PROJECT FOR ECOLO-ENVIROMENTAL IMPROVEMENT IN SANDY REGION OF QUANG TRI PROVINCE

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I. The Indispensability of the Project .

1. Position and Characteristics of Sandy Region in Quangtri .

Sandy region of Quangtri Province has an acreage of 28,630 hectares It is 6.2% of natural land; 54% of plain area. It is even larger than the paddy and subsidiary crop land. The sandy region has expanded its sizes by occupying arable land, and land for housing at villages. It may be divided into two sub-regions :

- Inland sandy sub-region : has an acreage of 7,570 hectares , including the sandy regions Hau Hau of Giolinh district; Ai Tu of Trieu Phong district and Dien Sanh of Hai Lang one .
- Coastal sandy region : has an acreage of 21,060 hectares stretching along the coast, 60 kms in length, 4 kms in average width , elevation from 3 to 12 metres. There are some places where the elevation reaches 31 metres. And the sandy bands there look like huge dykes in the East. (see map 1/100,000)

Sandy region, however, still has its superiority and potentiality.

- As for its superiority.

It helps prevent sea waves from filling up paddy fields, especially waves caused by sea-storms .

It has a very large acreage (21,060 hectares) and great volume of ground water resource which is pretty shallow.

The superiority as well as potentiality can bring about good conditions for turning sandy region into arable land. It also enables us to transform the region into an agricultural, forestry and aquacultural economic region, creating coastal thick woods that help protect agricultural production and the life of the resident in plain areas .

But sandy movement (drift sand, wind blown sand and jumping sand) has now caused damage to production and people's lives. Arable land is reduced every year. An acreage of 15 to 20 hectares of paddy fields, 5 to 6 kilometres of motorway on the sand and the sandy slopes, 4 to 5 kilometres of river communication loses per year . Communication by sea and irrigation are blocked in the region. Also, tens of hectares of land for housing and gardening are filled up by sand movement. Consequently this makes the life of the people in sandy regions unstable, their family economy unable to develop . Moreover, sand movement is causing flood and making the cultivated land gradually become acid aluminous and

barren, paddy fields adjacent to the sandy region are lack of alluvium. Water in combination with sand breeds trachoma and many diseases.

2. As for the People's Livelihood :
Quang Tri has a population of 458,000. In the meantime, its cultivated land covers only 32,000 hectares, the average of cultivated land per capita is 780 sq. metres. It would be reduced because of sand filling up. On the contrary, the sandy region has a very large acreage of 21,060 hectares. At present, only a small part of it is covered with casuarinas (1%), paddy and subsidiary crops (1.6%). 68,000 inhabitants in this region have been unemployed, 40% of all living along the coast work in aquaculture . Every year from January to August, 30% of strong male inhabitants are at sea for fishing. In the rest of the year they are at home with their wives and children, unemployed. In case the chief labourer of a certain family unfortunately is ill or dies, the others in the family will be at the end of their resources.
40% of the resident working in aquaculture is concentrated in coastal region.
60% of the population living by agricultural production is concentrated adjacent to the small field which is acid-aluminuous, barren and reduced by sand filling up. Thus, their life is very hard .

That is why transforming sandy region into an arable land, an agricultural, forestry, aquacultural economic region, increasing acreage cultivated, bringing work to the resident and preventing sand drift, wind-blown sand and jumping sand are urgent tasks. These will solve problems of sand filling up, acid-aluminuous and barren soil, and dangerous diseases. These will also help improve the region's ecolo-environment state .

II. Targets of Project .
1. Turning this sandy region into cultivated region, an agricultural forestry and aquacltural one, bringing jobs to people in this province in general, and in particular to those in the sandy region.

2. Preventing drift sand, wind-blown sand, jumping sand that fill up paddy and subsidiary crop fields, gardens and communication systems as well.

3. Restricting alumino-acidification, barreness, flood, diseases caused by water mixed with sand.

4. Increasing the volume of water for irrigating the field near the sand slope, which would give good conditions for getting alluvium for cultivation .

5. Forming woods along the coast so as to aquire a good ecolo-environmental region, restricting unfavourable wind and sea storms.

6. Constructing model experimental areas applied for sandy regions that have the same characteristics in provinces in Central Vietnam.

