

# Proposing Solutions to Tackle the Issues of Slow Progress and Lack of Materials for Mekong Delta Expressway Construction Projects in Period of 2021-2025

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## ABSTRACT

Up to now, Vietnam has spent 12 years implementing the State's policies on building an expressway system, and has initially achieved certain promising results. However, regarding projects which have been put into operation and projects which are in the preparation phase for implementation in the Mekong Delta, there have been many major shortcomings in materials, design, traffic safety, and the environment, etc. Therefore, timely adjustments and improvements are needed to avoid unfortunate consequences and losses both in the immediate and long term. The article used the method of synthesizing research and analysis to evaluate the current status of expressway construction projects in the recent period, mainly on Mekong Delta Expressway projects, and offered 4 solutions based on a practical basis to make prompt adjustments for sustainable development of the Mekong Delta including 1) solution 1; 2) solution 2; 3) solution 3; 4) solution 4.

**Keywords :** Expressway, Climate Change, Sea Level Rise, Weak Geology, Saline Sand.

## I. INTRODUCTION

Vietnam's first expressway was built in 2004 (Saigon - Trung Luong). After 20 years of construction and investment, the country now has over 1,200km of expressways with many management and investment models (public investment, PPP, establishment of state-owned enterprises - "VEC"), the banks provide capital and establish its own enterprise to implement "VID/FI" investment, etc.) [1]

However, up to now, the expressway routes put into operation have encountered many shortcomings such as: causing a lot of impact on the environment, speed of exploitation, traffic unsafety, lots of congestion, lack of materials, etc... Meanwhile, the speed of highway development is very low compared to other countries in the region.

In addition to the slow construction speed due to lack of careful research, there have been many issues

related to the investment in building expressways, both in short term and long term, including:

+ The amount of sand is too large, but the preparation of sand mines and earth mines is not well. Even the directions of the Ministry of Transport, the Ministry of Natural Resources and Environment and localities are not timely, while there have not been any material replacement solutions with specific plans and treatment solutions [2].

+ There have not been comprehensive plans of alternative viaduct design options when passing through weak soil areas and serving flood drainage work in the entire Mekong Delta region.

+ There have not been solutions for materials such as embankment soil, stone, and high-strength concrete to cope with increasing climate.

+ Water drainage and flood drainage measures have not been given due attention, causing flooding of the road base and road surface, road destruction since the roads have been accidentally turned into flood prevention dikes.

+ Calculations about the increase in climate change affecting the quality of works, even causing the destruction of works, have hardly been given due attention [3].

According to research by Prof. Dr. Tran Dinh Hoa, Director of the Southern Institute of Irrigation Sciences, "Countries such as Germany and the Netherlands are one of the phenomena of strong strongholds in preventing natural disasters and climate change" (July 2021). In July 2021, exceptionally heavy rain occurred in Germany, Belgium and other European countries with a probability of once every 1,000 years. Eastern Belgium has heavy rainfall of 271mm/48h, especially in Reifferscheid (Germany) with rainfall of 207mm/9h. Heavy rains killed 217 people, over 1,000 people were missing, and economic losses were estimated at over 5 billion USD.

- Landslides and flash floods in Guizhou, China in 2019 left 50 people dead or missing.

- Floods and flash floods in the Southern provinces of Japan in July, 2018 caused dikes to break, leaving over 200 people dead and missing.

- Harmful heat and cold: Mount Fuji is the symbol of Japan. In December 2020, there was no snow like every year. Snowfall, considered common in cold countries, appeared in Johannesburg City (South Africa), a region of the hottest continent in the world, on August 7 and 8, 2012, etc.

According to the World Meteorological Organization (WMO), June 2023 was recorded as the hottest June globally and higher than the previous record in June 2019. The average temperature in both the world and Vietnam has tended to be higher than average over the past decade [4].

Drought and lack of flow cause saltwater intrusion in the Mekong Delta to become more and more serious. In about 5 years, we have faced two extremely serious dry seasons of drought and saltwater intrusion (2015/2016 and 2019/2020), greatly affecting the socio-economic and people's lives. Meanwhile, the transportation sector has a very close connection with the response to natural disasters and climate change.

Thus, it can be seen that the preparation work for expressway projects has not been thoroughly conducted, especially the assessment of regional environmental impacts and materials. The appraisal work could not detect such issues, so they cause the phenomena mentioned above. In order to promptly take measures to correct errors in some projects of the transport sector, this article reviews the recent highway construction projects of the transport sector in the Mekong Delta region, through a number of basic areas and then, proposes adjustment solutions.

## II. ASSESS THE GEOLOGICAL - TOPOGRAPHIC AND HYDROLOGICAL CHARACTERISTICS OF THE MEKONG DELTA

The Mekong Delta is a lowland area with weak soil type (silt, clay, clayey mud, sandy mud), with a wide

distribution area, occupying a position from the south of Vam Co Dong River to the tip of Ca Mau.

