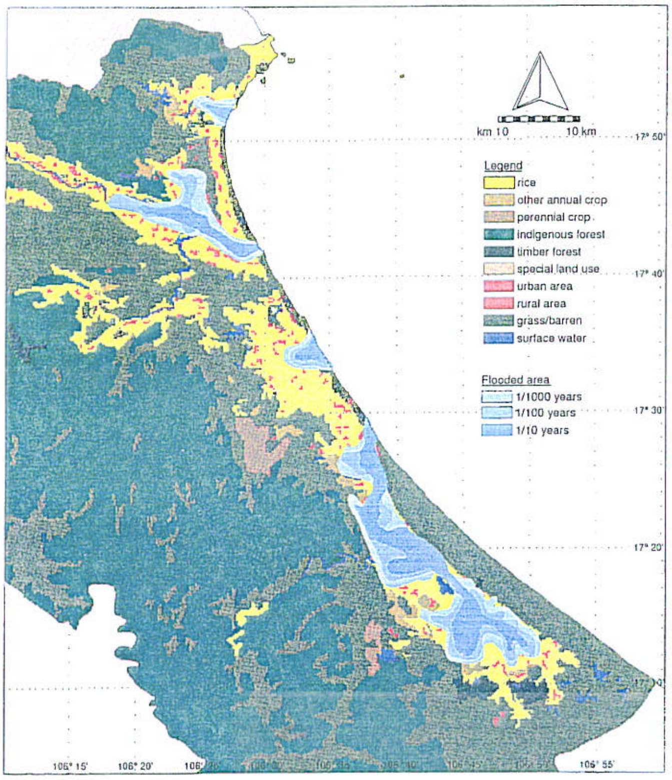
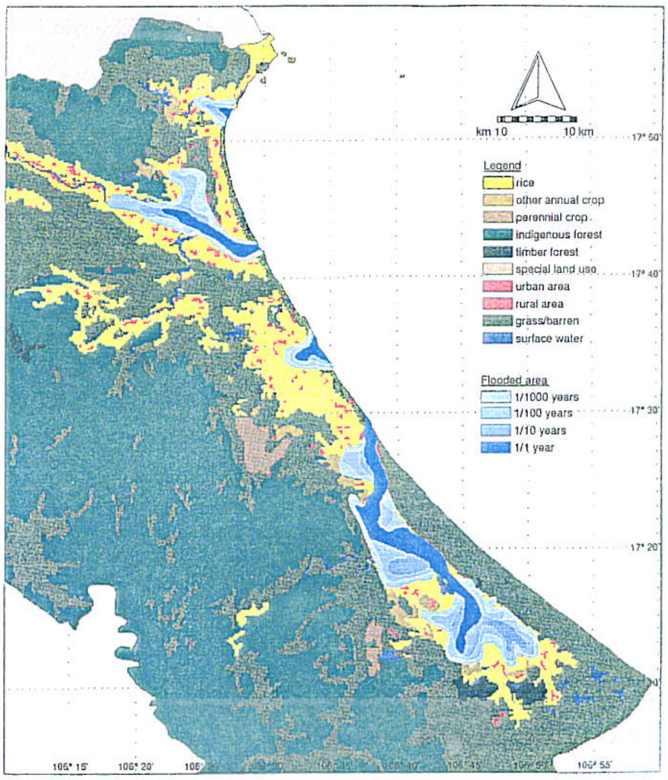
Government of The Netherlands
Ministry of Foreign Affairs

Government of the Socialist Republic of Vietnam
Hydrometeorological Services

VIETNAM COASTAL ZONE VULNERABILITY ASSESSMENT and First Steps Towards Integrated Coastal Zone Management

REPORT No.3





METHODOLOGY
September 1995

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List of Abbreviations

ASLR	Accelerated Sea Level Rise
BP	Before Present
CIS	Coastal Information System
CCP	Climate Change Programme (of Vietnam)
CSRG	Center for Remote Sensing & Geomatics, Institute of Geology, National Center for Natural Science & Technology, Vietnam
CZM	Coastal Zone Management
CZMC	Coastal Zone Management Centre of RIKZ
CZMS	Coastal Zone Management Subgroup, Response Strategies Working Group 3, IPCC
DEM	Digital Elevation Modelling
DGIS	Directorate General for International Co-operation
DH	Delft Hydraulics
DSS	Decision Support System
FNIS	Framework National Implementation Strategy
GIS	Geographical Information System
GMS	Geomanagement System
HCZ	Hydraulic Condition Zone
HMI	Hydrometeorological Institute, Ho Chi Minh City
HMS	Hydrometeorological Service, Hanoi
IPCC	Intergovernmental Panel on Climate Change
IBW-PAN	Institute of Hydro-Engineering, Gdańsk, Poland
ICZM	Integrated Coastal Zone Management
IPCC	Intergovernmental Panel for Climate Change
IS	Impact Segment
LTRA	Long Term Resident Advisor
MHC	Marine Hydrometeorological Centre, Hanoi
MS	Mekong Secretariat
MSL	Mean Sea Level
MTVA	Medium Term Visit Advisor
MWR	Ministry of Water Resources (Vietnam)
NIAPP	Nat. Institute for Agricultural Planning and Production, Ministry of Agriculture, Vietnam
RIKZ	National Institute for Coastal and Marine Management, Ministry of Transport, Public Works and Water Management of the Netherlands
RRMDP	Red River Delta Masterplan Development Project
RSWG	Response Strategies Working Group
SC	Steering Committee
SCS	State Committee for Sciences
SPC	State Planning Committee
STRA	Short Term Visit Advisor
STVA	Short Term Visit Advisors
ToR	Terms of Reference
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNITAR	United Nations Institute for Training and Research
VA	Vulnerability Assessment
VMS	Vietnamese Mekong Secretariat
WCC'93	World Coast Conference 1993 (The Hague, The Netherlands)
WMO	World Meteorological Organization

1 INTRODUCTION

In this study the methodology has closely followed the "7-steps" as outlined in the *Common Methodology* .

The key elements of the first steps of the methodology, namely selection of boundary conditions and the inventory of the study area characteristics are described in *Report No.1* and *Report No.2*. In this report the focus has been to describe the methodology steps concerned with assessing the impacts of the sea level rise, mainly in terms of flooding (using GIS, FFR). Further attention is paid to the cataloguing and display of the data inventory (using GMS).

A *Coastal Information System* (CIS) is defined as the combined GIS-GMS system which is described in this report.

This report contains working notes and descriptions as reference for the GIS, GMS and FFR procedures followed.

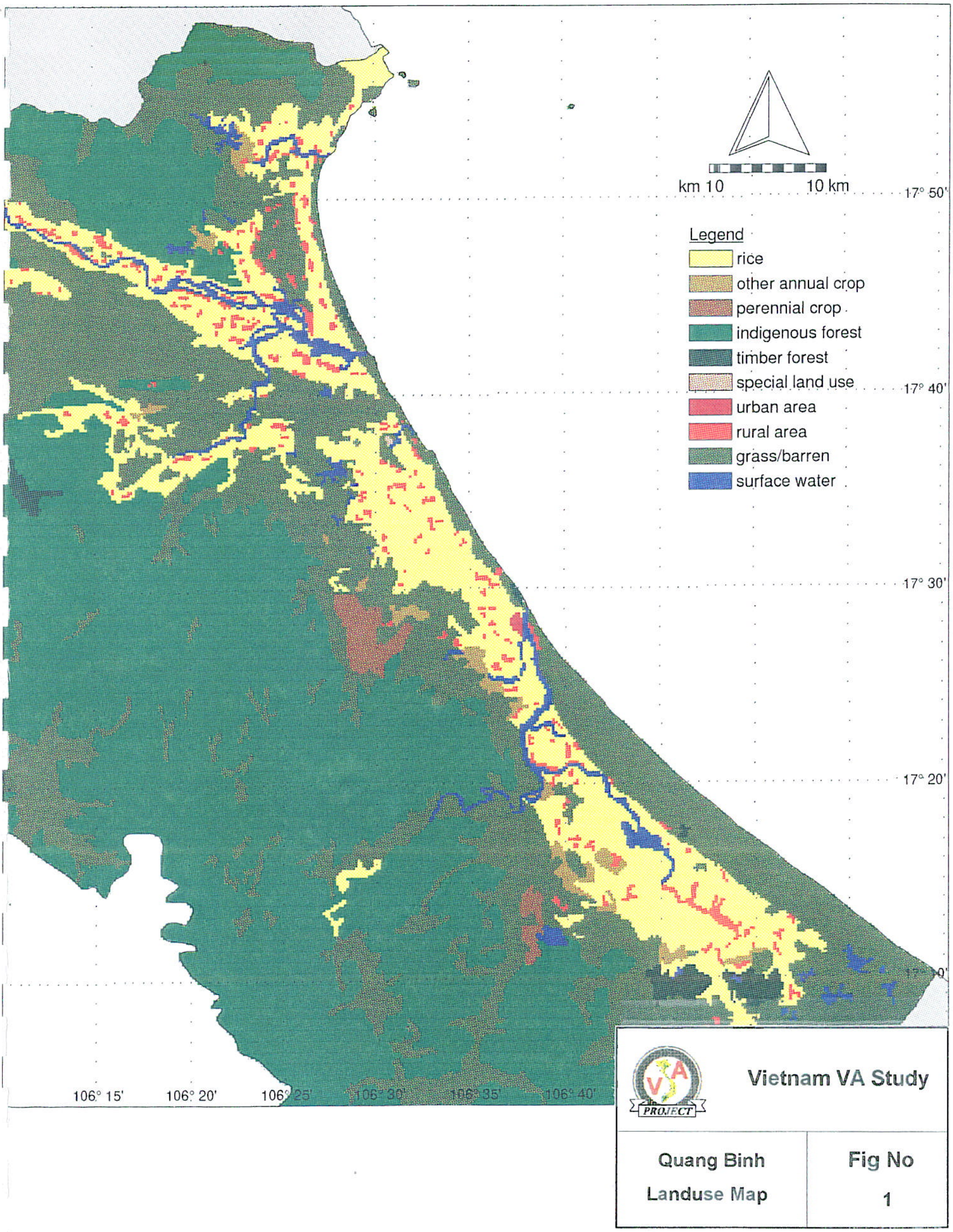
The most important input data for the analyses described in this report were the land use and topography of the coastal zone. An example of these data plotted for the central coast province of Quang Binh is given in Figures 1 and 2.

2 General procedures of the spatial analysis using GIS-SPANS Explorer

What is GIS?

Spatial analysis (or GIS) is a computer-based technology for producing, organizing and analyzing spatial or geographically-referenced information. It combines elements of database management, mapping, image processing and statistical analysis. The distinction between GIS and traditional information systems is the use of locations for referencing information as an important variable as an important variable in quantitative analysis. By exploiting the spatial dimension, GIS introduces a new perspective which can greatly enhance decision making and problem solving. As a result, GIS applications are of increasing importance in a wide range of disciplines using spatial data. Inter alia, GIS is a powerful, versatile and expanding system of data storage and management, which can be extremely helpful for CZM applications.

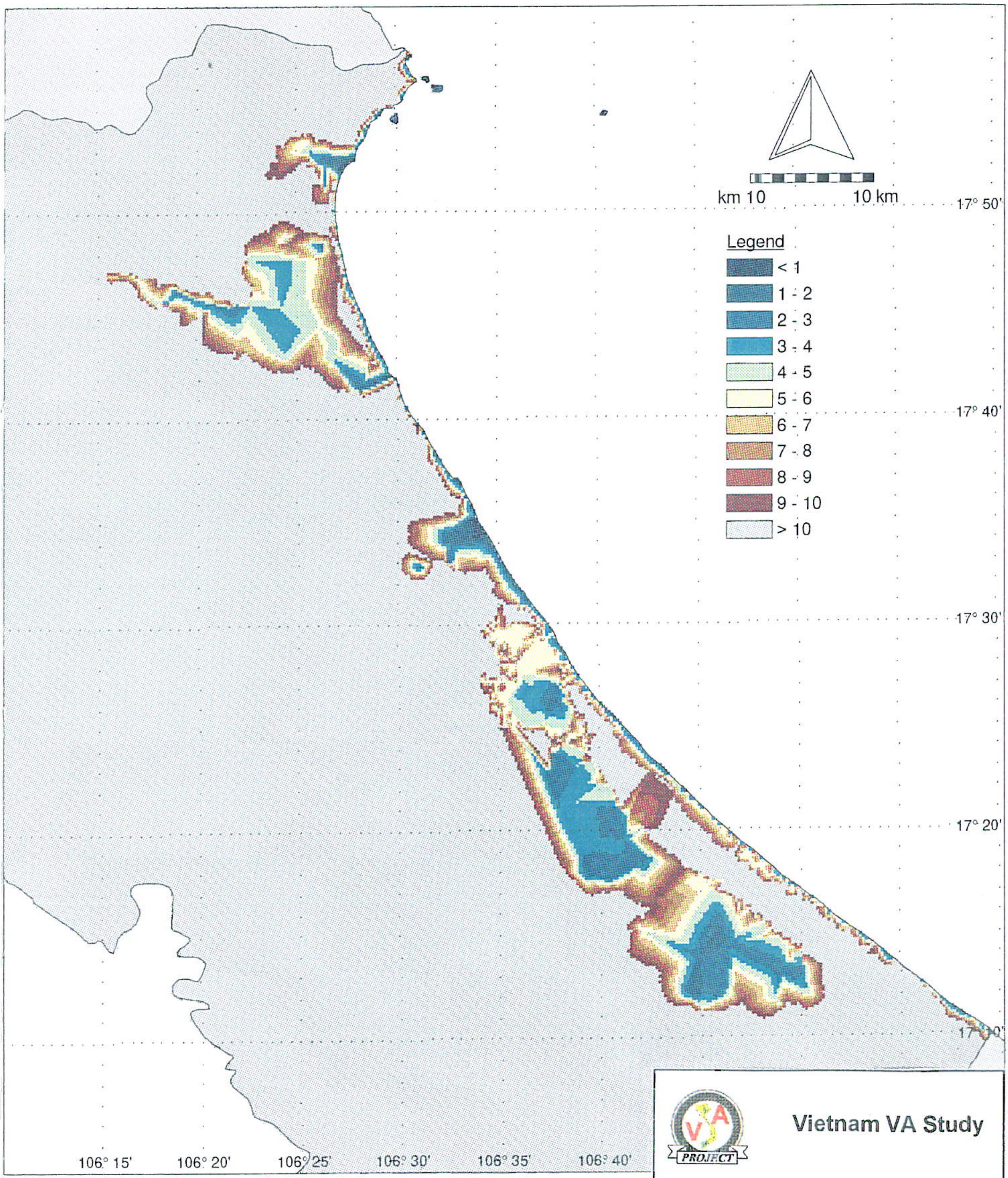
In Appendix A, the working document used as a guide for the GIS operations in this study is presented.