III. Measures .

To reach the above targets we take these three measures :

- Hydraulic Measures
- Forestry Measures
- Agricultural Measures

1. Hydraulic Measures .

Constructing embankment of retaining dams, water divide lines, multified dams and drainage cannals dividing the sandy region into sub-regions to form reservoirs to increase sand moisture during dry seasons for the prevention of wind-blown sand and movement of water with sand to the field, sand filling-up, acidification and barreness .

2. Forestry Measures .

Planting widespreadly perpendicular rows of casuarinas, dividing the sandy region into squares for wind prevention, stabilization of sand and protection of water work .

3. Agricultural Measures .

- After hydraulic and forestry measures are taken, the sand has stable moisture, various kinds of plants will grow, formation of land will be increased. Agricultural measures help accelerate this process by bending sand with soil, subsidiary green manual planting, enriching the soil by necessary fertilizers so as to rapid the formation of the soil and the addition of glue materials to the sand to turn the sandy region into cultivated land.

- Rearranging the population's inhabitation and production.

- Growing suitable plant species to turn the sand region into agricultural - forestry - aquacultural one .

IV. Evaluation for the work carried out in the last few years .

1. Experimental Work .

a. To prove the effects of three measures mentioned above :
During three years from 1977 to 1979 we carried out the construction of :

+ Retaining Dams : Building a retaining dam line, 24 kms in length, its measurements are as follow :

The width of the dam crest (m) = 5
The slope of embankment (m) = 5 - 7
Height (m) h = 3 - 4 (See figure below)

+ Multified Dams : (See figure below)

Three multified dam lines which are 4 kilometres long in all and have the same measurements as the retaining dams were built .

+ Drainage Cannals to the Sea : We built three cannal lines, the total length of which is 7 kms. Measurements as follows :

The width of cannal bottom (b) = 10 - 15 m
The slope of cannal (m) = 5 - 7 m
The anti-erosion slope of channel (i) = 0.0001 - 0.00015

The material used for the building of all these dams and channels was available sand .

9 reservoirs , the storage of each is from 1,000,000 to 3,000,000 cubic metres were built.

Rows of trees were planted on both sides of the dam and cannal slopes, the total width is 5 - 7 metres.

Other rows of trees have not been planted yet. In other words , this experimental area has not been perfect .

b. Effects of the Experimental Work .

In comparision with the planned measures, there is still something imperfect .

In details, they are as follows :

- The elevation of the retaining dams and multified dams is not high enough .
- The measurements of the cannals are not suitable .
- As for the forestry measures, rows of trees were only planted on the both sides of the retaining dams, in other words, only 20% of the work was done .
- As for the agricultural measures, there is still much to be fulfilled. The people were guided to try to carry out the measures in only several small parts of the region. But what was done is still imperfect and of incorrect measurements in comparision with the desinged ones .

Nevertheless we have attained a number of effects such as :
- Sand drifting no longer exists in the areas where there are dams .
- Water on sand flowing to the field has now been retained or made to run into the sea.

Thus, alumino-acidification, barreness and sand flood has been restricted, and alluvial water has been brought to the field . As a result, the rice field has raised a lot : from 1.5 tons/ha/crop before to 3 - 4 tons/ha/crop at present .
- The people's houses and gardens are no longer filled up by sand. The area has become populous .
- The systems of water work have been stabilized. The reservoirs have moistened the sandy region, added water for irrigating the fields .
- Though the number of trees planted is still small, the ecolo-environmental state of this region has been considerable improved.
- In parts of the sandy region now there are fields of sweet potatoes, water melons, peanuts and grass for animal husbandry. The reservoirs have become beautiful landscapes and the best places for boat-racing taking place during traditional festivals and Tet holidays.

a. Organizing Workshops .
In response to world's natural calamity reducing declaration, Ministry of water resources together with Quang Tri People's Committee held a workshop named 'Desertification Protection and Ecological Improvement in Marine Sandy Region of Quang Tri Province by Hydraulic, Forestry and Agricultural Measures' on December 26th 1991 at Thang Long meeting hall. Representatives of Central Organizations, Vietnamese Scientists, and international Organizations attending the workshop made this evaluation,' This project is of great scientific and technological value, social-economic significance and humanity' .