In parallel with the process of sea receding due to the fact that the Mekong River begins the process of filling low-lying areas, gradually encroaching into the sea with new alluvial layers. Thus, the Mekong Delta is formed through a long-term geological process, mainly deposited by alluvium from the Mekong River, quite flat with a low elevation of no more than 2m. In the delta, two hollows are also formed, Dong Thap Muoi and Long Xuyen Quadrangle [5].

The thickness of soft soil tends to increase gradually from North to South and towards large rivers. In the south of Ca Mau, almost the entire area between the Tien River - Hau River, the coastal area, the thickness of soft soil is greater than 20m.

All types of soft soils have high natural moisture and tend to increase gradually from North to South, with low shear strength and large compression resistance coefficient, so the load-bearing capacity is low [3,4].

The construction of traffic works, especially works that bear large static live loads and have long lifespans on soft soils, faces many difficulties, requiring a lot of investment in foundation and drainage treatment.

The stability of structures on weak ground, especially in the Southwest of Vietnam, is also threatened by river bank erosion and coastal erosion due to thousands of kilometers of dense rivers and rivers being depleted of alluvium. The process of river bank erosion is very common, especially along the large rivers of the Southwest (Tien River, Hau River, Vam Nao River, etc.)

Hydrological conditions

Typical water levels (average, maximum, minimum) change depending on the wind regime in the East Sea. The northeast monsoon over the East sea pushes water toward the West of the East Sea, causing the average water level to increase. In the months from April to August, the southwest monsoon will push water from the West to the East, so the average water level drops. Oscillation regime of sea level: water level rises and falls twice daily according to tides, high water levels

during the year usually appear in September, October, November [4].

Thus, building an expressway in the Mekong Delta faces many challenges at the same time:

+ Low terrain, weak ground, flooding, subsidence, sea level rise, erosion and landslides are becoming more and more serious. On the other hand, the lack of sand materials creates an increase in dredging, leading to increasingly serious landslides. If there is a shortage of river sand, using sea sand to compensate for the subsidence. Researching on replacing sand materials has been still very fragmented and not thorough, so the project implementation plan will completely lack a practical basis.

There are also inadequacies that are difficult to explain such as:

+ If there is not enough investment capital, the express design will be smaller with only 2 lanes, no emergency lanes, ignoring the factors of driving speed, traffic safety, congestion, rescue activities, etc.

+ Roads are built on weak, low-lying land, but drainage plans have not been carefully studied, especially in low-lying, low-altitude areas such as the Mekong Delta.

+ Toll collection policy is rigid (2,000 VND/km), completely ignoring regional characteristics and lacking a business strategy, especially in attracting vehicles [2,7].

To clarify the inadequacies, we can evaluate through a number of expressway projects that have been built through some remaining Southwestern provinces from different aspects.

### III. EVALUATING THE ISSUES OF SOME EXPRESSWAY PROJECTS IN MEKONG DELTA

#### Complete expressway projects

##### a) Ho Chi Minh City - Trung Luong Expressway Project

Ho Chi Minh City - Trung Luong Expressway was publicly invested in 2004 and is the first expressway project in Vietnam with a route length of 61.9 km. The

starting point of the route is at Binh Chanh District - Ho Chi Minh City, the final point is Chau Thanh district - Tien Giang province.

The route is invested to build expressway standards of type A, level 1 corresponding to  $V_{tk} = 120\text{Km/h}$ , phase 1 to build 4 lanes and 2 emergency stopping lanes ( $4 \times 3.75\text{m} + 2 \times 3,0\text{m}$ ) with a roadbed width of 25 to 26.0 m.

Drawbacks:

- The project had to be adjusted right from the beginning, replacing some road sections on the ground, due to weak ground and lack of backfill materials and leveling sand. According to experts, the design was changed timely, the project achieved the set goals but had to prolong the schedule due to additional designs.

- The environmental impact assessment work has not been strictly controlled by the appraisal agency. As a result, the rice plants along the route were continuously illuminated by the high-pressure lights of the roads at night, causing them to develop abnormally. The rice bloomed unevenly with high rate of flat rice. The project had to re-adjust the lighting system, leading to wasting investment funds [4]. It proves that the appraisal agency has not fulfilled its responsibilities or lacked expertise in assessing environmental impacts. And the state management lacks measures to monitor and learn from such experience.

- Poor planning, leading to lack of connection and failure to promote regional connectivity. The routes intersecting with the expressway down to Ben Luc district are not complete. When the project is put into operation, a component project must be added. Currently, the ongoing project has to be stopped because the management contractor violated the law. This proves that there were problems in the project appraisal work, not considering the connection aspect. Although the above shortcomings have been overcome relatively promptly, in order to invest in expressway routes in the Mekong Delta, lessons need to be seriously learned [7]

- The operation and management (O&M) process is incomplete. After transferring the state project, the lack of binding terms led to a loss of state capital revenue (about VND 725 billion in taxes, not to mention the inaccurate determination of vehicle traffic due to not applying ETC automatic fee collection). It proves that state management has not done a good job in project transfer contracts and in controlling toll collection activities [7].