Vietnam VA Study

Quang Binh Landuse Map

Fig No 1



Vietnam VA Study

Quang Binh Topography Map	Fig No 2

3 Concepts and procedures of the flood and flood risk (FFR) model

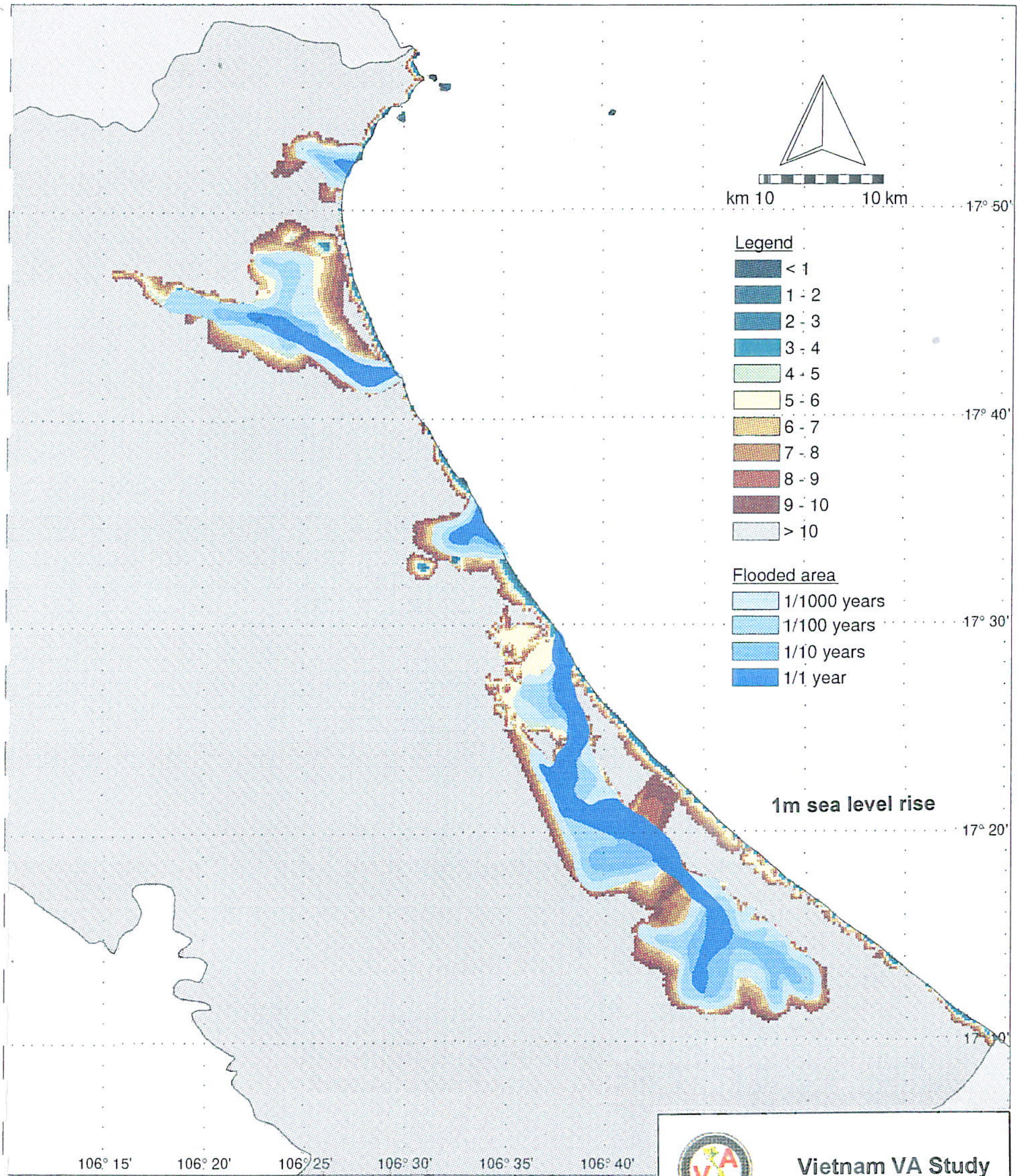
What is FFR?

FFR stands for software that implements a procedure to determine "Flood and Flood Risk" given as input the areas of different land use types flooded or at risk of flooding up to 1 in 1000 years..

The concepts and procedures followed in the analysis of GIS data to produce areas at loss and at risk of flooding are described in Appendix B. The FFR used as input the cross tabulation results from the GIS analysis. These provided areas per land use category that fall within certain flooding frequencies. An example of the graphical output is given in Figures 3, 4 and 5 for Quang Binh Province. Other examples will be presented in Report No.7.

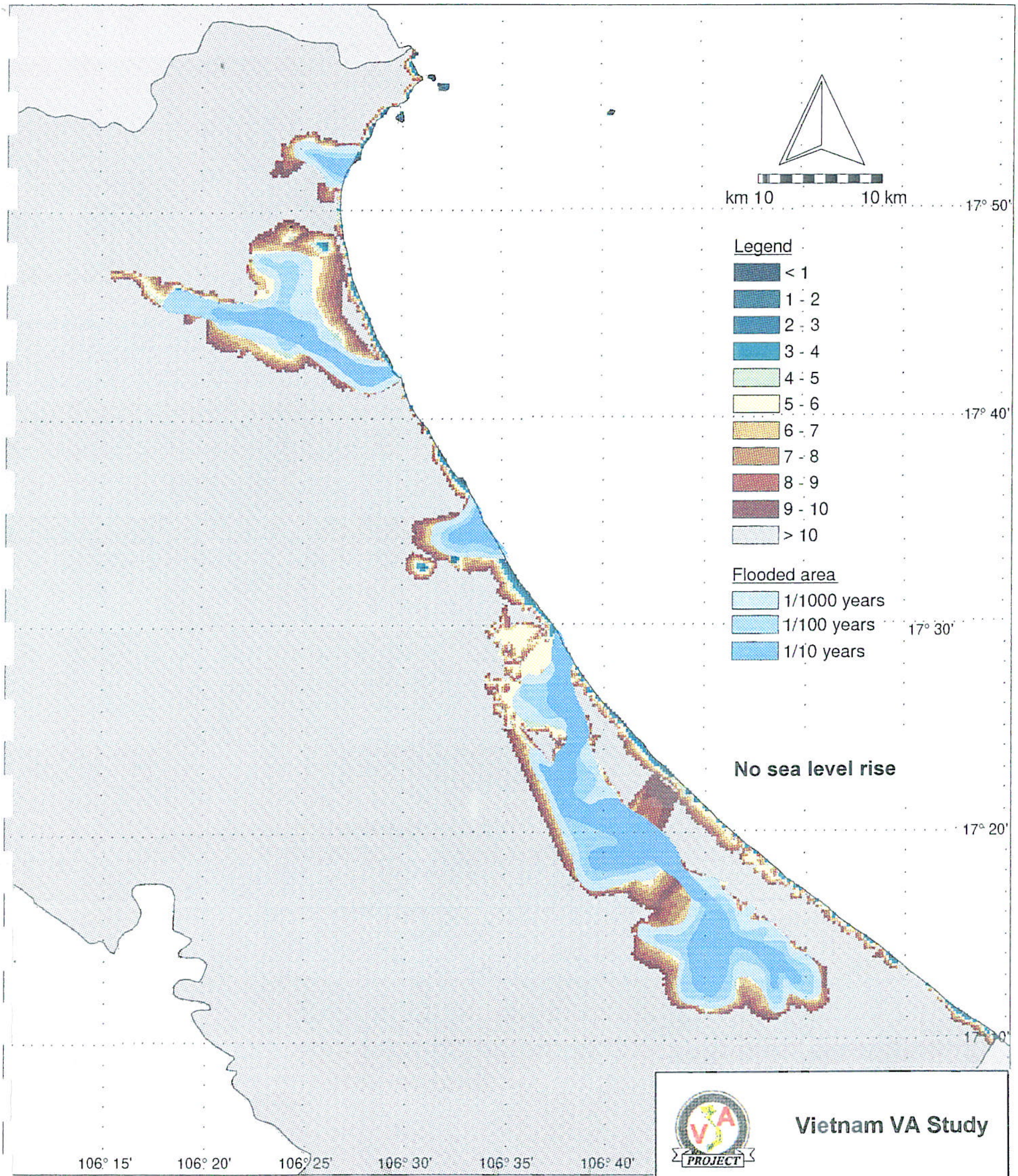
The cross tabulation provided tabulated data that were used as basic input into derivation of people to be moved, people at risk, capital value at loss and capital value at risk. The analysis was recomputed for the future scenario (2025) by adjustment of the land use distribution, population densities per land use class and capital value per land use class.

The results of the FFR model were used directly for reporting and analysis of vulnerability in the Final Report (*Report No.7*).



Vietnam VA Study

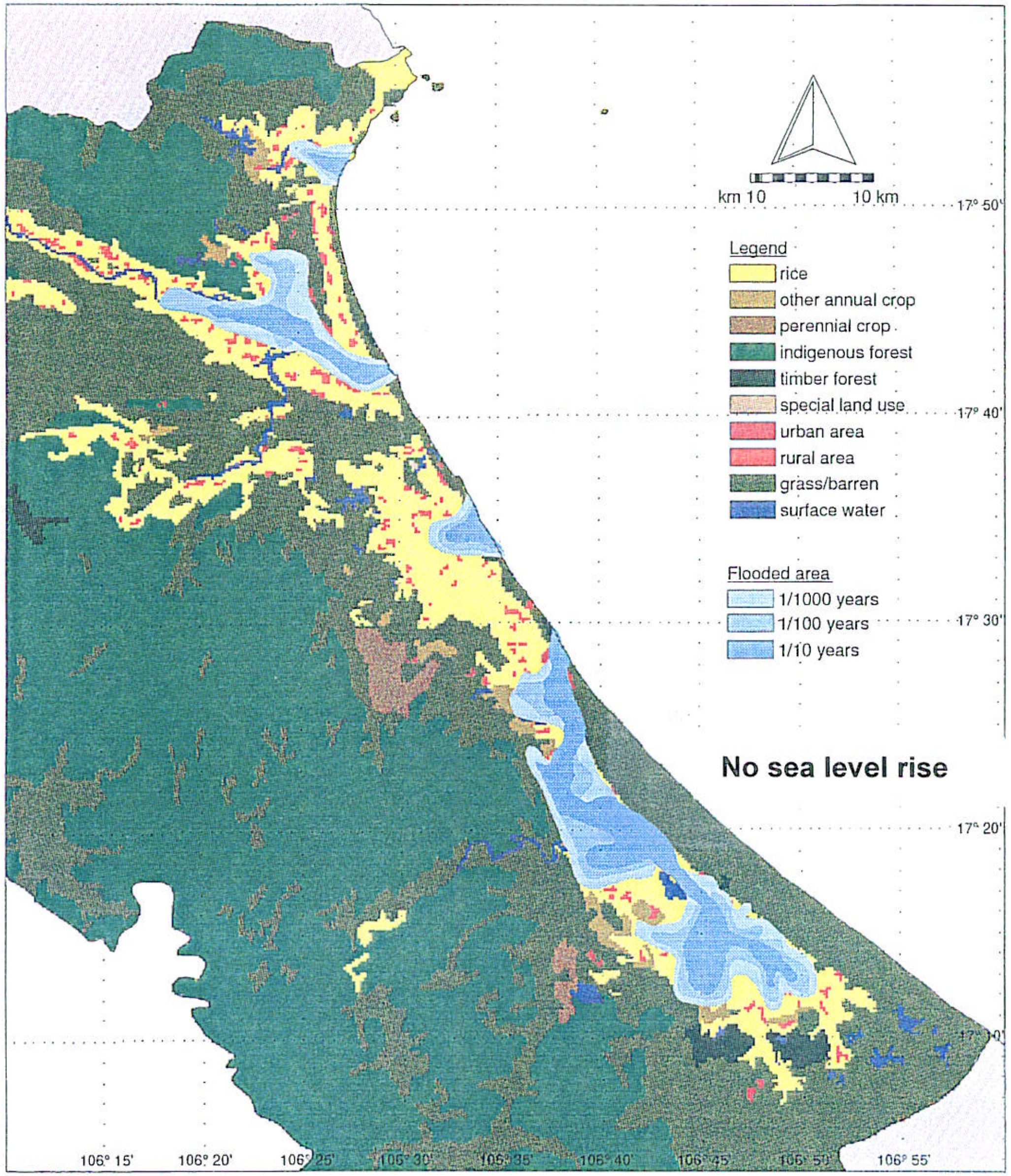
Quang Binh Topo. Map and Flooded Areas (ASLR)	Fig No 3