To make the project more perfect, the attendance suggested :
1/ That the project should be considered as a state-level one to be continuously completed .
2/ That the state should invest in experimentation .
3/ That the project should be carried out to call on foreign investment .

On the basic of the above theoretical points, we have perfectly established an experimental area to estimate the effects of this project, and created a theoretical and practical model which will

be applied in sandy regions in provinces in Central Vietnam where natural conditions are similar to those of Quang Tri .

V. Establishing a Perfect Experimental Area .

1. Selection of Area .

In the completed experimental area, we will choose three sub-areas to turn them into a perfect one .

- Sub-area 1 : Sandy area at Hoi Yen which is south and north of Hoi Yen motorway to My Thuy. In the map (1/10,000) it is area 4 and area 5, with an acreage of 440 hectares and 462 hectares respectively .
- Sub-area 2 : It is Trieu Van Village, Trieu Phong District , lying by Cua Viet with an acreage of 298 hectares (Square Nº 9)

These are two established areas where systems of the water works have already been constructed and forestry measures taken .

In area 1 (Hoi Yen)60 per cent of water works and 40 per cent forestry works have been built .
In area 2 (Trieu Van) only 20 per cent of both agricultural and forestry works has been completed while 20% of water works has been built .

On the other hand, these two areas have changed the topography and altitude of the sandy region.

2. Tasks To Be Fulfilled in the Experimental Area .

a. Continuing to perfect the previous experimental area to prove the effect of this project so that it would make a model of ecological - environmental improvement which will be applied in sandy regions in the Central of Vietnam.

b. Transforming 549 hectares of the sandy region into arable land to bring work to the resident. This will set a model for the people encourage them to move to the sandy region so that they could help reclaim the land.

c. Protecting 180 hectares of field at Hai Ba and Hai Que of Hai Lang district from sand filling up, alumino-acidification, and barreness.

d. Basing on the effect of the experrimental area, we will suggest international investment for ecolo-environmental improvement in the marine sandy region .

3. Plan and quantitive computation of hydraulic, forestry and agricultural works :

a. Plan and computation of investable capital for hydraulic works (recorded in research document of project)

a1. Measurements of hydraulic works :

- The entire disposition of hydraulic works including retaining dams, multified dams, cannals and reservoirs (See 1/10,000 map of the lay-out)
- Materials for construction : available white sand
- Document on topography : We have a 1/10,000 map of retaining dams, water divide dams lines and canals .
- Determination of measurements of such water works as : retaining dams, multified dams, and canals is as follows :

+ Retaining dams and multified ones :

The width of dam crest : B = 5 - 6 ms

Inside and outside dam slope : m = 5 - 7 ms

+ Canals :

The width of canal bottom : b = 5 - 10 ms

The slope of canal : m = 5 - 7 ms

The anti-erosion slope of canal : i = 0.0001 - 0.00015

The above data are determined through accumulation of experience, effects from experimental work and even computer computation .

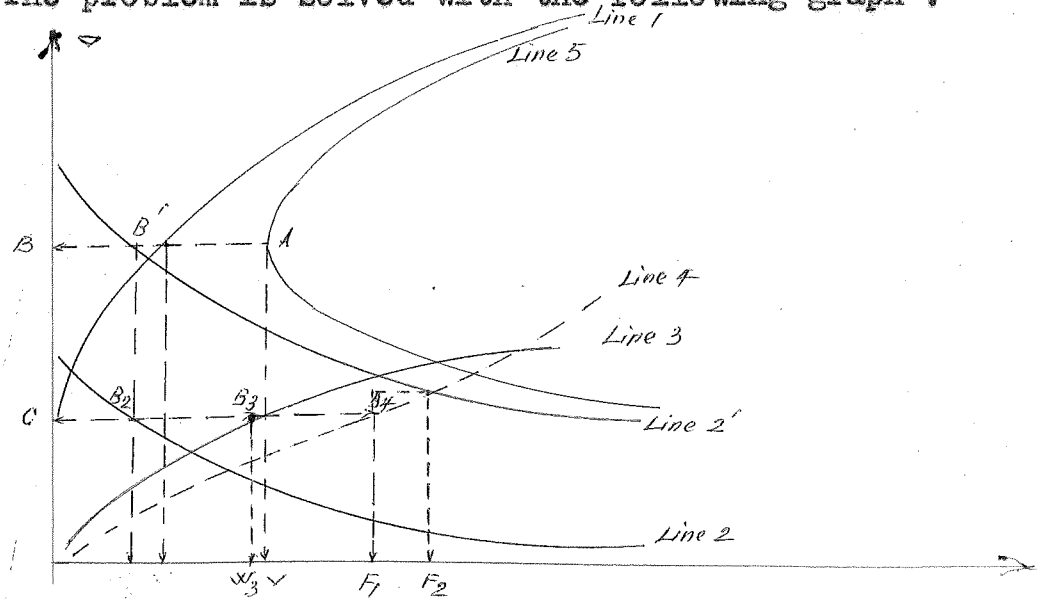
+ The dam elevation and bottom of the canals are determined with this view :