All of the above shortcomings indicate that there are issues in the legal corridor, project management and control process in the investment preparation phase. It is necessary to make adjustment to increase the efficiency and transparency of the project, on the basis of consensus of investors and the community to limit the loss of state assets.

#### **b) Trung Luong - My Thuan Expressway Project**

Route length is 51.5km. The first point is adjacent to Saigon - Trung Luong expressway (My Tho city), the last point is the intersection with National Highway 30 (Cai Be district - Tien Giang province).

The project started in 2009 and was basically completed in phase 1 of June 2022 (connection work was expected to be completed by December 2022).

During the trial operation from June 1, 2022 to June 30, 2022 (30 days), it was recorded by the operation management unit that there were 720,000 vehicles/month (Average of 24,000 vehicles/day and night). In terms of traffic safety, there were 25 traffic accidents without casualties.

The total project investment is 8,304.856 billion VND (including bank loan capital of 4,781.021 billion VND; equity capital of 1,589.805 billion VND; other mobilized capital of 1,934.029 billion VND).

Regarding the road fare plan, the Tien Giang Department of Finance organized an appraisal in June 2022 and the People's Council decided on a unified toll price (vehicles with less than 12 seats, loading less than 2 tons are 103,000 VND/turn; vehicles with a load capacity from 18 tons and 40-foot container trucks are 334,000 VND/turn).

From August 1, 2022, the project officially started collecting fees to pay back capital for the project. According to investor reports, from September 1, 2022 to October 1, 2022 (one month), there were a total of 507,568 vehicles passing through the station. Thus, the actual number of vehicles passing through the station only accounts for 70% of the number of vehicles during the trial period. So if the price of gasoline and materials escalates, leading to increased transportation costs. There are insufficient maintenance costs due to the number of vehicles passing through the station possibly decreasing. As a result, it is very difficult in terms of financial plan, causing disputes between the state and investors.

- Fare increased compared to the average price of other stations since the notice No. 99/TB-VPCP dated March 18, 2019 on a meeting chaired by Prime Minister Nguyen Xuan Phuc, deciding on a project's payback plan of no more than 15 years. Therefore, the People's Committee of Tien Giang province has decided that the project fee collection period is 14 years and 8 months. Thus, the ticket price for vehicles passing through the station must increase, causing transportation costs to increase. To reduce costs, vehicles must switch to national way 1. The number of vehicles passing through the highway decrease. This can easily disrupt the financial plan of the project. In the short term, there may be a lack of maintenance funding. [7]

Evaluating the perspective of traffic safety and operating speed

- Phase 1 design has a road surface width of 17m, including 4 lanes, each lane is 3.5m. Both directions have no emergency lanes, driving speed is from 60km/h - 80km/h. Meanwhile, a report by the Department of Transport of Tien Giang province from January 28, 2022 to February 6, 2022, during the trial operation of the route, there were 4 traffic accidents, killing 1 person and damaging 10 vehicles. From April 30, 2022 to June 9, 2022, through trial toll collection, there were 225 incidents, causing congestion for many hours. Rescue work was also slow due to lack of

connection routes, and no emergency lane for rescue vehicles to enter. This has caused concern for drivers, especially trucks carrying frozen seafood from western provinces to Ho Chi Minh City and the southern key economic region, not daring to cross the route due to accidents and traffic jams. Aquatic products are easily damaged, while trucks are banned from entering the city during the day, which will cause great damage to the food suppliers. On the other hand, highways without emergency lanes will always create psychological instability for drivers when driving. It is easy to break the financial plan, creating many disputes between the state and investors, causing a reduction in investment attraction. There are also potential risks and the projects may suffer losses. [7]

An interview of Saigon Giai Phong Newspaper with Mr. Le Kim Thanh, Director of the Highway Department (September 2023), he also admitted that with the current reality, some new expressway projects only have 2 lanes. Speed must be limited to ensure traffic safety and we must wait for phase-2 investment to meet design requirements due to lack of funding. Thus, in the opinion of experts and the authors, investments such as Trung Luong - My Thuan Expressway are too wasteful and have low investment efficiency.

Investment perspective

Up to now, the exploitation time has only been about 15 months, but many shortcomings have arisen. This forced the Government to invest in phase 2 (widening the road by about 12m), which causes a waste of investment funds. This also caused many problems including: difficult for the design work, having to adjust the vertical and horizontal drainage systems, lighting, etc. Also, it also needs to adjust the loading time of phase 2 to ensure uniformity of the two phases. In addition, this decision creates insecurity, social problems since many times of land clearance have disrupted people's lives in terms of income, resettlement and changes in production structure [7].



**c) Cai Lay bypass project (Cai Lay town, Tien Giang province)**

This is an investment project under BOT mode to build National Highway 1 bypass and strengthen Highway 1 section through Cai Lay town, route length of 38km, in which the length of new investment bypass is 12km, the length of the old National Highway 1 is 26km. The project started to collect fees from August 1, 2018.