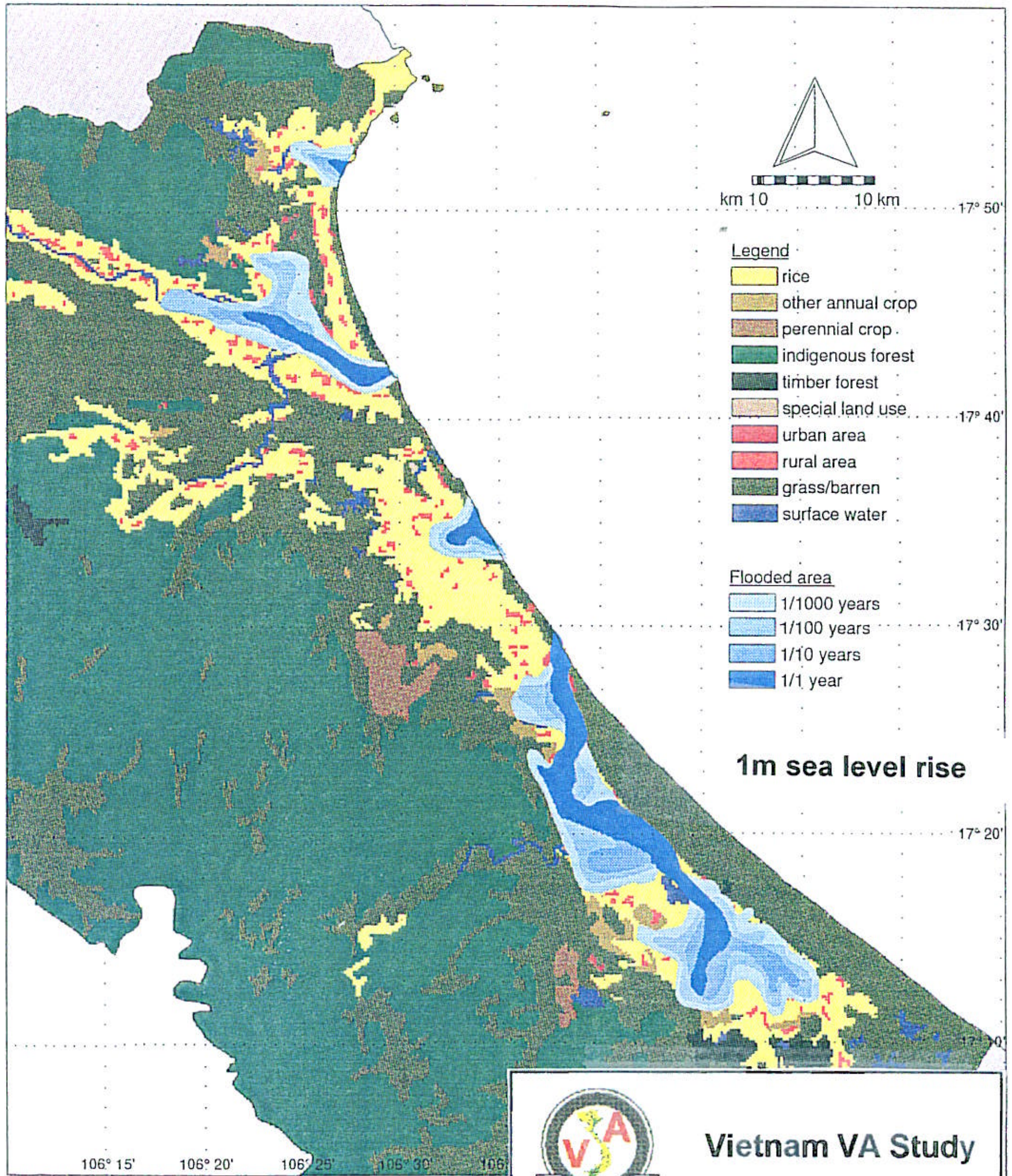


Vietnam VA Study

Quang Binh Topo. Map and Flooded Areas (NSLR)

Fig No 4





Vietnam VA Study	
Quang Binh Land use Flooded areas	Fig No 5

4 GMS-DECIDE as part of the Coastal Information System)

What is GMS-DECIDE?

The GMS-DECIDE software was used purely as a means to catalog and display the relevant information about the coastal zone of Vietnam. It is not an analysis tool but has proved to be a very convenient way of storing data from a wide variety of sources and formats for rapid display and retrieval.

The GMS-DECIDE system implemented in this study is described in Appendix C.

APPENDIX A :

Vietnam VA Study
Working Document : GIS SPANS EXPLORER

VIETNAM VA PROJECT

GENERAL PROCEDURES SPATIAL ANALYSIS
USING SPANS EXPLORER

-- Contents --

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October 1995

1. Introduction

Although the VA analysis is much broader the focus in this document will be on the analysis procedures to be carried out within SPANS Explorer. The VA methodology will be applied to the whole coastal area of Vietnam. As we are dealing with about 3000 kilometres of coast line it has been decided to split the coast in several study areas. The VA methodology will be applied to each study area separately.
The study areas of the Mekong Delta and the Red River Delta are of a special kind, due to their relative flatness. Therefore we will address the VA procedure for these deltas in a separate chapter.
The coastal area not covered by the deltas will be divided into study areas based on provinces. It's clear that natural phenomena do not follow administrative borders. Fortunately a great deal of the provincial borders in the coastal zone follow natural phenomena, like ridges. When necessary it is possible to choose for another division of study areas. At this moment the following study areas for the coastal zone are foreseen:

15. Quang Ninh
22. Thanh Hoa
23. Nghe An
24. Ha Tinh
25. Quang Binh
26. Quang Tri
27. Thua Thien Hue

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28. Quang Nam
29. Quang Ngai
30. Bin Dinh
31. Phu Yen
32. Khanh Hoa
33. Ninh Thuan
34. Binh Thuan
53. Ba Ria-Vung Tau
2. Ho Chi Minh City

All the study areas will work with the same kind of information. As this information come separated for the north and south of Vietnam, it was decided to set up two standard study areas with the basic information for the north and south respectively. We will not follow a strict division by 16° N. The division can be made between Thua Tien Hue province and Quang Nam province. Advantage of this approach is that all study areas in the North have the same settings. This allows you to copy internal SPANS data files from one study area to another when necessary. The same applies to the study areas in the south. The extents of the study areas were chosen in such a way that a quadtree level of 13 exactly represents a square of 0.25 km x 0.25 km, which is the maximum resolution for the analysis based on the input maps. For a description of the settings of the base universes reference is made to appendix 1.
The VA-procedure can be split in several stages. These stages are:

- Checking the status of the study area
- setting up a study area
- creating a base map
- identifying flooded areas
- printing results
- correction of results for major rivers
- cross tabulation of adjusted flooded areas with land use map

- printing results

In the coming sections the process of the VA-analysis will be described by means of these stages, as detailed as possible.

2. ANALYSIS PROCEDURE CENTRAL COAST

The analysis procedure can be split in several stages. These stages are:

- Checking the status of the study area
- setting up a study area
- creating a base map
- identifying flooded areas
- printing first results
- correction of flood zones for major rivers
- drawing flood zones for the sea level rise scenario
- cross tabulation of adjusted flooded areas with land use map
- presentation of results

In the coming sections the process of the VA-analysis will be described by means of these stages, as detailed as possible.
A separate section is added that discuss how to deal with the so called 'inside islands' or 'holes' in area and quadtree layers.

2.1 Checking the status of the study area

Starting a VA analysis their are two possibilities, either the study area is already set up or it is not. You can easily check this by clicking on the **Open study area** option under the **File** menu after you activated SPANS Explorer. A list of all study areas present is given. If the study area of your interest is not in the list, you should press **Cancel** and start the procedure from 2.2.
If the study area is in the list activate it with your mouse (line will be highlighted) and press **OK**. SPANS will make the study area of your choice the active one. Now we should check whether all our data is present. To do this choose from the **Map** menu **New**. This is just to be sure that you will not activate an existing map composition. Afterwards choose Map/Edit. A new box will appear on your screen. The main area of this box gives an overview of the layers in the activated map composition. In our case there will be no layers present, as we chose a new map composition. Therefore the
---*NEW*---
layer line will be highlighted in this box. Click on **Edit**-button. A new bow will appear with an overview of all the layers available for this study area, grouped per type (point, line, area, quadtree, raster). If you click on *point*, an overview will be given of all available point layers. If you click on *line* you will notice that the layer names are updated with the names of the available line layers. Check of all the standard layers are present. An overview of the standard layers in a study area is given in appendix 2. If the standard layers are not all present, you should close this session in SPANS Explorer and start the VA procedure from 2.2.
Assuming all the layers are present, the next check is to see whether the right base map is existing. Control whether the map composition control box is still available. If not, activate it by choosing Edit from the **Map** menu. Be sure --*NEW*-- is highlighted and press the Edit button. From the layer-overview box select *Quadtrees* from the first column. From the second column select *Base*. Press the **OK** button. You will continue to the legend menu. Unless you are willing to change the drawing colour you can skip this stage by pressing OK. Now you will return to the map composition control box. You will notice that the quadtree layer 'Base' has been added to the list of layers. Now it is time to press Display. The map composition control box will disappear and the base map will be drawn. You can check the correctness of the base map by its shape. If the shape is that of the province under study, it is correct. If it has the shape of the whole of North or South Vietnam, it is not the proper base map and you should continue with 2.3.

If all the checks were successfully passed, so the study area was present and the standard layers were present and the proper base map was available, then you can skip the next two sections and continue with 2.4.

2.2 Setting up a study area

To create a proper study area the following steps should be performed:

1) Check whether a subdirectory for your study area is available under \GIS_FFR. For an overview of the names of the preset areas see appendix 3.
2) If the study area is located in the North of Vietnam you should copy all the files stored in \GIS_ORIG\NORTH\BASE_SP to the appropriate subdirectory under \GIS_FFR.
   If the study area is located in the South of Vietnam you should copy all the files stored in \GIS_ORIG\SOUTH\BASE_SP to the appropriate subdirectory under \GIS_FFR.
3) If the study area is located in the North of Vietnam you should copy those SPANS vectorfiles (VEC/VEH) from the \GIS_ORIG\NORTH\ADMIN to the directory of your study area that correspond with the province of interest (For an overview of the filenames of these vectorfiles is referred to appendix 3).
   If the study area is located in the South of Vietnam you should copy those SPANS vectorfiles (VEC/VEH) from the \GIS_ORIG\SOUTH\ADMIN to the directory of your study area that correspond with the province of interest (For an overview of the filenames of these vectorfiles is referred to appendix 3).
4) Start SPANS Explorer and add the just created study area to the 'list of study areas'. To do this select **File/New study area creation** from the menu bar. The **Create study area** dialogue box appears.

Directory of New study area:	c:\gis_ffr\thanhhoa
Title of New study area:	VA analysis Than Hoa Province

   Press OK afterwards.

2.3 Creating a base-map

To create a base map the following steps should be taken:

1) Open the study area of interest. From the File menu choose **Open existing study area**. The Select study area box appears. Select the study area from the list and press OK.
2) Import the copied SPANS vectorfile (see step 3 of section 2.2) into your study area. Call the resulting layer 'BASE'. To do this select **File/Import/Spans Vectors** from the menu bar. A dialogue box displays.