1/ Minimizing the volume of earth moved .

2/ Maximizing the total reservoir storage .

3/ Acquiring the largest acreage of free water surface .

The problem is solved with the following graph :



- Line 1 shows the relation between the volume of embankment and the height of the dam .
- Line 2: the relation between the volume of earth digged out for canals and the canal elevation .
- Line 3 : the relation between the reservoir volume and the elevation of the reservoir stored water .
- Line 4 : the relation between the acreage of the free flood water surface and the super high water level .
- Line 2' is originally line 2. It moves in a parallel way in a distance h plus AH (safe elevation and elevation of waves)
- Line 5 is the combination of Lines 1 and 2 (volume of earth embanked and digged out)

Determination of elevation of dam top, of bottom of canal, reservoir storage, free water surface (with normal water level and flood water level) and volume of earth moved is as follows (with a look at the graph):

1) Point A on Line 5 shows the smallest volume of earth moved, B shows elevation of dam top .
2) Point C shows elevation of canal bottom .
3) Point W shows reservoir storage; F1 normal free water surface; F2 increasing free water surface (when water level increases)
4) Point V shows volume of earth moved .

Elevation, reservoir storage, acreage of free water surface, volume of earth moved of hydraulic works in other areas are determined similarly .
The table below shows tree rows and volume of hydraulic work.

Technical norms and volume of work	84	85	89	Total
Elevation of Dam top (m)	8.5	8.2	5.6	
Elevation of canal bottom (m)	6.5	6.2	3.6	
Reservoir storage ($10^6 m^3$)	445	0.391	2.0	
Normal free water surface (ha)	50.0	8.5	48.0	
Increasing freewater surface(ha)	152.0	136.0	215.0	
Volume of earth moved(m^3)	103,310	52,748	126,246	282,304
Cost per cubic metre (VN Dong)	2,000	2,000	2,000	
Expenditure for earth moved (VN Dong)	206,628.00	102,390.00	252,492.00	565,510.00
Expenditure for planning				
Expenditure for Side A				

b. Designing and computation of initial investment capital for forestry works.

The entire disposition of forestry works is presented on a 1/10,000 map (Please see the map)

- Section of plant species : casuarinas are planted in main rows, cajeputs in secondary rows .
- Main planting rows: They are perpendicular to one another so as to divide the sandy area into squares, acreage of each square is 4 sq. kms .
  + The width of each row is from 7 to 10 ms .
  + The distance between two main rows is 200 ms .

Secondary rows of trees are planted between two main rows; distance between a main row and a secondary one is 100 ms; the width of each secondary one is 4 - 5 ms .

- All the rows of trees are planted in furrows, the height of each furrow is 0.4 - 0.5 m .
- The acreage of secondary planting rows is 47 hastares
- The acreage of main planting rows is 101 hectares .
- The acreage of both kinds is 148 hectares .
- The volume of sand earthed up in furrows .

The planting acreage, volume of sand earthed up in furrows and investment capital for forestry works .

1) Planting acreage :

1.1 Square N° 4 has an acreage of 442 hectares .

- Casuarina-planting acreage of main rows is: 442 x 9.7% = 43 ha
- Cajeput-planting acreage of secondary rows is :

442 x 4.5% = 20 ha

1.2 The acreage of square N° 5 is 462 ha

- Casuarina-planting acreage of main rows is 462 x 9.7% = 45 ha
- Cajeput-planting acreage of secondary rows is 462 x 4.5% = 21 ha

1.3 The acreage of square N° 10 is 340 ha

60% of the acreage of this square has been covered with trees. The remainer is 136 ha .