The lowest toll is 35,000 VND and the highest is 180,000 VND/vehicle.

Issues of the project:

The toll collection process has caused social insecurity, because people made protests. People, especially those in Cai Lay town area, near the protest toll station, put their vehicles into the toll station and then leave the vehicles to obstruct the road, creating congestion at the station. Some violent individuals also threatened toll collectors. To ensure the security, local authorities and police had to intervene for several days, but the issues continued. Finally, the project must stop the fee collection.

The above phenomena are due to the following reasons:

- Toll rate: Vehicles passing through bypass or only going to or through Cai Lay town, not passing through bypass to pay or receive goods are subject to the same toll rate. Even a car that only goes within the town still has to pay the prescribed fee, there is no discount.
- The section along the National Highway 1 is only repaired and upgraded and the investment principle on the existing roads does not use BOT investment but must be public investment. However, the Cai Lay bypass BOT project still violates the investment in the existing road (National Highway 1), which is invested by BOT mode. Therefore, there is a reason for public opinion to protest, causing social insecurity. And as a result, the state had to buy back the project to correct its mistakes because the project's financial plan was easily broken. Currently, the investor has been arrested for many violations of the law from different angles [7].
- On the other hand, when the project was acquired by the state, in 2020 (after 2 years of being put into

operation), many sections had to be repaired due to subsidence and cracking of the road surface. One of the reasons is the lack of drainage system. When there is heavy rain, water on both sides overflows onto the road surface, leading to the quality of the route being not guaranteed. Moreover, due to the construction process in terms of material quality and construction techniques, the control of the project implementation process is not guaranteed. Lack of rigor in the project creates cracking, breaking, subsidence, and collapse, causing disruptions in operations, raising doubts about the lack of transparency and quality of the project [7].

**Eastern Expressway projects in the period 2017:2020, 2021:2025**

The period of 2017 ÷ 2020 has a route length of 654km, divided into 11 component projects: Expected to be completed by the end of 2021.

But up to now, the project has basically completed about 70% of the volume. It is expected that it will be completely completed by the end of 2025 [8].

Issues of the projects:

- *Project preparation and technical design:*

Basically, many segments of the project are designed according to Level 2 Expressway standards, roadbed width Broadbed of 17m, speed of 80km/h. Similar to Trung Luong - My Thuan Expressway, they do not have emergency stopping lanes. Therefore, identifying these sections as the Delta expressway is not accurate. On the other hand, current vehicles are very diverse, with different levels of safety. Damages can occur at any time, so, it is very difficult to ensure traffic safety. Actually, in two months (from April 30 to July 31), in Nha Trang - Dau Giay section, there were 5 major accidents, causing deaths and damaging many vehicles.

- *Appraisal process:*

These are very large, motivating projects that are the driving force for economic development in the Mekong Delta. But the appraisal work has probably not been done carefully, lacking of transparency. It can be said that this is the responsibilities of state management, resulting to inhibiting the economic

development of a quarter of the country. Urgent adjustments are needed to avoid loss, waste, and low investment efficiency.

- *In terms of materials:* The volume of backfilling materials has been basically calculated in the bidding documents, right from the basic design stage. There are relatively accurate data, but the preparation of material sources must be done by the Ministry of Transport. This Ministry needs to create a specific plan and agree with localities along the route about sand mines. But this work is not carefully prepared during the construction preparation phase, so during the construction phase, contractors had to wait for administrative procedures such as: licensing to clear forest land for exploitation, environmental impact assessment, etc., causes months of delays. This error belongs to State management and it requires serious experience in materials work.

- *The environmental impact perspective:*

This is a problem that requires investment in research and preparation when establishing an investment project. In other words, it can be said that the environmental impact assessment documents must be very thorough and detailed because of the following reasons: [2,4,6]

(1) The Expressway projects in Mekong Delta are divided into component projects for many different reasons, with different investment times. If we only evaluate each project individually, it will be a problem for the environment. The Mekong Delta has nearly 600km of coastline with thousands of kilometers of interlaced rivers and canals. If the construction of solid expressways is not thoroughly assessed for environmental impact, these roads will inevitably create water-blocking dikes, causing local flooding, destroying production, traffic works, etc.

(2) The Mekong Delta is increasingly narrowing not only due to landslides, but is also sinking at an average rate of more than 1cm per year, plus 3-8 times the increase in sea level. Therefore, every year, the Mekong Delta is becoming gradually lower than sea level (Southern Institute of Irrigation Science) [2,4,14].

Research by Dr. Rafael Schmitt (Stanford University) and his colleagues in 2021 showed that 23-90% of the Mekong Delta will be submerged under the ocean by 2100, depending on sediments, groundwater levels and sea level rise. Thus, the Mekong Delta downstream of the Mekong River is the last place to appear but will disappear and be submerged first when sea levels rise as calculated.