Vector file:	t-hoa	.vec/veh
Projection:	Universal Transversal Mercator (zone 48 Vietnam)	
import options:	'areas'	
output files:	base	.top/vtx

   Press OK afterwards.
   The standard universe comes with an area and quadtree layer called 'BASE', which is covering the whole of North/South Vietnam. Therefore the system will prompt you whether you want to overwrite the existing layer. Press **Yes**.
   Normally the used projection will be read from the vectorfile to import. If no projection name appears, you should click the arrow behind the projection field. A

list of available projections displays. Select 'Vietnam UTM 48 - Everest ellipsoid'. Press OK and once again to confirm the next appearing box. You will return to the main menu.
In general the 'import options' will be grey. If not, be sure that the 'areas' option is ticked. If the 'import option' is 'arcs' in stead of 'areas' than continue with step 3, other wise skip that step.

3) This step should only be performed if the layer 'BASE' is not an area-layer.
If necessary, transform the line layer 'BASE' into an area layer 'BASE'. To do this you select File/Transform/**Lines to Areas** from the menu.

Vector dataset:	base .top/vtx
Report file:	base .rep

Press OK.

4) From the Layer menu choose Open. The Open layer dialogue box appears. First choose layer type. In our case this will be 'Areas'. All available area layers will display in the second column. Select 'BASE' and press **OK**. The layer data will be displayed both graphically and in table form.
From the Analysis menu choose **Table Calculate**. Give as new field name BASE, give an appropriate title and type after EQUATION just '1' (without the brackets). Press OK.
A new column is added to your area table, called BASE which has a value of 1 for every record.
Select Layer/save from the menu and then Layer/Close.

5) Select Map/New from the menu followed by Map/Edit. The **Edit Map** dialogue box displays. The first entry under **Map Layers** is ---NEW---. This one is also selected. Press **Edit** to display the **New layer** box.
In the first column (**layer type**) select 'Areas'.
From the second column (**Layer**) select 'base'.
As attribute (third column) you select 'base'.
Finally you select 'nominal' from the fourth column.
Press OK. The next box will appear, but you can just click OK and you will return to the Edit Map box. Here you press **Display**.
The map will be drawn, representing the province of interest. To transform this map our base quadtree layer we have to select **Transform/Areas to Quadtree** from the **File** menu. The **Area to Quadtree** dialogue box appears.

Area layer dataset:	*AREA: base
Quad level:	13
New Map:	base .map

Press OK.
As the quadtree layer is already existing (see also step 2) the system will prompt you whether it is OK to overwrite the existing quadtree layer. Press **Yes**.
Finally we will assign the created quadtree layer as our basemap. Select **File/Options/Study area status**. Define 'BASE.MAP' as our Base Map and press **OK**.

Note: Display the just created quadtree layer in a new map composition before assigning it as our new base map. If there seems to be no problems you can proceed with the assignment. If you notify some errors in the quadtree map (for example: holes) then the solution might be to correct the topology of the area layer 'BASE' by choosing the SELFINTERSECTING option from the EDIT menu. After you have 'selfintersected' the layer, you have to export the area layer 'base' into a Spans vector-file and import it again. Then you should perform step 4) again.

6) Create a window based on the borders of the area of interest and save this under the numeric code for the study area (for province codes see appendix 3).
To create a new window one should select **Map/Window/New**. Move the mouse to the upper left corner of the map. Press the left mouse button and drag the mouse to the lower right corner. There you can release the mouse button. To save the created window one should select **Map/Window/Save**.

Window:	22
Title:	Window for Thanh Hoa province

All data relevant to a study area should be in the directory \GIS_FFR\<name_study_area> How to control this is described in section 2.2. The structure of the study area is described in appendix 2.

2.4 Identifying flooded areas

To identify the areas at risk for flooding we have to perform several steps. These steps has to be carried out three times in order to establish the areas at risk:
- 1/10 years
- 1/100 years
- 1/1000 years

Here we will describe the steps for the 1/10 years scenario.

1) Get from the table in appendix 4 the water level height for 1/10 years event for the province under study.

Note: the number given in the table is in meters, while we are using decimeters!!!!

2) We are going to reclassify the DEM for the province. All the areas below the figure read from the table will be assigned class 1 (=subject to flooding), while all the other areas will be assigned class 0. In our example (Thanh Hoa) we will use 15 decimeters (=1.5 meter) as the water level corresponding with a 1/10 years event.
Select **Edit/Quadtrees/Reclassification** and the **Quadtree reclassification** dialogue box displays.

Map:	elev_dm .map
Window:	22 (= window for our province)
Reclassification Scheme:	Interactively
	====> new menu appears; fill in:
	low high new
	1 15 1 Press Add
	16 101 0 Press Add
	Press OK
	<==== Return to main dialogue
Quad level:	13
Basemap cut:	yes (select box)
New map:	b10 .map

Press OK

3) Transform the quadtree layer to an area layer. Select **File/Transform/Quadtree to layer**. A dialogue box appears:

Map:	b10 .map
Window:	22 (= province window)
Entity option:	'area layer' (activate by clicking in circle in front)
	do NOT create an entity map

Quad level for thinning tolerance: 0
New vector dataset: b10 .top/vtx

Press OK.

4) While the layer B10 is opened select **Edit/Column/Add column**. The **Add column** dialogue displays.

column name:	value
column description:	area value
data type:	numeric
precision:	0
justification:	right
display width:	2

Press OK.
A column called 'VALUE' will be added to your table containing **MISSING** values for all records.
Activate by means of a mouse click the VALUE field in the first record of the layer table. The selected polygon is highlighted in the graphic screen. If this polygon will be flooded give as value '1'. If not, assign as value '0'. Assign a value to each polygon in this way.

Note: Do NOT try to be clever and assign already the flood event values like 10, 100 or 1000. If you do so this will cause a lot of trouble later on.

5) Check whether the created area layer contains 'inside islands'. These are areas that won't flood, which are surrounded by areas that do flood. SPANS will have problems displaying these layers. Therefore you should apply the method described in section 2.10 to overcome these problems. In that case two extra area layers will be created according to the following naming conventions:
<org.name>d - containing all true flood areas
<org.name>h - containing all 'inside islands'

The same method have to be applied to create both quadtree and area layers for the 1/100 and 1/1000 years events. It is urged to use the following file names:

event	area layer	quadtree layer
1/10	B10(.top/vtx)	B10(.map)
1/100	B100(.top/vtx)	B100(.map)
1/1000	B1000(.top vtx)	B1000(.map)

2.5 Printing first results

We are now at a very important point in our analysis procedure. The results until now has to be presented to Mr. Van der Knaap. The results until now do not take into account the flooding as a result of water level rise in rivers. Therefore he will make modifications to the calculated flood areas on paper. To guide him a set of paper maps have to be prepared. This set consists at least of the following:

- land use map, including rivers
- topography map (elevation per meter, including rivers)
- land use map combined with flood areas on top; including rivers
- topography map combined with flood areas on top; including rivers

For one province these maps should be made in the same scale. This means that a window has to be created that covers the whole coastal zone and the area up to 10 meters (how to create a window see step 6 of section 2.3). It also implies that the shape and size of the graphic window in SPANS Explorer should be the same for all the maps to be produced. So the actual seize depends on both the SPANS window, which determines the extents displayed at the map, and the graphic window, which determines the amount of 'white' (=non used) space on the paper.
Apart from the information describe above, all the maps should have a scale bar. As there will be not enough space to include a full legend, it is advised to print the legends of the landuse map and that one of the elevation per meter map separately on A4 paper. These legends can then be used for all maps.
To create a paper map the following steps should be performed:

1) create a map composition
2) draw map composition
3) append map annotation, in particular a scale bar
4) create a metafile
   use the following filenames:

lu.wmf	landuse, including rivers
el.wmf	elevation per meter, including rivers
lu_fz.wmf	landuse plus flood zones, including rivers
el_fz.wmf	elevation per meter plus flood zones, including rivers

5) print metafiles

The drawing order of the combined map composition should be:
- quadtree layer (LANDUSE.MAP or elev_m.MAP)
- area layer B1000 - unclassified (or B1000D, if original layer contains 'inside islands')
- area layer B100 - unclassified (or B100D, if original layer contains 'inside islands')
- area layer B10 - unclassified (or B10D, if original layer contains 'inside islands')

Select distinguishing colours for the flood zones and use these colours throughout the whole project.

Further information about creating and printing maps can be found in the manual.

Note: printing at a specific scale should be possible, but Tydac warned me that problems may occur. I suggest to apply a scale that fit the selected paper as optimal as possible. Use this scale factor for all the maps to be printed for one study area.

2.6 Correction of flood zones for major rivers

Mr. Van der Knaap will adjust the calculated flood areas based on river figures and expert judgement. The result will be drawn on transparencies. These transparencies will be the input for the GIS team to correct the flood zones. We will always start with the flood zone that floods the smallest area. In general this will be the 1/10 years zone. If this zone is not present (due to existing dyke structures, for example) it will be the 1/100 years zone.
Several steps have to be carried out:

1) Display the elevation per meter map plus the flood zone contours of B1000, B100 and B10 as reference map (You may use the map composition created in section 2.5)
2) From the Layer menu select New. The New Layer dialogue box appears.

   Name: a10
   Title: adjusted area 1/10 years event
   layer type: area

Press OK

3) Start drawing the areas for the 1/10 years flooding as indicated by Mr. Van der Knaap. In general the following options are possible:
- create new area
  - create island
  - create adjoining polygon
- change area boundary
- merge adjacent areas

For a complete overview of how to use these functions reference is made to pages 10-12 to 10-16 of the SPANS Explorer manual.
It is advised to save your work quite often during the on screen digitizing.

4) While the layer A10 is opened select **Edit/Column/Add column**. The **Add column** dialogue displays.

column name:	value
column description:	area value
data type:	numeric
precision:	0
justification:	right
display width:	2

Press OK.
A column called 'VALUE' will be added to your table containing **MISSING** values for all records.
Activate by means of a mouse click the VALUE field in the first record of the layer table. The selected polygon is highlighted in the graphic screen. If this polygon will be flooded give as value '1'. If not, assign as value '0'. Assign a value to each polygon in this way.

Note: Do NOT try to be clever and assign already the flood event values like 10, 100 or 1000. If you do so this will cause a lot of trouble later on.

Note: special attention should be paid to so called 'inside islands' or 'holes'. How to deal with this phenomenon is subject of section 2.10.

Note: Sometimes it may happen that you will be unable to select polygons, or that error messages are displayed. A solution may be to close the layer. Run ***Selfintersection*** *from the* ***Edit*** *menu. Export the layer to a SPANS vectorfile (VEC/VEH) and import this vectorfile again using the same name for the layer to create.*

5) Prepare and print a map composition that indicates the adjusted 1/10 years flood zone on top of the elevation per meter map. Show the result to Mr. Van der Knaap. If he has remarks, these should be corrected before continuing with step 6).

6) We will make a copy of area layer A10. From the **Layer** menu select **Open**. From the **Open layer** dialogue pick 'areas' as layer type and 'A10' as layer. Activate the 'Read only' option and press OK. After the layer has opened you select **Layer/Save as**.

Name:	a100
Title:	adjusted area layer 1/100 year event

Press OK

7) To open the just created layer select **Layer/Open** and choose the layer A100 from the dialogue box.

8) Start editing the areas for the 1/100 years event. In general these areas will be adjacent to the 1/10 year flood area(s). So the most common functions of the **Edit/Area** menu will be 'adding adjoining polygons' and 'merging adjacent polygons'.
As we want to deal with as less polygons as possible, all polygons that will be flooded and are separated by a single line should be merged together.
Do not forget to assign the right values for the column 'value', this means a '1' for each polygon that will flood 1/100 years and a '0' for the polygons that do not flood.

9) In the same way as the A10 layer was the base for A100, A100 will be the base layer for A1000. So repeat step 5), 6) and 7) to create layer A1000, based on A100.
This means also that you first have to present the result of the layer to Mr. Van der Knaap. He will check the result with his own drawing. After his approval you may continue with the creation of the A1000-layer.

2.7 Drawing flood zones for the sea level rise scenario

Apart from the adjusted flood areas without sea level rise Mr. Van der Knaap will also provide one or more transparencies on which the flood areas are drawn assuming a sea level rise of 1 meter. To draw (on screen digitizing) these areas the same steps has to be followed as described in section 2.6 for the adjustment of the calculated flood zones. Maybe it is helpful to display the elevation map together with the adjusted flood zones instead of the elevation map with the calculated flood zones. Use the following layer names:

1/10 years	SLR10(.top/vtx)
1/100 years	SLR100(.top/vtx)
1/1000 years	SLR1000(.top/vtx)

2.8 Area cross tabulation of results with landuse map

In order to perform the area cross tabulation we should convert the created area layers for the flood zones into quadtree layers. Here we will describe the process for the present day scenario (without sea level rise). The same steps should be applied to the sea level rise scenario.