- Casuarina-planting acreage of main rows is 136 x 9.7% = 13 ha
- Cajeput-planting acreage of secondary rows is 136 x 4.5% = 6 ha

2) Volume of sand earthed up in furrows :

2.1 Square N° 4 = (43 + 20) x 0.5 m = 315,000 m^3 .

2.2 Square N° 5 = (45 + 21) x 0.5 m = 330,000 m^3 .

2.3 Square N° 9 = (13 + 6) x 0.5 m = 91,000 m^3 .

Total = 736,000 m^3

Investment Capital

Item	Unit	Square N° 4	Square N° 5	Square N° 9	Total
ting acreage	ha	63	66	19	148
e per ha	dong/ha	3,000,000	3,000,000	3,000,000	
tal	million d	198	198	57	444
ume of earth					
furrows	m^3	315,000	330,000	91,000	736,000
e per m^3	dong/m^3	2,000	2,000	2,000	
al	million d	615	660	182	1,457
al of both parts	million/ dong	804	858	239	1,900

Designing and computation of volume of work and investment capital for agriculture .

land that remains is used for :

1) Meadows for cattle

2) Cultivation of food crops : sweet potato, casava, rice, and industrial crops such as peanut, pimento, sesame .

40% of land is used for cattle breeding in order to fertilize the sand with animal dung. And the land will be used up .

Food crop acreage is 60% .

1. The acreage of land remains after using for agricultural works.

a) As for Square N° 4 :

- 422 ha - (63 ha + 30 ha)(for hydraulic and forestry work)= 349 ha
- Cattle-breeding ground : 349 x 40% = 139.6 ha
- Volume of work of land reclaimation

Besides hydraulic and forestry measures, in order to carry out agricultural measures these tasks are to be accomplished :

i) Adding alluvium and basaltic soil to the white sand to increase the retaining of water, degree of capillary, humus and other fertile substances. 200 - 300 m^3 of alluvium and basaltic soil is added to a hectare of sandy land .

Price per ha = 300m^3 x 5,000 dongs = 1,500,000 dongs .

ii) Fertilizers :

- Nitrogenous fertilizer)
- Phosphate) 0.500
- Kalium fertilizer)

iii) Subsidiary green manure planting for sweet potato fields :

Expenditure for a hectare of potato: (0.3 + 1.5) = 2 million dongs

iv)Expenditure for a square : 200 ha x 2 = 400 million dongs .

b) As for Square N° 5: natural acreage : 462 ha
- Acreage of land for agricultural production :
462 x 45% = 208 ha
- Acreage for grass planting : 462 x 34% = 147 ha
(45% and 34% are ratios from square N° 4)
Expenditure for square N° 5 : 208 x 2 = 416 million dongs .

c) As for Square N° 9: natural acreage: 340 ha, but only 138 ha will be reclaimed :
- Acreage of land for agricultural production :
138 x 45% = 141 ha
- Acreage of land for grass planting :
138 x 34% = 109 ha
Expenditure for square N° 9 : 138 x 2 = 276 million dongs .

Total Expenditure for 3 Experimental Areas :

Measures	Sq. N° 4	Sq. N° 5	Sq. N° 9	Total	
Hydraulic	206	102	252	660	million dong
Forestry	804	858	239	1,901	" "
Agriculture	400	416	276	1,092	" "
Total	1,410	1,476	767	3,653	" "

Investment capital for a hectare of sandy land is :
3,653 : 1,200 ha = 3 million dongs/ha
Time for Implementation : 3 years

1/ In the first year (1992) works will be constructed at Square N°4
1.1 Hydraulic works :
- Embankment of retaining dams : 340 million dongs
+ for volume of earth embanked : 206 million dongs
+ for planting : 34 million dongs
- Embankment of multified dams :
+ for volume of earth embanked :
+ for planting
- Canal digging :
+ for digging
+ for planting
1.2 Forestry Works : 804 million dongs
- Earthing up in furrows
+ 9 rows along the sandy region (parallel rows)
+ 12 rows across the sandy region
+ 9 secondary parallel rows
+ 12 secondary rows across the sandy region

1.3 Agriculture Works :

- Reclaiming sandy land into arable land .
  a) Adding fertile soil to sand
  b) Subsidiary green manure planting

1.4 Total Estimates : 1,470 million dongs
Staée Fund : 700 million dongs
Local Fund : 770 million dongs

Effects of Experimental Work .