Thus, predictions and calculations about economic development will become meaningless when climate change is increasing and sea levels are rising. The flood intensity is high, the rate of shoreline erosion is increasing and the most important problem is the landslides. Landslides prevail because the Mekong River lacks silt, sand and gravel - the main materials that create the shape of the Mekong Delta.

The Mekong River Commission determined that since 1994, the annual amount of sediment flowing downstream has decreased dramatically from 160 million tons/year (1992) to 47.77 million tons/year (2021). This agency forecasts that by 2040, there will be only 4.5 million tons/year, a decrease of 36 times compared to 1992. An extreme forecast also states that when downstream hydroelectric dams are completed (400 dams), 100% of the sand, gravel at the river bottom will be completely retained by the dams. Along with that, the occurrence of landslides in the Mekong Delta is clearly increasing, from less than 100 landslides (before 2012) to about 600 today. River, canal and creek landslides are concentrated in upstream provinces such as An Giang, Dong Thap, and transition areas affected by slopes and upstream such as Can Tho, Tien Giang, Vinh Long to the coastal areas including Soc Trang and Ca Mau [4,5,9].

According to Mr. Goicho, Head of the freshwater program of the International Organization for Conservation of Nature (WWF) in the Asia Pacific region, compared to delta areas such as the Rhine River (Netherlands) and Mississippi (USA), both also encountering similar problems as the Mekong Delta, they progress much slower than in Vietnam.

Thus, the Mekong River is killing the Mekong Delta. According to experts, since 1992 until now, landslides have escaped natural laws and are increasing dramatically.

According to statistics from the Southern Institute of Water Resources Research (SIWRR), the number of landslides in the Mekong Delta tends to increase. In the first 6 months of 2023, the Mekong Delta had 145 cases of landslides on river banks and canals, more than the number in the entire year of 2022. The root cause of landslides is that the Mekong Delta is starving for sand and silt. Mr. Marc Goichot said that when the river no longer had sediment to fill the deep holes at the bottom. "It will attack the land on both banks" [1]. According to WWF Vietnam (National Sustainable Sand Management Project), recent scientific studies indicate that the Mekong Delta is experiencing serious sediment imbalance. Each year, the volume of sand poured into the Mekong Delta is 6.8-7 million tons, while the amount of sand exploited is 28-40 million tons along with the amount of sand dumped into the sea of about 6.5 million tons [2, 4,6,10].

Thus, the Mekong Delta has a deficit of 27.5 million tons of sand each year.

The sand mining process has created deep holes in the river bed, the river needs sand from upstream to fill the deep holes. However, hydroelectric dams have trapped silt, causing the amount of material downstream to decrease. According to the rule, the main stream will drain mud and sand from the main river bottoms, and the river bottom draining chain will spread to smaller tributaries. That was when landslides spread throughout the Mekong Delta.

The problem of lack of alluvium, sand, and landslides occurring in all main rivers and spreading to all secondary branches will become increasingly serious. Thus, the construction of expressways in the Mekong Delta using freshwater sand is very difficult to implement. If you use saltwater sand, you have to wash the sand, which costs a lot of water resources and causes the problem of lack of fresh water. If you take unsalted sea sand, it will bring salt into the freshwater

ecosystem and the spread of salt to weak and low-lying land like the Mekong Delta is very high [2,14].

On the other hand, sea sand exploitation, if not carefully calculated, will once again cause coastal erosion, causing even greater consequences [2,15].

The above arguments show that the projects to build expressway routes in the Mekong Delta needs to be reconsidered from all perspectives, including the following basic stages: 1) Project preparation and route outlining; 2) Design; 3) Materials; 4) Environmental impact assessment from a master planning; 5) Traffic safety when vehicle size, density and traffic speed are increasing.

Currently, through the practice of the new Mekong Delta expressway projects in the early stages of the investment implementation process, the authors realize that there is a need for adjustment with a long-term perspective. This is to increase investment efficiency by extending the life cycle of the projects. And the immediate task is to minimize the increasing impacts of climate change (disasters caused by climate change).

## IV. SOLUTION SYSTEMS

### A. Solution building orientations

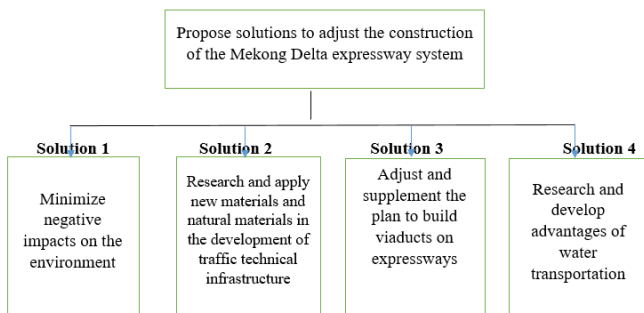
- Economic development speed of the Mekong Delta.
- Review and readjust planning for the Mekong Delta, including planning for coastal areas where sand can be exploited based on the reality of climate change.
- Minimize the increase in climate change causing increased temperature, high-intensity extreme rain, and saltwater intrusion encroaching deep into the field.
- Overcome the shortage of backfill materials and freshwater sand
- Minimize the rate of subsidence and landslides in the Mekong Delta
- Accelerate scientific research on the production of artificial sand from rocks mined off the islands.
- Research on the use of saline sand (desalination) and coal in thermal power plants.