1) Check whether the area layers to convert contain so called 'holes'. If so, use the procedure described in section 2.10. If not continue with step 2.
2) Create a quadtree layer of the area layer A10. Select **Map/New** from the menu followed by **Map/Edit**. The **Edit Map** dialogue box displays. The first entry under Map Layers is ---NEW---. This one is also selected. Press Edit to display the **New** layer box.
In the first column (layer type) select 'Areas'.
From the second column (Layer) select 'A10'.
As attribute (third column) you select 'unclassified'.
Press OK. The next box will appear, but you can just click OK and you will return to the **Edit Map** box. Here you press **Display**.
The map will be drawn, representing the adjusted flood areas for a 1/10 years event. To transform to a quadtree layer we have to select **Transform/Areas to Quadtree** from the File menu. The **Area to Quadtree** dialogue box appears.

Area layer dataset: *AREA: a10

Quad level:	13
New Map:	a10 .map

Press **OK**.

The same procedure should be followed to produce the quadtree layers 'A100.MAP' and 'A1000.MAP' from their respective area layers.

3) Make prints of each of the quadtree layers separately (including for example the province borders as reference) and show them to Mr. Van der Knaap.

4) We have to combine the three different quadtree layers into one quadtree layer. We will achieve this in two steps. Select **Analysis/Matrix overlay/Create Quadtree from template**. The Matrix dialogue box appears.

Matrix template:	a1 .mat
Window:	22 (= province window)
Quad level:	13
New Map:	temp .map

Press OK.

We are making use of a prepared matrix. The matrix in itself is simple. It looks like this:

```
        a100  adjusted areas for 1/100 year event
:-------------------------------
:
:-------------------------------
:               0        1
:-------------------------------
a10  adjusted area for 1/10 years event
:    0          0        100
:    1          10       10
```

In this matrix all possible combinations of classes of the two input maps are assigned new values. In our case it says:

- if class is A10 is 0 (no flood) and class in A100 is 0 (no flood) then the class in temp will be 0.
- if class is A10 is 1 (flood) and class in A100 is 0 (no flood) then the class in temp will be 10 (this is a theoretical case; in general an area that floods every ten years will also flood every hundred years)
- if class is A10 is 1 (flood) and class in A100 is 1 (flood) then the class in temp will be 10.
- if class is A10 is 0 (no flood) and class in A100 is 1 (flood) then the class in temp will be 100.

The second step is to combine our created temporary quadtree layer (TEMP.MAP; combination of A10.MAP and A100.MAP) with the 1/1000 years quadtree layer (A1000.MAP). Again we will use a matrix overlay. The template to use is available too. It is called A2.mat.

Matrix template:	a2 .mat
Window:	22 (= province window)
Quad level:	13
New Map:	tot_nslr .map

Press OK.

5) First we will delete our temporary quadtree layer. Therefore we select **File/Delete**

layer from the menu. Select the quadtree layer TEMP.MAP from the appearing scroll list. Then press OK.

6) Finally we will make a cross tabulation between our combined flood areas quadtree layer and the land use quadtree layer. From the **Analysis** menu pick **Area cross tabulation**. The system will display the **Map cross tabulated area analysis** dialogue box.

Row map:	tot_nslr	.map
Column map:	landuse	.map
New report file:	tot_nslr	.rep

Press OK.

After a while the report will appear on the screen by means of the notepad-editor. You will see a matrix with columns (land use classes) and rows (flood probabilities). Every Row consists of 4 records. The first one indicates the area per land use class. The second the total percentage. The row percentage is displayed in the third record and the last record of each row is displaying the column percentage. We are only interested in the first record, so the second, third and fourth of each row should be deleted.
This report (TOT_NSLR.REP) has to be printed. The figures will be transferred into an Excel spreadsheet.

*Note: Check in the header whether behind 'area' '(sq km)' is displayed. If the report is displaying '(sq mi)' you should change your system preferences from imperial to metric. To do this select **File/Options/System preferences**.*

7) The same steps have to be taken for the scenario with sea level rise. The names to be used are.

	area layer	quadtree layer
1/10 years	SLR10(.top/vtx)	SLR10(.MAP)
1/100 years	SLR100(.top/vtx)	SLR100(.MAP)
1/1000 years	SLR1000(.top/vtx)	SLR1000(.MAP)

To join SLR10.MAP and SLR100.MAP we make use of the matrix template slr1.mat. The result we will call SLR_TEMP.MAP.
The matrix template slr2.mat will be used to combine SLR_TEMP.MAP and SLR1000.MAP. The result of this last join we will call TOT_ASLR.MAP.
The result of the area cross tabulation between TOT_ASLR.MAP and LANDUSE.MAP have to be named TOT_ASLR.REP.

2.9 Presentation of results

Four maps has to be presented:
- land use map of the province, consisting of:
  - quadtree layer LANDUSE
- elevation map of the province, consisting of:
  - quadtree layer elev_m
  - line layer river
- land use map with areas at risk without sea level rise, consisting of:
  - quadtree layer LANDUSE
  - area layer A1000*
  - area layer A100*
  - area layer A10*

- land use map with areas at risk with sea level rise, consisting of:
  - quadtree layer LANDUSE
  - area layer SLR1000*
  - area layer SLR100*
  - area layer SLR10*

  ** In the case of an area layer containing so called 'holes' we will make use of the equivalent layer name with a 'd' appended. For example SLR100D in stead of SLR100. How to create these extra layers is described in section 2.10 dealing with the problem of area layers containing 'holes'.*

For each map a map composition has to be created. Use the following names when saving your map compositions:
- LANDUSE.CMD (land use map)
- ELEVATIO.CMD (elevation map)
- FFR_NSLR.CMD (land use map plus areas at risk without sea level rise)
- FFR_ASLR.CMD (land use map plus areas at risk when sea level rise = 1 meter)

All map composition should contain legends, scale bar and north arrow
The PCX files to be created should have a maximum resolution of 640x480 pixels, in order to be imported in the GMS system. So, adjust the size of your graphic window, but also the text size used in your picture. You have to try some things out, and check the results in GMS. Once you have found the right dimensions for both graphic window and text size, use these settings for all other PCX-files.

Note: The import into GMS will be done by Mr. Tuyen. So check with him whether the results area usable.

2.10 Dealing with 'holes' ('inside islands')

It may happen that an area layer contains so called 'holes' or 'inside islands'. This is nothing to worry about. We have to deal with this in a standard way.

area layers
Let's assume we have an area layer SLR100 that contains 'holes'. Open these layer 'Read only' using **Layer/Open**.
The so called 'holes' will be assigned a value of '0' for the attribute 'value' (see step 4 section 2.6), while the real polygons will have a value of '1'. Select all polygons that contain a value '1'. To do this we have to select **Query/Query by example**. In the dialogue that appears we build the following equation:
VALUE = 1
Be sure that the equation is stored in the frame at the bottom of the dialogue box. You also have to give the equation a name and a title. Press **OK**.
All polygons of SLR100 that meet the criterium will be highlighted in both the table and the graphic screen. Now we will save these polygons into a new layer, using **Layer/Save** as with as new name, SLR100D.
We will do the same, but now for the 'holes'. So we select all polygons with a value of '0'. We will save these polygons, using **Layer/Save** as. Call the result SLR100H.
Now we will close our layer by means of **Layer/Close**. In fact we do have three area layers regarding a 1/100 years event with sea level rise:

SLR100	- to be used as base for SLR1000, and to create a quadtree layer
SLR100D	- to be used to display SLR100 polygons
SLR100H	- to be used to create a quadtree layer

It goes without saying that in the case of 1/10 or 1/1000 years events the file names will change according to their original file name. The same holds true of course for the area layers of the events without sea level rise (A10, A100 and A1000).

quadtree layers

In our quadtree layer for SLR100 we do not want the 'holes' to be filled. To be sure that this is the case we will follow a strict procedure.

1) Start with enquadding the area layer SLR100. Follow the same procedure as described in step 1 of section 2.8. Call the resulting quadtree layer SLR100X.
2) Next enquad the area layer SLR100H. Again, follow the same procedure as described in steps 1 of section 2.8. Call the result SLR100H.

To produce our 'final' quadtree layer we have to subtract SLR100H from SLR100X. This can be done using a matrix overlay.

3) Create a matrix template by selecting **Analysis/Matrix overlay/Create matrix template**. The **Create matrix template** dialogue box will appear.

```
Row map:              slr100x    .map
Column map:           slr100h    .map
New matrix template:  slr100     .mat
```

Press OK

4) The foregoing step created an empty template. We are now going to fill it and create a new quadtree layer. Select **Analysis/Matrix overlay/Create quadtree from template**. The **Matrix** dialogue box appears. Click on the arrow behind the 'Matrix template' line. the **Matrix files** dialogue box displays. From the list select SLR100 and press **Edit**. This will invoke the notepad-editor showing the matrix template. Fill the template as in the next example:

```
          slr100h  slr100h
:---------------------------
:
:---------------------------
:                    0    1
:---------------------------
slr100x  slr100x
:          - 0       0    0
:          - 1       1    0
```

Select **File/Save** from the editor-menu and close the editor. You will return to the **Matrix Files** dialogue. Now press **OK**. This will bring you back to the **Matrix** dialogue box. Complete the filling of this dialogue:

```
Matrix template:   slr100    .mat
Window:            22 ( = province window)
Quad level:        13
New Map:           slr100    .map
```

Now we have created a quadtree layer that represent the original area layer. This quadtree layer have to be used in combination with quadtree layers for the other flood probability classes.

3. ANALYSIS PROCEDURE MEKONG AND RED RIVER

3.1 Introduction

The procedure for the Red River Delta and the Mekong Delta is slightly different from that one for the Central Coast. For the deltas we are not going to start from the flood frequency curve for the sea. Based on expert judgement and experiences of former flood events maps area drawn indicating the areas at risk every 10, 100 and 100 years respectively. This is done for the present day situation and for the scenario with a sea level rise of one meter. These maps will be the starting point for our analysis.

!! The exact procedure has not been finalised yet. Especially how to deal with numbers for the separate provinces within the respective deltas need further study. A separate document will provided in which this procedure will be worked out in more detail. So it is advised to analyse the deltas at the end of the project !!

3.2 Red River

The risk area for the Red River are already digitized. Therefore they are available in digital format. They are stored in the directory:

C:\GIS_FFR\REDRIVER

This study area contains all necessary information. Apart from the standard database the following layers are present:
- A10(.top/vtx)
- A100(.top/vtx)
- A1000(.top/vtx)
- SLR10(.top/vtx)
- SLR100(.top/vtx)
- SLR1000(.top/vtx)

The following steps has to be performed:
- create base map
  Follow steps as described in section 2.3. Use the area layer REDRIVER.
- cut flood zone layers per province withing the Red River Delta
- perform area cross tabulation of results per province with land use map
  Follow steps as described ion section 2.8
- presentation of results
  Follow steps as described in section 2.9

3.3 Mekong River

Unfortunately we were not able to establish flood zones for the Mekong Delta. So these have to be created from the paper maps. The following steps have to performed.
- set up a study area for the Mekong Delta
  Follow steps as described in section 2.2
- create base map
  Follow steps as described in section 2.3
- digitize flood areas for the present day situation
  Follow the steps as described in section 2.6. Take as reference map a map

indicating rivers and roads, eventually the land use map (takes a long drawing time). Ask the appropriate drawings from Mr. Van der Knaap. It is advised to ask Mr. Van der Knaap to sit next to you to assist you when you are drawing the flood zones. Start with 1/10 years layer (A10) and once this one is finished use this one as base for A100. etc..

- digitize flood areas for a sea level rise of 30 centimetres
  For the Mekong Delta we will not use the scenario of a sea level rise of 1 meter, but we will use the 30 centimetres rise scenario. Maps that indicate the flood areas are already prepared. To digitize this on screen, use the same procedure as described in the previous step.
- cut flood zones per province within the Mekong Delta
- perform area cross tabulation of results per province with land use map
  Follow steps as described ion section 2.8
- presentation of results
  Follow steps as described in section 2.9

4. Concluding remarks

It is very difficult to provide a time frame for the next period. However, I would like to provide some structure for the coming actions.

I suggest that the GIS start in week 42 with the example of Thanh Hoa. Mr. Van der Knaap already drew the maps with the adjusted flood zones on it. When Mr. van der Knaap returned from his short holiday, he can discuss the results with the GIS-team.

After the return of Mr. Van der Knaap the process of digitizing the on screen the flood zones for the Mekong delta can start. This requires that at least for the Mekong Delta rivers and road files are available. They have to be imported into the study area for the Mekong.

Meanwhile the analysis if the other coastal provinces can start. As we are not sure whether the elevation map for the South is good enough, it is advised to start with the northern coastal provinces (Thanh Hoa till TT-Hue).
Back in Holland Mr. Van Veldhuizen and Mr. Toms will check the elevation map for the south. If necessary corrections will be made. If so, we will send the new digital maps to the project office, including a report on how to import it into the base study area for the south.
As soon as there is a decision which map to use we will inform the project office. From that moment the analysis of the southern coastal province can start (Da Nang to HCMC).

The analysis of the two delta will be done at the end. A full description of the procedure will be provided somewhere in November.