1. Proving the firmness of the project of ecolo-environmental improvement in marine sandy region of Quang Tri province .
2. Setting a model that can be applied for ecolo-environmental improvement in marine sandy region of Quang Tri as well as in others which have similar natural conditions .
3. Drawing a conclusion of measures for ecolo-environmental improvement in sandy regions.
4. On the effects of experimental work, we can deduce technical norms, kinds of materials for constructinn of hydraulic works , forestry and agricultural ones in sandy regions such as width of dam crest, dam anti-erosion canal slope, species of trees, distances between tree rows, stabilization of sand, creation of humidity, irrigation and fertilization of sandy land, water vaporization etc.
5. Effects from Experimental Areas .

- Turning sandy regions into cultivated ones :
  * Casuarinas and cajeputs cover 148 hectares
  * Food crops acreage : 549 hectares
  * Land for cattle breeding : 359.6 hectares
- Giving work to 1,500 people living in the sandy region .
- Sand filling up protection :
  * Food crops fields : 5 ha/year
  * Roads : 4 km/year
  * Gardens : 5 ha/year
- Preventing 500 hectares from alumino-acidification and barreness.

Techical norms of works in
Experimental area .

Techical Norms	Unit	Names of Reservoirs IV	V	IX	Notes
I. Reservoirs :					
) Acreage of Basin storage	ha	265	236	438	
) Normal water level	m	6,5	6,2	3,6	
) Maximum water level	m	7.5	7,2	4,6	
) Normal storage	10^3m^3	455	61	405	
) Maximum storage	10 m	1,445	931	2,000	
) Normal Acreage of free water surface	ha	50	8.5	48	
) Maximum Acreage of free water surface	ha	152	136	215	
II. Dams :					
) Canal elevation	m	8.5	8.2	5.6	
) Width of dam crest	m	5	5	5	
) Slope of dam	m	5	5	5	
) Maximum height	m	3.7	4	3	
III. Dreinage canal					
) Canal elevation	m	6.5	6.2	36	
) Slope of canal	m	5	5	m	
) Factor of roughness	m	0.025	0.025	0.025	
) Anti-erosion slope		1.10^{-4}	1.10^{-4}	1.10^{-4}	
) designed water lavel	m	1	1	1	
) Width of canal bottom	m	4	5	5	
) Anti-erosion flowing speed	m/s	0.3	0.3	0.3	
) Flowing volume	m^3/s	2.6	3.0	5.0	
IV. Tree Fence for wind protection					
)-Row distance	m.m	200.200	200.200	200.200	
-Width of each row	m	10	10	10	

Summarization table of volume of work and investment capital for the experimental area of the project of ecolo - enviromental improvement in marine sandy region

Contents of Investment work	Total		Area № 4			Area № 5			Area № 9		
	Volume	expenditure	Unit price	Volume		Unit price	Volume		Unit price	Volume	
I/ Hydraulic works	280757	660.000	98.586	103314	206.628		51.197	102.394		126246	252.492
1) Construction of dams	254189	508.378	2000đ/m^3	98.119	196.238	2000đ/m^3	49.649	99.292	2000đ/m^3	106424	212.848
-Volume of earth				86.627	173254		41.846	83.692		87.428	174.856
-embanked				11.492	22.984		7.800	15.600		18.996	37.992
2) Drainage canals	26.568	53.036	2000đ/m^3	5.195	10.390	2000đ/m^3	1.551	3.102	2000đ/m^3	19.822	39.644
3) Extra expenses		98.586									
II/ Tree planting for wind protection		1.901.000			804.000			858.000			239.000
1) Tree planting	1428ha	444.000		63	189.000		06	198.000		19	57.000
2) Earthing up in furrows	736000	1.457.000		315000	615.000		330000	660.000		91.000	182.000
III/ Land reclaimation	546ha	1.092.000		200ha	400.000		208 ha	416.000		138ha	276.000
-Grand total		3.653.000		98.586	1410628			1376394			767.492
Capital provided for											
+ State Fund		1.800.000									
+ Local Fund		1.853.000