**B. Solution system**

- The Mekong Delta is planned with expressway routes. Although the route planning and design work has been temporarily arranged, the appraisal and assessment of environmental impacts, materials, and traffic safety need to be seriously considered on a large scale to have timely corrective solutions for the following reasons:
- The Mekong Delta has a relatively flat terrain with 2 low-lying areas, Dong Thap Muoi and Long Xuyen Quadrangle. In the flood season, the flooding in these areas is very large. This helps avoid flooding, destroying the foundation, road surface, and killing crops, especially rice, such as the meter-long flood (km 58) of the Phan Thiet - Dau Giay expressway. At this time, this has not been completely resolved, causing traffic congestion and deterioration of road surface quality [2,11].

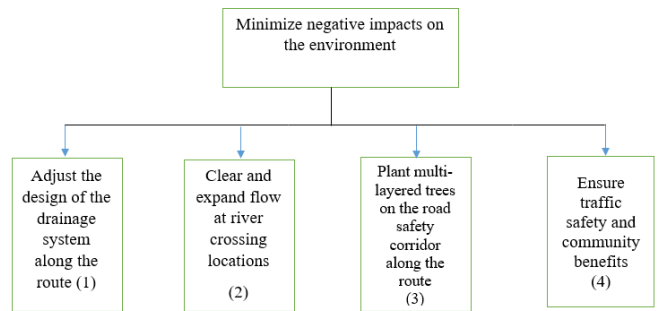
Thus, the road system in general and the expressway routes in particular need to be comprehensively researched from all aspects of the environmental impact, materials, traffic organization, etc. .. to serve as a basis for drawing routes, flood drainage plans, design plans, construction materials, etc. Propose solutions to adjust the construction of the Mekong Delta expressway system are showed in Figure 1.



**Figure 1.** Propose solutions to adjust the construction of the Mekong Delta expressway system

**a) Solution 1: Minimize negative impacts on the environment**

Purposes: Learning from experience through a number of implemented projects, there are still incidents of flooding causing destruction of road surfaces, traffic congestion, etc. The Mekong Delta is a low-lying area, so careful attention should be paid. Minimize negative impacts on the environment are illustrated in Figure 2.



**Figure 2.**

(1) On expressway routes, there is always a strip of reserve land for the purpose of route expansion, which investors often use the word: for “Phase 2 investment”. Therefore, planning (rearrangement) is needed for such strip of land to arrange drainage culverts along the road with solid concrete culvert walls. In addition to the task of draining surface water, it also serves as a retaining wall and keeps the roadbed soil from being destroyed by water due to local flooding. We can solve this problem in design and construction.

In addition, the vertical drainage system is also responsible for retaining water to prevent fires and take care of trees.

(2) Clearing and expanding the flow at river crossing locations increases the drainage capacity of natural river systems, canals, etc. And this also has the effect of protecting bridge abutments, piers, and bridge leading roads from flooding and local vortexes caused by natural obstacles.

(3) Increasing thick, multi-layered trees along the route not only ensures environmental problems but also reduces the temperature of the route, blocks smoke and dust, stabilizes the ground along the route,

and blocks the light of the streetlight system so that crops along the route can grow normally, etc.

(4) Re-evaluating traffic safety and community benefits: Current road routes in general, and expressway routes in particular, current designers pay attention to standards and regulations when designing roads (vertical curves, horizontal curves, bridges on the route, super high, road surface roughness, drainage, etc.). But regarding the environmental problems of the Mekong Delta as mentioned above, we have not paid attention to drainage issues, about trees, etc. as well as the problem of the social environment. This also has not been thoroughly taken care of, leading to major consequences. For instance, the Noi Bai - Lao Cao expressway when put into operation, farmers along the route have demolished road safety corridor barriers to pick up passengers and lead animals across the route. This is because there are no underground tunnels, and the detour is too long. So they have to lead their cattle cross the expressway. As a result, 11 people died and 5 people were injured [7,13].

Along the 51km long Lo Te - Rach Soi Expressway passing through Can Tho City and Kien Giang Province, there are dozens of fence locations that have been dismantled, becoming a major threat to vehicles participating in traffic when traveling at high speeds of 80-100km/h. Or the Cam Lo - La Son Expressway passing through Quang Tri and Thua Thien Hue, 98.35km long, has dozens of places where people have cut through protective fences. A similar situation also occurs at Ho Chi Minh City - Long Thanh - Dau Giay Expressway, Lien Khuong - Da Lat Expressway, etc.