PPENDIX I

Parameters of base study areas in SPANS

North-Vietnam
projection: UTM, zone 48
ellipsoid: Everest
coordinates of lower left corner: 102.0°E 16.0°N
quadtree-level 13 represents 0.250 kilometre

System parameters of SPANS are:

mapid : base
window id : 00
Origin of Universe:
lon 102.0000 lat 16.0000
Midpoint of Universe:
lon 111.9622 lat 25.1103
Projection string 3 10 105.000000 0 0.9996 500000 0
conversion factor: 0.0625

South Vietnam
projection: UTM, zone 48
ellipsoid: Everest
coordinates of lower left corner: 102.0°E 8.0°N
quadtree level 13 represents 0.250 kilometre

System Parameters of SPANS are:

mapid : base
window id : 00
Origin of universe
lon 102.0000 lat 8.0000
Midpoint of Universe
lon 111.5083 lat 17.1661
Projection string 3 10 105.000000 0 0.9996 500000 0
conversion factor : 0.062500

APPENDIX II

Contents of base study areas

North Vietnam (\GIS_ORIG\NORTH\BASE_SP)

Quadtree layers(extension .MAP)

BASE	- base map
LANDUSE	- land use map
ELEV_DM	- elevation per decimeter
ELEV_M	- elevation per meter
VN_NORTH	- provinces of North Vietnam

Area layers(extension .TOP/VTX/TBB)

BASE	- base map
VN_NORTH	- provinces of North Vietnam

Line layers(extension .TOP/VTX/TBB)

COAST	- coast line (based on province map)
INFRA	- main infrastructure (roads and railroads)
RIVDYKE	- river dykes
RIVER	- main rivers
SEADYKE	- sea dykes

Matrix templates(extension .MAT)

A1	- to combine A10.MAP and A100.MAP = = > TEMP.MAP
A2	- to combine TEMP.MAP and A1000.MAP = = > TOT_NSLR.MAP
SLR1	- to combine SLR10.MAP and SLR100.MAP = = > SLR_TEMP.MAP
SLR2	- to combine SLR_TEMP.MAP and SLR1000.MAP = = > TOT_ASLR.MAP

South Vietnam (\GIS_ORIG\SOUTH\BASE_SP)

Quadtree layers(extension .MAP)

BASE	- base map
LANDUSE	- land use map
ELEV_DM	- elevation per decimeter
ELEV_M	- elevation per meter
VN_SOUTH	- provinces of South Vietnam

Area layers(extension .TOP/VTX/TBB)

BASE	- base map
VN_SOUTH	- provinces of South Vietnam

Line layers(extension .TOP/VTX/TBB)

COAST	- coast line (based on province map)

Matrix templates(extension .MAT)

A1	- to combine A10.MAP and A100.MAP = = > TEMP.MAP
A2	- to combine TEMP.MAP and A1000.MAP = = > TOT_NSLR.MAP
SLR1	- to combine SLR10.MAP and SLR100.MAP = = > SLR_TEMP.MAP
SLR2	- to combine SLR_TEMP.MAP and SLR1000.MAP = = > TOT_ASLR.MAP

APPENDIX III

Provinces, province numbers, vectorfiles and directories

NORTH

prov. #	province name	related vector file	directory of study area
15	Quang Ninh	q-ninh.vec/veh	\GIS_FFR\Q_NINH
22	Thanh Hoa	t-hoa.vec/veh	\GIS_FFR\THANHHOA
23	Nghe An	nghean.vec/veh	\GIS_FFR\NGHE_AN
24	Ha Tinh	hatinh.vec/veh	\GIS_FFR\HA_TINH
25	Quang Binh	q-binh.vec/veh	\GIS_FFR\Q_BINH
26	Quang Tri	q-tri.vec/vec	\GIS_FFR\G_TRI
27	Thua Thien Hue	tt-hue.vec/veh	\GIS_FFR\TT_HUE
--	Red River	redriver.vec/veh	\GIS_FFR\REDRIVER

SOUTH

prov. #	province name	related vector file	directory of study area
28	Quang Nam-Da Nang	qndn.vec/veh	\GIS_FFR\DA_NANG
29	Quang Ngai	q_ngai.vec/veh	\GIS_FFR\Q_NGAI
30	Bin Dinh	b_dinh.vec/veh	\GIS_FFR\B_DINH
31	Phu Yen	phuyen.vec/veh	\GIS_FFR\PHU_YEN
32	Khanh Hoa	k_hoa.vec/veh	\GIS_FFR\KHANHHOA
33	Ninh Thuan	n_thuan.vec/vec	\GIS_FFR\N_THUAN
34	Binh Thuan	b_thuan.vec/veh	\GIS_FFR\B_THUAN
53	Ba Ria-Vung Tau	br_vt.vec/veh	\GIS_FFR\VUNG_TAU
2	Ho Chi Minh City	??	\GIS_FFR\HCMC
--	Mekong Delta	redriver.vec/veh	\GIS_FFR\REDRIVER

APPENDIX IV

Return periods for extreme water levels (in meters) per province

Province name	1/10 yr.	1/100 yr.	1/1000 yr.
Quang Ninh	2.3	2.6	2.8
Thanh Hoa	1.9	2.2	2.4
Nghe An	1.8	2.1	2.3
Ha Tinh	1.8	2.0	2.2
Quang Binh	1.4	1.7	2.0
Quang Tri	1.3	1.6	1.9
Thua Thien Hue	1.3	1.6	1.9
Quang Nam - Da Nang	1.3	1.6	1.9
Quang Ngai	1.2	1.5	1.7
Binh Dinh	1.1	1.3	1.5
Phu Yen	1.1	1.3	1.5
Khanh Hoa	1.1	1.3	1.5
Ninh Thuan	1.1	1.3	1.5
Binh Thuan	1.4	1.5	1.6
Ba Ria - Vung Tau	1.6	1.7	1.8
Ho Chi Minh City	1.4	1.5	1.5

Calculating risk-areas per province for the main deltas

In our vulnerability analysis we treat the deltas of both the Mekong and the Red River as two study areas. However, we would like to calculate the areas of the risk zones per province. In this document I will describe the steps needed to achieve this.

1 *Create a complete dataset for the delta*
Create a study area of the delta that includes the layers indicating the 1/1, 1/10, 1/100 and 1/1000 risk zones, both for the present day situation and for the 1 meter sea level rise scenario.

2 *Copy study area to province directories*
Create for every province within the delta a new directory under \GIS_FFR. Copy the contents of the study area of the delta to each of these directories (for example: create a directory \GIS_FFR\HANOI and copy the contents of \GIS_FFR\REDRIVER into the created directory)

3 *Define study areas*
Start SPANS Explorer and define the created directories as new study areas.

4 *Create a proper base map*
In DOS: copy the SPANS vectorfile (*.VEC/VEH) of the province border to the directory of the province. (for example: copy HANOI.VEC/VEH to \GIS_FFR\HANOI)
Open the study area of the province and import the just copied vectorfile, in order to create an area layer.
Transform the area-layer of the province into a quadtree-map of the province, containing only 1 class. Call the result BASE (overwrite existing base-map of the delta). (for mor information on how to create a base map I refer to section 2.3 of the document "General procedures spatial analysis")

5 *Perform area cross tabulation*
As an area cross tabulation would only be performed within the area of the base map, it would now give figures for the province of interest. The procedure is described in section 2.8 of "General procedures spatial analysis".

Some remarks about the concepts of SPANS Explorer

Spans Explorer will be used in this project to analyze land use maps and the expected flood zones for different scenario's. Furthermore the software will be used to present the results by means of maps (both digital and paper).
This document is meant to give a conceptual overview of the software.
Spans Explorer is project based. This means that all data for a given project should be in one and the same directory of your hard disk. Spans Explorer refers to these projects as 'study areas'. Although the VA-study covers the whole of Vietnam, we decided to split the Vietnamese coast into various 'study areas' (1 for each of the main delta's and 1 for each of the remaining coastal provinces). Consequently within SPANS Explorer study areas has been designed that point to a specific directory of the hard disk containing the data for that region.
Main features of SPANS Explorer are the 'layers'. A layer represents geographic elements of the same kind (for example: parcels). There are different types of layers:

- point layers
- line layers
- area layers
- label layer
- quadtree layers
- raster layers

It is possible to transform the data layers from one type to another, though sometimes it takes several steps (for example to go from raster to points). Keep in mind that transforming data from one layer to another in general causes loss of information.

Different layers can be combined into a 'map'. Because of historic reasons often the term map is also used to indicate a quadtree layer. Therefore I prefer to call a combination of layers a 'map composition'. It is possible though that a map composition consists of just one layer. Apart from layers all kind of cartographic annotation can be added to a map composition, such as titles, legends and scalebars. The map composition can be stored and/or printed.
The order of the layers will influence the final result of the map. Though technically possible it makes no sense to add more than one quadtree and/or raster layer to your map composition. Because of the data structure such a layer makes the underlying layers 'invisible', even if such a layer only displays a small part of the study area. Therefore, if a quadtree or raster layer is added it should be the first layer to draw.

Point, line and area layers are <u>vector based</u>. They consist of a certain number of geographic entities to which one can link one or more attributes. The vectors are stored in a geographic file while the attribute data are stored in a table. The table is entity-based, this means that each entity of the geographic file has one record (row) in the table. The link between these two is established by a unique entity number.
A table always contains the following columns entity, class, area and perimeter. The values for area and perimeter are calculated automatically once the layer is created and every time the geography is edited.

! *The values are metric or imperial depending on the choice made by the user in the preferences for the study area. If 'strange' values occur it could be that while you expect metric values the system preferences has been set to imperial.*

It is possible to make selections based on location or attribute values. Such a selection can be stored in a new layer. It is also possible to do (simple) table calculations based on the attributes of a layer. The outcomes will be stored in a new layer and could be mapped by the user.

Edits can also be made on the geographic entities (for example: merging two areas or changing the shape of a line). Special attention should be paid to the attribute values if in such edits more that one entities are involved (for example: if you merge two areas it depends on the order of selecting which attributes are kept for the new area).
A special kind of edit is the combination of two vector layers to create a new vector layer containing the information of both original vector layers (geographic overlay). Such a process is possible, though time consuming.
A label layer is a special kind of point layer. It is created to label geographic features in a map composition (for example: city names).

Raster and quadtree layers are raster based (quadtree is a special kind of raster technique). The geographic file consists of cells. Each cell contains one value for the phenomenon the layer is representing. These data structures imply that no attribute data can be linked to these layers by means of a table (in fact, the attributes are incorporated in the geography).
An advantage of the data structure of raster based layers is the high speed of analysis. Most analyzing techniques within Explorer apply to the quadtree layers. Overlaying two or more quadtree layers is peace of cake and do not allow you to leave the room for a 'coffee break'. It is possible to produce area reports (for one quadtree layer, or cross tabulated for two quadtree layers). Furthermore there are two techniques for overlaying maps. The 'matrix overlay' overlays two quadtree layers. The user has to assign new values for each possible combination of the original layer classes. In a 'multi criteria overlay' up to 20 quadtree layers can be overlayed in one time. The user has to assign a weight for each layer (related to its importance compared to the other layers). In addition the user should assign weights to the individual classes of each layer to indicate their relative importance.

The main menu reflects more or less the different aspects described above.
FILE: functions related to maintenance of study areas
- opening/creating/deleting study areas
- import/export of data layers and library information
- transformation and deletion of data layers
- study area preferences

MAP: functions related to map compositions
- creating/editing/deleting/displaying map compositions
- adding/removing cartographic annotation
- zooming/windowing functions

LAYER: functions related to vector based layers
- opening/creating vector based layers
- export table attributes to other dataformats
- attribute computations

CHART: functions related to charts in the chart window (not described in this document)

QUERY: functions for queries and selections
- queries/selections based on location or attributes

EDIT: functions related to editing of layers
- reclassification of quadtree layers
- changing geometry of vector based layers

ANALYSIS: functions related to combination of layers
- overlaying techniques

APPENDIX B :

Vietnam VA Study
Working Document : FFR ANALYSIS

concepts and procedures
of
Flooding and Flood Risk model

Contents

X.1 Approach

The Common Methodology presenting a common approach of the vulnerability assessment (VA) to accelerated sea level rise (ASLR), requires an estimate of capital values and people at risk in the low lying coastal areas of the world. The variable "at risk" can be defined as "the product of the specific value in a certain risk zone and the probability of a flooding event in this risk zone". The result can be interpreted as a theoretical value which is thought to be subject to flooding events. This "risk value" reflects changes of functions in the risk zones (e.g. due to growth of population density) and changes in flooding frequency (an accelerated sea level rise, subsidence, changes in the storm climate and river run-off) and is essential in a general flooding and flood risk analysis of a coastal area.

In order to execute a flood and flood risk analysis of the Vietnamese coast, the following steps are taken:

1. Definition of the *Study Areas* (SA).

2. Definition of *Hydraulic Condition Zones* (HCZ). A HCZ can be described as a part of the coast to which a specific set of hydraulic conditions applies.

