delta is not formed on the parent rock geology like the Southeast region or other plains. Most of the area is deposited from the early Pleistocene period (about 1.2 to 2 million years ago) while many areas along the Tien and Hau rivers and wetlands in Dong Thap Muoi and Tu Giac. Long Xuyen ... is 4,000 to 6,000 years old based on C14 analysis. Therefore, the stability of the geological ground is very limited. Topsoil in Dong Thap Muoi, Long Giac Long Xuyen and U Minh suspension areas are mainly humus-shaped alluvial soil, formed from very thick decomposing vegetation layer. In the riverside areas, there is a porous, sweet alluvial strip, while the seaward side is a sandy soil, composed mainly of sandy soil with decreasing adhesion. Because of the above-mentioned characteristics, in general, the natural disintegration ability of the topsoil in the Mekong Delta is very high, the cohesion and elastic resistance to the effects of the flow is very limited.

In addition, low-lying terrain features with an average height of 1-1.2m also create advantages for erosion, especially during high tide (in coastal areas),

heavy rains and in the flood season. It is also worth noting that the terrain inclination in the direction of the flow of the Tien and Hau rivers (northwest - southeast) but along these two large rivers is a network of canals intertwinedly interconnected with the direction of almost perpendicular flow. Meanwhile, the water power in the confluence of the river will create very strong underground vortices. As these vortices move, they will create "frog jaws" at the junction and crossroads of the river and continue to penetrate the banks until the river bank collapses. The Vam Nao River, where the last landslide occurred, is a prime example of this factor. Because this section of the river connects Tien and Hau rivers, the collision between the two water created many whirlpools along the river with big waves and easily wrecked boats. Therefore, the local people have called this place Vam Nao ("Vam" means the cape where the confluence of two rivers, "nao" implies only fast and swirling water, making people flinch when they travel back and forth). This place still retains many folklore stories:

Thuyền xuôi Châu Đốc, thả xuống Vàm Nao, (Boats from Chau Doc, to Vam Nao,) Thăng tới Ba Sao, coi chừng con nước đấy. (Straight to the Ba Sao, watch out for the water)

or:

Bắp non mà nướng cửa lò, (Young corn grilling with oven door,) Đố ai ve được con đò Vàm Nao. (I challenge anyone to get to Vam Nao boat.)

Thus, the geological and topographical characteristics of the Mekong Delta itself create restrictions that make water flows easy to erode and cause landslides.

The factor of "double acting"

Climate change, in particular the sea level rise and increasing temperature amplitude by day and night, together with hydroelectric dams in the upper Mekong are creating a "double impact" on the natural environment in The Mekong Delta, making their consequences more swift and complex than any forecast from climate change scenarios in Vietnam. Global warming causes sea level rise while rising temperatures cause changes in the ocean currents in terms of range and

intensity of movement. The increase in sea water flow due to melting ice has increased the flow and energy of tidal currents impacting the coast on the move. In this context, the exposure of the coastal currents inevitably creates great stresses on the shoreline resulting in large-scale erosion. Therefore, the young geological features and the protruding coastline in the direction of the ocean currents, estuaries and coastal areas from Tien Giang to Mui Ca Mau become the most ideal for the erosion of waves.

In addition, the occurrence of upstream dams has prevented a large amount of sediment and annual water flow to the Mekong Delta. This not only causes a shortage of sediment resources to expand the coast, but also makes the water flowing from the Tien and Hau rivers insufficient, not enough to push the coastal currents away to reduce the intrusion. saltwater intrusion and limiting the amount of water impacting on the coast. Given the increasing encroachment from sea level rise while alluvial resources for deposition are increasingly exhausted, the retreat of the coast in the Mekong Delta is unavoidable.

Sand mining

Sand mining only creates benefits for businesses (and also illegal mining facilities), but the environmental and economic implications are immense and very difficult to recover. With the nascent geologic characteristics as in the Mekong Delta, the exploitation of sand will create huge deep pits on the bottom of the river, permanently changing the riverbed and the natural flow characteristics. According to scientists, it took hundreds of years for sand mines on the bottom of the Tien and Hau rivers to form and be fixed as today. In the context that the silt is not as abundant as it used to be due to dams upstream, it is unthinkable to expect sand mines to fill and revert themselves after mining.

Therefore, when there are many deep holes in the river bed, it will change the direction of the flow at the bottom of the river and create impacts large enough to create eddies and generate energy to impact the two sides of the river. times than normal. Cases of frequent and large-scale landslides in Tan Loc islet (Thot Not District) or areas adjacent to Can Tho and Hau Rivers in Ninh Kieu District,

Cai Rang District (Can Tho City) in recent years is a testament to how dangerous the deep pits that sand mining creates.

Land subsidence

This is a little-mentioned cause when explaining landslides in the Mekong Delta. According to the monitoring results from domestic and foreign organizations, including the announced results of the project "Rise and Fall" (Can Tho University in conjunction with the University of Utrecht - the Netherlands) and the Geotechnical Institute According to the Royal Art (NGI), the average rate of land subsidence in the Mekong Delta is 1-2 cm / year in rural areas and 2.5cm / year in urban and industrial areas.