The reason why people destroy fences and guardrails is simple. They want to go to their family's land and have to go dozens of kilometers away, which takes hours. On the other hand, when they have to bring cattle and working tools, the only way is to cut the fence and remove the guardrail. This is a sad reality, but it still happens. It is difficult for the road management unit to manage it. This proves that the appraisal and assessment of impacts on the natural environment and social environment is not thorough and not based on

community benefits. Therefore, the solution is to build a viaduct in the Mekong Delta is the best solution to solve many problems of flood control, drainage, lack of materials and community benefits along the route.

#### **b) Solution 2: Research and apply new materials and natural materials in the development of traffic technical infrastructure:**

Purposes: This issue occurs not only in Vietnam but also in other regional countries. In Vietnam, Eastern expressway construction projects in the 2017 - 2020 period are behind schedule. Also due to lack of materials, projects from 2021 to 2025 need timely adjustment solutions.

Application of new materials is an urgent issue but up to now it has not been given thorough attention. In traffic construction industry, there have not been specific solutions to ensure the quality of works, especially materials, and minimize the impacts of environmental factors, in the context of increasing climate change. This helps investors and design contractors have many options for choosing materials suitable to project characteristics to save costs, ensure quality and construction progress, and ensure functionality and longevity with the following criteria:

- For producing construction materials, we must eliminate outdated production technologies that consume a lot of resources and pollute the environment.
- The development of construction materials requires the application of science and technology to minimize the use of natural resources and minerals, maximize the use of industrial by-products, save energy, and protect the environment.
- Innovate and perfect standards, regulations, techniques, promote research activities that are groundbreaking and boldly applied to production practices in the context of increasing climate change.
- Increase the application of new materials adapted to climate change to limit the impact of climate change on vulnerable construction items of traffic projects such as abutments, bridge piers, roadbeds, pavements,

slopes, etc. .. To concretize the problem, we can give a few specific examples:

#### - *Sand*

Currently, according to the design, the basic material for road construction is to use sand. But currently, the 13 provinces and cities of the Mekong Delta are a late-formed, low-lying delta with weak ground. On the other hand, under the conditions of climate change and sea level rising, freshwater sand mining will create deep holes (depressions) in the river bottom while alluvium is being depleted by nearly 400 hydroelectric dams in the upstream of the Mekong River. What can we do to compensate for the depressions in the river bottom? The river is starved of alluvium, forcing it to take land along the banks, which will cause increasingly large landslides, affecting the system of abutments and bridge piers across the river.

- The idea of using sea sand to replace river sand, even though it is only a pilot program, needs careful considerations. There were scientific topics conducted 20 years ago but have not been applied because of the constrained legal system. There are too many decisions as well as the slow innovation of ministries, branches and localities with outdated ideas that do not dare to make breakthroughs, afraid of making mistakes. But up to now, because there is a shortage of freshwater sand, the investor (Ministry of Transport) has recommended that all relevant units proactively research and replace freshwater sand with saltwater sand. The problem now is where to get fresh water and where to discharge it to wash away saltwater. On the other hand, if the sand is not washed, does it mean that salt has been introduced into the freshwater ecosystem? The problem of how the environment is desalinated has not been clarified. Moreover, due to the physical and mechanical properties and settlement deformation of small, round sand particles, the settlement time and geology of the different routes need to be adjusted to avoid prolonged settlement treatment through the exploitation stage. On the other hand, it is necessary to have a plan for the exploitation area, exploitation reserves for large sand

grain size with low mud content and low salinity. Exploratory studies are required to ensure the quality of road routes [ 2].

Note: Sand mining must be relatively far from shore, away from the delta shelf, to ensure stability of the delta shelf and not cause coastal erosion.

#### - *Stones*

Currently, qualified stone materials are temporarily sufficient to meet the requirements for building technical infrastructure. However, with the current rate of technical infrastructure development, stones materials with enough strength will eventually decrease, the same situation of sand.

On the other hand, stone mining in the period of increasing climate change can easily cause landslides, flash floods, pipe floods, etc., causing local stone scarcity. This requires long-term research orientations to exploit stones on deserted islands at sea. In particular, the research of environmental pollution and the impact of continental shelf erosion needs to be carefully studied.

#### - *Ash and slag materials, rice husks*

Currently, thermal power plants in Vietnam have a lot of excess ash and slag that must be dumped into the sea. Rice mills in the Mekong Delta, which is the rice granary of the whole country, also have a large amount of rice husks every month, causing many problems. There have been already many scientific studies in this field. However, we do not have any extensive and in-depth appraisal work to make decisions for the solutions. Thus, the role of the Ministry of Science and Technology needs to be promoted in a breakthrough way to solve the shortage of materials.

#### **c) Solution 3: Adjust the viaduct construction plan on the Mekong Delta Expressway.**

Purposes: The issues of drainage, and minimizing negative impacts on the environment are very necessary for the Mekong Delta. When the rate of subsidence is very large, so the viaduct solution will meet the requirements of weak geology, drainage of

surface water and flood water, and meet the requirements of sustainable development of Mekong Delta.