3. Definition of the *Flooding Impact Zones* (FIZ). A FIZ can be described as the extent of the area within a Study Area which will be flooded with a certain probability. *This distinction is not strictly necessary for the VA-analysis, but is of interest for presentation purposes.*

4. Definition of homogeneous *Protection Sections* (PS) within the individual Study Areas (if possible).

5. Confrontation of the Hydraulic Condition Zones with the Protection Sections for each individual Study area.

6. Based on an inventory of socio-economic values, the flood risk modelling will result in data on the effect of flooding and flood risk on the lower sections of Vietnam.

On basis of information which can be processed following the above steps, a number of more in-depth analyses can be performed, either as a sensitivity analysis or in order to support specific scenarios.

In sections 2 ... 10 each of the above mentioned steps will be discussed in detail.

X.2 Definition of concepts of risk, loss and change

In the Common Methodology, the *concept of risk* is defined as the consequence of natural hazardous events times the probability of the occurrence of these events, *without* taking the system response into account.
The *concepts of loss and of change* are defined as the consequences of natural hazardous events times the probability of the occurrence of these events, *with* taking the system response into account.
The natural hazardous events in Vietnam vary from national events such as eustatic sea-level rise, to regional events such as subsidence, wave intensities and river run-off. The socio-economic or physical response and the intrinsic time response scale of the relevant "system" (people, agriculture, ecosystems) determine the type of hazardous event which is relevant.

The *concept of risk* is considered to be appropriate in the context of assessing the consequences of ASLR to the coastal zone population and nearby economic values. The short term consequence of flooding events to population varies from minor effects such as flooding of peoples' goods to possible losses of lives. As the Common Methodology describes, it is not realistic to predict any effects these events might have on the behaviour of the population in the longer term. It is for instance likely to assume that frequent flooding leads to migration, but this is certainly not true for countries where migration is no realistic alternative. Therefore the concept of risk rather than the concept of loss or change is applied to indicate the impact on the populations of the coastal zone.

The concepts of change and of loss are considered essential in the context of agricultural production and of ecosystems, respectively. In these cases it is not so much the short term flooding events (exceedance frequencies of storm surge levels) that determine the consequences on these resources, but rather the persistence of the average longer term hydraulic changes, such as ASLR. The probability of the occurrence of ASLR is assumed to be 100%; only the rates of change are subject to discussion.

X.3 Definition of Study Areas

The Vietnamese coast will be subdivided into 16 Study areas to facilitate a regional breakdown in the assessment and presentation of the impacts of sea level rise. From a practical point of few, these Study Areas are chosen similar to the boundaries of the Coastal Provinces (except for the two deltaic areas), i.e.:

1. Quang Ninh
2. Red River Delta
3. Thanh Hoa
4. Nghe An
5. Ha Tinh
6. Quang Bin
7. Quang Tri
8. Thua Thien Hue
9. Quang Nam
10. Quang Ngai
11. Binh Dinh
12. Phu Ven
13. Khanh Hoa
14. Ninh Thuan
15. Binh Thuan
16. Baria-Vung/Tau
17. Ho Chi Minh City
18. Mekong Delta

X.4 Definition of Hydraulic Condition Zones

Assessment of hydraulic conditions provides quantitative information of the potential flooding situation for the low lying coastal and river areas of Vietnam. A Hydraulic Condition Zone (HCZ) can be described as a part of the coast to which a specific set of hydraulic conditions applies. They are used to express the various sets of hydraulic conditions which apply to different parts of the Vietnamese central coast (e.g. the North, Middle and South hydraulic conditions). For each HCZ a unique initial water level Exceedance Frequency Curve (EFC) applies which describes the exceedance frequency of tide and storm surge levels.

In general, coastal zones are vulnerable to flooding if they lie below a water level which may occur within a specific time horizon. This flood level is determined by a number of factors.

- Global hydraulic factors.

The global hydraulic factor taken into account in the VA study is the accelerated sea level rise of 1.0 m per 100 years.

- Regional geophysical factors.

Subsidence and tectonic uplift are taken into account, based upon rough information. For the VA-VIETNAM, only subsidence is valid in deltaic regions.

- Local hydraulic factors.

The exceedance frequencies of storm surges shall be taken into account: for the VA- analysis a return interval of once a year, 10 years, 100 years and 1000 years (the latter will be the result of interpolation but is conform other studies).

Generally, an EFC can be determined with the following formula:

$$EFC = SURGE_{(f)} + SUBS + SLR \qquad (1)$$

where:

$SURGE_{(f)}$	=	water level given a specific storm surge frequency, by a duration of 2-3 days (f between 1 and 1/1000)
SUBS	=	subsidence rate of 0 mm/year (deltaic regions pm)
SLR	=	sea level rise of 1.0 m in 100 years

For each Province , theoretically, one initial water level Exceedance Frequency Curve (EFC) applies which describes the exceedance frequency of tide and storm surge levels for this specific region.
In practice however, three EFC's for the central coast will be more than sufficient.

example of EFC input file (file xxx.EFC):

Province: Quang Binh

H1	=0.9	m	f1	=1
H10	=1.5	m	f2	=0.1
H100	=1.8	m	f3	=0.01
H1000	=2.1	m	f4	=0.001

Each EFC will be stored in a unique input file per Study Area (xxx.EFC) and will be used to analyse the effect of ASLR on the coast, including the effect of ASLR on the (estimated) present defence system.

The analysis will be executed with the FORTRAN program EFC.EXE based upon the above defined input files.
Programs steps:

- The user will select a province and case number (case 0 [base case] to case4)
- the program EFC.EXE will import the corresponding EFC-input file
- the rate of ASLR will be asked (0 and 1.00 m)
- the (estimated) design frequency of the coastal/river protection will be asked (no dike or between 1 and 0.001)

By fitting a function through the data points, the program will produce output (xxx.RCL files) on:

- new water levels with corresponding frequencies in case of ASLR and no dikes
- new water levels with corresponding frequencies and reduction of safety levels/to even dike failures in case of ASLR with dikes

The above described model EFC.EXE was originally planned to be part of the internal spreadsheet of SPANS-EXPLORER, but this could not be executed as a result of the disappointing functionality of the dynamic link between maps and spreadsheet as well as the absence of a macro-language.

In the case of the two delta's, two or more HCZ's will apply to a single Delta Study area. The overall susceptibility of this Study Area to flooding is defined by the Partial flooding level Exceedance Frequency Curves of both Hydraulic Condition Zones. This confrontation results in one Combined flooding level Exceedance Frequency Curve (CEFC) valid for a single Study area, indicating the remaining flood level related to a range of frequencies of exceedance .

Example of output EFC.EXE

(xxx.EFC= input file for analysis with EFC.EXE
(xxx.RCL file= output of EFC.EXE and input file for analysis with SPANS-EXPLORER)

file: **pro1_c3.RCL** (read province 1, case 2, EFC input file)

```
:
:EFC output - Province no  1
:               case  3
:
```
:ASLR = 0.600
:fdold= 0.020 (original design frequency)
```
:
:h(1)o=  1.600        (1)  =  1.000
:hdike= 2.544         fdike= 0.380 (new design frequency related to ASLR)
:h(2) =  2.700        f(2) =  0.100
:h(3) =  3.200        f(3) =  0.010
:h(4) =  3.800        f(4) =  0.001
:
:SPANS reclassification
:
  0   0    0
  1  16 1000          "intertidal" area
 17  25 9990          area between f=1 and fdike=0.38
 26  27  100          area between  fdike=0.38 and f=0.1
 28  32   10          area between f=0.1 and f=0.01
 33  38    1          area between f=0.01 and f=0.001
 39  61 9999
```

Only data in rows without a colon (last 3 columns) are relevant input for case-runs with SPANS-EXPLORER. Rows starting with a colon will serve as extra data check.

To analyse the effect of ASLR and coastal and river protection systems, several scenarios should be considered:

(1) no dike, no ASLR

h0-h1	intertidal area
h1-h2	risk zone between f1-f2
h2-h3	risk zone between f2-f3
h3-h4	risk zone between f3-f4

(2) no dike, with ASLR

h0(old)-h0(new)	below MSL (new)
h0(new)-h1(old)	remaining part of "old" intertidal area
h1(old)-h1(new)	area at loss (upper part of intertidal area)
h1(new)-h2(new)	risk zone between f1-f2
h2(new)-h3(new)	risk zone between f2-f3
h3(new)-h4(new)	risk zone between f3-f4

(3) with dike, no ASLR

h0-h1	Intertidal area
h1-hdike	area protected by dike with design frequency 1/fdike
hdike-h2	risk zone between fdike-h2
h2-h3	risk zone between f2-f3
h3-h4	risk zone between f3-f4

(4) with dike, with ASLR, no failure

h0(old)-h0(new)	below MSL
h0(new)-h1(old)	remaining part of "old"intertidal area
h1(old)-hdike	area protected by dike with reduced design frequency fdike(new)
hdike-h2(new)	risk zone between fdike(new)-f2
h2(new)-h3(new)	risk zone between f2-f3
h4(new)-h4(new)	risk zone between f3-f4

(5) with dike, with ASLR, failure (=flooding; similar to 2)

h0(old)-h0(new)	below MSL(new)
h0(new)-h1(old)	remaining part of "old"intertidal area
h1(old)-h1(new)	area at loss (upper part of intertidal area)
h1(new)-h2(new)	risk zone between f1-f2
h2(new)-h3(new)	risk zone between f2-f3
h3(new)-h4(new)	risk zone between f3-f4

remarks:

- "new" related to rate of ASLR
- design frequency dike between (1/year and 1/1000 year failure)
- "intertidal area" not included in analysis
- f1-f4 fixed on 1, 0.1, 0.01 and 0.001; fdike(new) depending on rate ASLR

X.5 Definition of Flooding Impact Zones

Based on the hydraulic conditions of the Vietnamese coast including an accelerated sea level rise of 1 m, the land-inward elevation line of MSL +6 m forms in this study the upper boundary of the low-lying coastal zone of the coast. This 6 m elevation is an estimate, based upon direct effects of ASLR and storm surges, and indirect effects such as increased salt ground water intrusion. It may be expected that this area will be in some way or another affected by an increase of the sea level and will be defined as the potential Flooding Impact Zone (FIZ) The notion "affected" in this context refers to *direct loss* of land due to flooding, and to *indirect effects* due to changes in flood risks (for salt intrusion and ecological responses, a simple model should be developed).

X.6 Definition of Protection Sections

A Protection Section (PS) can be defined as a coastal defence system with a uniform protection status. A subdivision is made between *artificial* and *natural* defence systems.

In case of an *artificial* defence system (dikes, sea walls, etc.), the protection status is based on the crest height in combination with the local exceedance frequency curve of tide, storm surges and wave run-up. The actual safety height of the system determines whether failure of the structure will occur, based on the local hydraulic conditions. The notion "safety height" is defined as the theoretical height of the defence structure which, given a certain water level (tide, storm surges) and wave attack, will just lead to critical damage of the structure and inundation of the hinterland.

In case of a *natural* defence system (dunes), the failure mechanism is based on the lowest spots in the dune crest. By overtopping of the crest, the dune is considered as broken and inundation of the hinterland will occur.

For the areas at risk it may be safely assumed that those settlement areas, which are potentially affected by flooding, have some kind of basic protection. With this in mind, the assumption can be made that risk levels mainly change due to ASLR for people living on what can be defined as dry land (inundation frequency less than once per year).

From a practical point of view), the design frequency of each coastal province will be estimated in stead of safety heights. By means of the program EFC.EXE, also several protection scenarios can be prepared. Considering the lack of data and considering this national study on vulnerability, this approach will be sufficient. A detailed inventory of the coastal protection system is subject for the Pilot Studies.

X.7 Confrontation of Hydraulic Condition Zones and Protection Sections

In order to assess the changes of the flood risk and flooding situation for each Study Area (SA), the initial water level Exceedance Frequency Curves (EFC) of the Hydraulic Condition Zones (HCZ) have to be confronted with the coastal Protection Sections (PS) along the coast.

If more than one Protection Section applies to a single Study Area (only valid for deltas, the individual safety heights for these Protection Sections will result in a flood level distribution curve based on the *weakest spot* in the protection status of the entire Study area. In this situation, the safety heights of the Protection Sections in combination with the hydraulic conditions determine to what extent the coastal defence system is actually valid for the entire impact zone. In case of a single defence structure with a given safety height, flooding of the flood prone area will occur only if the water level exceeds the safety height of the structure (once per xx years). For the flood risk analysis, however, only that part of the EFC that induces flooding (once per (xx+n) years, with a maximum of 1000 years) is taken into account and is defined as the Partial flooding level Exceedance Frequency Curve (PEFC).

X.8 Analysis of Impact Areas

SPANS_EXPLORER will be used to digitise:

- land use maps
- topography/elevation
- infrastructure
- population distribution (optional)
- boundaries of provinces.

As interpolation between contour lines per metre is not possible within SPANS-explorer, which means that the interval between contour lines should match with the exceedance frequency data and taken into account the inaccuracy of the digitised elevation data and the RF-curves, a contour interval of 10 cm is chosen.