The core cause of land subsidence is due to economic development and population explosion, which has led to an increase in rampant exploitation of underground water and massive expansion of the infrastructure network, creating enormous pressure on the ground. land. When the ground is subsided, the surface soil layer which has low cohesion will be forced down, exposed to river and sea currents. As a result, the process of erosion and slippery soil becomes easier and tends to occur under the "domino" effect - that is, a landslide area, water will quickly infiltrate the vicinity and continue. Create the next landslide hole.

The successive occurrence of other alarm landslides not far from the landslide area of the Vam Nao River shows that the landslide and subsidence are somewhat related. Therefore, in the studies to assess the causes of landslides in the Mekong Delta, it is necessary to mention and further study this relationship.

Socio-economic factor

According to customs and geographical factors, the residential areas are often concentrated in river sections that are favorable for living and trading such as confluence, river crossroads, banks, bays and estuaries. Unfortunately, such economically strategic settlements are at high risk of landslides (see topographic elements analyzed above). In addition, the population explosion and the expansion of the construction infrastructure network (roads, factories, industrial

parks, etc.) in these areas have increased the rate of land subsidence as mentioned above. , while construction foundations often create isolation from surrounding soil. When there is a combination of impacts from other factors, such as sand mining, the "alluvial" swirling lakes will tend to move to these urban areas and quickly form "frog jaws." "With a (negative) depth of tens of meters on the bottom of the river.

Therefore, the planning of riverside residential areas is the time to take into account the factors of load and bearing capacity of the local geology in order to prevent people and businesses from building on it. financial capacity than paying attention to the ability of land subsidence.

In addition, increasing industrialization also means the reduction of natural forest strips along the river. Some localities, such as Ca Mau, have chosen to clear the mangrove and nipa palm forests along Ong Doc river - a place with high risk of erosion - to develop urban areas and industrial production. In the long run, the replacement of these forest flaps with concrete embankments will not only end the process of natural sediment accumulation on both sides of the river, but also increase water strength and impact waves on the dike bank due to the wind was no longer hindered by the forest.

Risk and response

With tens of kilometers of coastline and hundreds of hectares of land being eroded, swept away to the sea each year, the appearance of the Mekong Delta is changing faster than ever. In the context that upstream and middle Mekong countries are trying to share water resources through hydropower projects and construction of irrigation canals, the small amount of sediment remaining when coming to the Mekong Delta will certainly not be enough. to maintain the existence of the current coastline. At that time, the prospect of narrowing the delta area or losing part of the Ca Mau Peninsula could come much earlier than expected. But the immediate risk is the risk of security, livelihoods and food security caused by riverbank erosion.

The above-mentioned analysis on the one hand shows that the landslide situation is caused by the resonance of many causes, so the landslide will become many times larger than normal and more difficult in forecast. Therefore, in addition to landslide mapping to identify and warn potential areas, the pooling of risk factors from the above causes of erosion may be a viable basis for receiving. Early exposure to vulnerable areas and high erosion risk.

For example, for river confluence areas, especially where the two flow regimes differ in intensity and water flow, where groundwater whirlpools and frog jaws often exist, it is necessary to Avoid populous planning and construction with large tonnage. The planning of riverside residential areas has taken into account the load factors and bearing capacity of the local geological foundation. In addition, the area around industrial riparian sites, where factories exploit groundwater for production, is also at a high risk of landslides.

On the other hand, the above causes also show that the human factor is becoming a key factor in the current landslide picture in the Mekong Delta. While domestic and international public opinion are opposed to dam construction and diversion projects upstream of the Mekong River, it is time for the functional sectors in Vietnam to recognize the underlying causes - their own cause. Clearly, the lack of sustainable planning in resource exploitation, in particular river sand and groundwater, together with the limitations in the management of local functional agencies over long periods of time, has created impacts. extreme geological movements (subsidence of the ground, formation of deep pits in the river bed, change of flow regime ...) are almost impossible to recover, making the landslide situation more complicated and increasingly serious.

Therefore, while promoting efforts to conserve water and the remaining sediment on the Mekong River, the self-reliant policy needed for the Mekong Delta at this time is sustainable urbanization and industrialization. forest cover to increase groundwater and minimize sand exploration and exploitation, especially in Tien and Hau rivers. In estuarine and coastal areas where landslides have not been or are less prone, it is necessary to promote activities of planting trees with good wave-shielding and sea encroachment properties such as mangrove, lucky, nipa palm... In landslide areas, localities The construction of breakwaters should be

integrated with the bunker construction method to retain alluvium instead of focusing on pure concrete breakwaters as today.

MSc. Quang Minh Nguyen, Can Tho University

[1] Ministry of Agriculture and Rural Development and Royal Norwegian Geotechnical Institute (NGI), [Dự án "Nghiên cứu sụt lún đất của Bán đảo Cà Mau"](#).