- Because the routing and design have been arranged, there is still time to correct errors and supplement the design at this stage, to avoid unfortunate mistakes later for the following reasons: [2]

+ Along with the main streams of the Tien River and Hau River, there is an intricate system of canals with a density of 4km/ km<sup>2</sup>. On the other hand, the Mekong Delta is a low-lying region, filled with marine or continental sediments (sandstone, schist, limestone, etc.). The structure of this sediment is mainly composed of coarse particles ranging from 66-75% of sand, 5% of rounded gravel, the rest is light gray less plastic clay. The thickness of the new alluvial layer gradually increases from North to South and from land to sea. On the surface, riverbanks and relatively high coastal sand dunes appear. In the delta, two large depressions are formed: Dong Thap Muoi and Long Xuyen Quadrangle [2,4,9].

Thus, when designing road routes or expressways in the Mekong Delta, we must pay close attention to the ability to drain surface water and flood water (in flooding season) in order to minimize the risk when designing roads and avoid water retention. Local water during the flood season cannot drain in time, causing flooding and destroying crops. On the other hand, in the dry season, salt water follows the ocean tide deep into river branches blocked by roads. Then, it easily spreads on the ground and easily stagnates because salt water is heavier than fresh water. Therefore, it is easy to spread into farming and aquaculture areas, causing destruction of the ecosystem of shrimp and freshwater fish farming areas, etc. This shows that although the viaduct lane solution in the Mekong Delta does increase drainage costs, for sustainable development, this solution will be optimal, solving the phenomenon of lack of materials as well as solving environmental problems throughout the Mekong Delta region. With the Mekong Delta sinking at a rapid rate and river bank

erosion, the coast is threatened by sediment shortage while climate change is increasing.

#### **d) Solution 4: Research and develop advantages of inland waterway transportation:**

Purposes: It is a traditional type of transport with low cost but great support for transport with 14,826 km of river routes. Therefore, research is needed to have necessary support measures to develop the strengths of inland waterway transport [1,4,5].

This type of waterway transport has existed and developed in the Mekong Delta for hundreds of years and is a traditional form of transport for residents of the region. The total length of the Mekong Delta waterway is 14,826.4km with 0.61km/km<sup>2</sup> including 2 vertical routes and 5 horizontal routes. There are 57 inland waterway ports and 3,988 inland waterway wharves (small-scale wharves), lacking specialized ports for containers [4,6,9,12].

The current water transportation system does not ensure the connection between seaports and inland waterway ports, between inland waterways and the road transportation system. There are no large logistics centers in the region, so this is a problem. It is necessary to start working immediately and start with the clearance of boats, followed by research on landslide prevention in curved river sections. The authors also give examples of water transport, typically the two high-speed boat routes from Ho Chi Minh City to Vung Tau and Ho Chi Minh City to Can Tho. Two routes developed massively at first and gradually disappeared. Particularly, the Ho Chi Minh City to Can Tho route only operated for a short time and had to be stopped due to its high speed causing shoreline erosion and greatly affecting people's water vehicles, both upstream and downstream, etc.

(1) The investors have not carefully researched the type of high speed train when using in the Mekong Delta. Since it will cause shoreline erosion, issues for people along the rivers. The investors must accept the risk of stopping operations and losing investment capital.

(2) State management for the development of this type of business has almost no strategy, so there is planning, but not careful survey, no plan for train types, train operating speed. There will inevitably be consequences for such issues.

For the above reasons, it is imperative that state management must re-adjust the planning of waterway routes for transporting goods and passengers; inland ports; load, capacity and speed of waterway vehicles; connecting with road traffic. Such plans need to be conducted immediately to support road traffic in conditions of high vehicle density, increasing load, subsidence, as well as lack of sand materials.

On the other hand, when there is detailed, complete and careful planning, there can be direction for the type of watercraft and maximum load involved. It is also necessary to harden the coastal line, river banks to avoid landslides and dike breaks causing flooding. This will serve as a basis and orientation for investors and Ministry of Transport to plan for waterway development.

## V. CONCLUSIONS

The article has synthesized the current situation through the practice of road traffic construction projects taking place in the Mekong Delta, under the increasing impact of climate change and the shortage of alluvium, leading to complete loss of alluvium due to hydroelectric projects on the Mekong River. Just as the subsidence of the Mekong Delta increase due to the depletion of groundwater and low rainfall, the flood season also cannot compensate for the amount of water due to the high rate of groundwater exploitation. Because of these things, we must be even more careful in developing technical infrastructure systems, including transportation technical infrastructure, which can easily cause negative impacts on the environment, especially in the Mekong Delta, causing great consequences for the economic development.

The authors have proposed a number of solutions although they are only immediate solutions. In the

long term period, fundamental solutions are needed to cope with the increasingly sinking Mekong Delta, groundwater exploitation and sediment shortage, increased saltwater intrusion, etc. We need to propose feasible solutions for sustainable development of the Mekong Delta, minimizing the negative impact of humans on nature in the context of increasing climate change. People have been disrupting the natural laws; cities and lands that were once very prosperous but are now sunk deep in the ocean. Therefore, we need to have immediate action for those problems.

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