Based on the output of the EFC-model (unique xxx.RCL files has to be imported within SPANS-EXPLORER) and the digitised maps of elevation and land use, each Study Area will be confronted with eight scenarios of different sets of input values. These sets of input values, called CASE-0 (base case) through Case-3, are listed in the table below.

	ASLR (cm yrs)	PS (x/yr)
CASE-0	0	non
CASE-1	100	non
CASE-2	0	x
CASE-3	100	x

remark: range x between 1 and 0.001

Table ... description of cases to be analysed with the FFR model

The outcome of the analysis with SPANS-EXPLORER will be a ASCII-table containing data of areas of the 13 Land Use classes divided over the contour intervals as a result of execution of EFC.EXE. This raw data-file (xxx.REP) will be polish up by running the FORTRAN model FFR_inp.EXE. The table presented on the next page shows for each frequency classes (in this case 1-1/10 year, 1/10-1/100 and 1/100-1/1000) the corresponding areas of land use classes (if present) in square km.

AREA CROSS TABULATION

Row : pr01_c3 - pr01_c3

Col : landuse - landuse

Window : qb - Quangbi nh province

Contingency Coefficient 0.2381

Tschuprow's T 0.0132

Cramer's V 0.0708

Area (sq km)

Total %

Row %

Col %	RIC	OAC	PRC	IDF	TBF	SLU	URA	RUA	NOL	SFW	Total
1.00	9.63	0.00	0.19	0.00	0.00	0.00	0.44	1.19	37.19	5.25	53.88
	0.37	0.00	0.01	0.00	0.00	0.00	0.02	0.05	1.42	0.20	2.05
	17.87	0.00	0.35	0.00	0.00	0.00	0.81	2.20	69.03	9.74	
	1.46	0.00	0.56	0.00	0.00	0.00	22.58	1.58	3.09	5.00	
10.00	12.19	0.00	0.00	0.00	0.00	0.00	0.63	2.00	21.94	7.94	44.69
	0.46	0.00	0.00	0.00	0.00	0.00	0.02	0.08	0.84	0.30	1.70
	27.27	0.00	0.00	0.00	0.00	0.00	1.40	4.48	49.09	17.76	
	1.85	0.00	0.00	0.00	0.00	0.00	32.26	2.65	1.82	7.56	
100.00	3.44	0.00	0.06	0.00	0.00	0.00	0.13	0.31	7.25	1.19	12.38
	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.28	0.05	0.47
	27.78	0.00	0.51	0.00	0.00	0.00	1.01	2.53	58.59	9.60	
	0.52	0.00	0.19	0.00	0.00	0.00	6.45	0.41	0.60	1.13	
1000.00	37.25	0.00	0.00	0.00	2.44	0.00	0.00	8.25	84.31	5.63	137.88
	1.42	0.00	0.00	0.00	0.09	0.00	0.00	0.31	3.21	0.21	5.26
	27.02	0.00	0.00	0.00	1.77	0.00	0.00	5.98	61.15	4.08	
	5.65	0.00	0.00	0.00	7.78	0.00	0.00	10.95	7.01	5.35	
9990.00	16.38	0.00	0.06	0.00	0.00	0.00	0.31	3.38	25.00	6.94	52.06
	0.62	0.00	0.00	0.00	0.00	0.00	0.01	0.13	0.95	0.26	1.98
	31.45	0.00	0.12	0.00	0.00	0.00	0.60	6.48	48.02	13.33	
	2.48	0.00	0.19	0.00	0.00	0.00	16.13	4.48	2.08	6.60	
9999.00	580.44	45.31	32.88	468.81	28.88	0.50	0.44	60.25	1027.19	78.13	2322.81
	22.12	1.73	1.25	17.87	1.10	0.02	0.02	2.30	39.15	2.98	88.53
	24.99	1.95	1.42	20.18	1.24	0.02	0.02	2.59	44.22	3.36	
	88.04 1	0.00	99.06	100.00	92.22	100.00	22.58	79.93	85.39	74.36	
Total	659.31	45.31	33.19	468.81	31.31	0.50	1.94	75.38	1202.88	105.06	2623.69
	25.13	1.73	1.26	17.87	1.19	0.02	0.07	2.87	45.85	4.00	

X.9 Concept of the area at risk

In order to calculate the areas at risk in the various Study areas, an assumption has to be made of the correlation of the exceedance frequency of the hydraulic condition and the area distributed over the impact sectors. This problem can be clarified by the following example.

Suppose that near a zone of interest the sea level exceeds a level of 0.4 m once every hundred years ($f_{0.4}$ = 0.01 y^{-1}), and that the exceedance frequency of a level of 1.0 m is once every thousand years ($f_{1.0}$ = 0.001 y^{-1}). Suppose further that between the levels corresponding with f_3 and f_4, the area is 1000 km^2. If the whole area has an elevation of approx. 0.4 m, the average area at risk per year (AAR) would be equal to $AAR_{0.4,\ 1.0}$ = 10 km^2/yr (1/100 * 1000 km^2). On the other hand, if the area has an elevation of approx. 1.0 m, the result would be $AAR_{0.4,\ 1.0}$ = 1 km^2/yr (1/1000 * 1000 km^2). In general, the average area at risk per year will lie somewhere in between these two limits.

By inserting the values (per km^2) of the relevant functions associated with each Delta Study area and/or Delta Elevation Zone, an estimate of flooding and flood risk can be calculated (Hoozemans et al., 1993).

It is important to realise that the area of a Study Area which will actually be flooded may be smaller than calculated according to the used approach. This is the case if the total amount of water flowing into the study area during the storm surge is smaller than the volume of the study area. In the present VA this aspect has not been taken into account. Therefore, in some situations, the actual impacted area might be over-estimated (not included in VA scenarios!)

X.10 Runs with the Flooding and Flood Risk model FFR

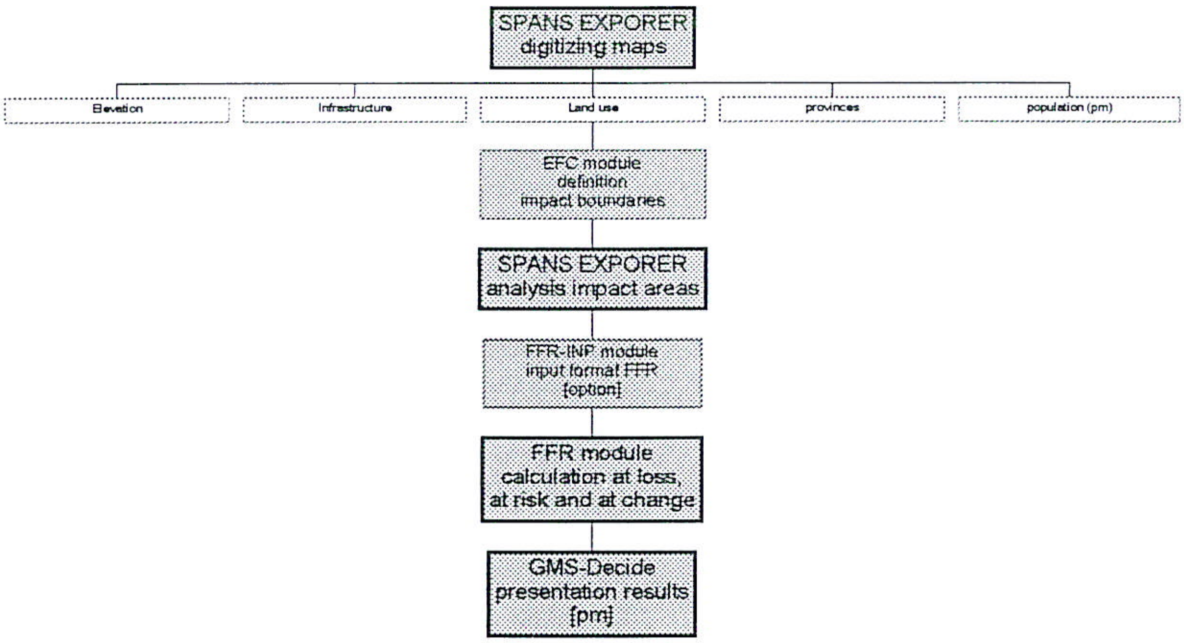
For the final analysis of areas at loss, change (pm; to be discussed) and risk (read people, land use, capital values) a Flooding and Flood Risk model (FFR.XLS) was built under Microsoft-EXCEL. For each Study Area (read coastal province) a "empty" workbook is created subdivided into 8 sheets of which each spreadsheet refers to a unique case (see tables on next pages).

The analysis with the first version of the FFR-model will result in data on:

- AAL Area at loss (km^2)
- VAL Values at loss (10^6 US$)
- PM People to be moved (10^3)
- AAR Area at risk (km^2/yr)
- VAR Value at risk (10^6 US$/yr)
- PAR People at risk (10^3 people/yr)

X.11 Summary of FFR-steps in data flow chart

Flow chart risk analysis procedure



APPENDIX C :

Vietnam VA Study
Working Document : GMS-DECIDE

VULNERABILITY ASSESSMENT STUDY IN VIETNAM

GMS-DECIDE

as part of the

Coastal Information System

Lay-out and procedures

Frank Hoozemans

Contents

1. Objectives and goals

Data management, whatever type or kind of data, consists basically of acquisition, preprocessing, storage, import/export (retrieval from other sources and transfer to external means of data storage), processing and analysis. All these activities require appropriate organizational and logistic arrangements within a certain system, possibly topic- or project-oriented.

Appropriate systems, such as the proposed Coastal Information System (CIS) must be used for data management and clear-cut database support. Once arranged, a GIS system can be employed for a good many destinations serving the purposes of both VA and future projects.

Given below in this report is a description of data management for particular needs resulting from the VA project. The system tailored for VA has been suggested as a compromise based on project goals to be achieved, the availability and cost of software and hardware, Vietnamese potentials (manpower, experience etc) and other factors, supported by the best knowledge of the trilateral project team. Chapters 2,3, and 4 focus on the general CIS. Chapters 5 to 8 describe the role of the package GMS-DECIDE as part of the CIS and the required procedures.

2 General considerations

A Coastal Information System can be described as a system which enables the systematic storage, compilation, interpretation and presentation and visualization of data of a specific set of coastal issues. Although simple data or maps for one site (read province) can assist the team members of the VA VIETNAM, such an ad hoc effort is not regarded appropriate for the creation of an effective CIS. Rather, several requirements must be met to qualify a CIS:

- information collected should be issue-oriented, designed to lay the foundation for the activities of the Vietnamese organizations to executed the VA VIETNAM;
- information should be collected consistently for the same parameters, and preferably but not necessary at the same scale (national or regional);
- information should be stored in a logical data base structure, and
- information should be easily retrievable for analysis, interpretation and presentation.

For the VA specifically and integrated coastal management in Vietnam in general, the data base should refer to a set of information systematically organized around consistent geographical units (read provinces along the coast of Vietnam) in order to support the information stream as information for and aims and queries from the user. Since a CIS records the condition of the coastal zone at a given moment in time (such as coastline dynamics, risks, land use, etc), it provide a valuable bench mark to be used as the basis for comparisons in future. In this way, rates and patterns of changes can be monitored and the effectiveness of a measure (read change in any system) can be evaluated.

3. General structure

As described in the beginning of this report, the proposed CIS will focus on the structure of the information stream of the already gathered data and data that will come available during the execution of the VA Vietnam. In the CIS, the analysis of data will be executed by running SPANS-EXPLORER Relevant results of these analysis (read output of models; e.g. extent of Flooding Zones related to flooding levels) will be stored and visualized in the CIS using GMS-DECIDE.

So, the proposed CIS will be divided into three main units:

1 Coastal Data Management System by GMS-DECIDE;
2 Coastal Analysis System by SPANS-EXPLORER, and
3 Results of models and inventories

4. Basic components and functions

4.1 Introduction

Recently updated, commercially available CIS-software which is particularly suited for the given requirements are the commercial available programs GMS-DECIDE in combination with SPANS-EXPLORER. In IBW-PAN and DELFT HYDRAULICS as well as with other users in Vietnam, SPANS-EXPLORER and /or GMS-DECIDE has been successfully applied.

In this VA project specifically GMS-DECIDE is considered to be an optimal solution to fulfil the general framework of the CIS. This package will be the shell of the CIS. The package has many built-in facilities of a general kind, which can be fed with the current project data specifically and the future data in general.

The packages themselves contain no data. Data of various kinds, including all the needed maps in digitized form (either produced by e.g. SPANS-EXPLORER or by scanning available maps), figures, drawings, photographs, and other entries have to be prepared separately. To devise this in a well-structured way which will retain its value for the foreseeable future within the project and afterwards, a detailed analysis is required of the way the information must be pre-processed, digitized, shown on the screen, related to each other both in space and in time, and produced in the form of hard copies and reports. This analysis and design of the overall CIS under SPANS-EXPLORER and GMS-DECIDE will be supported by Polish and Dutch specialists who have extensive experience in this field.

It is useful to give some explanation in this chapter of the way CIS is handling the available data. In general, the CIS involves a chain of activities from the observation and collection of data through to its analysis and use in the VA project. The proposed CIS may therefore be considered to have six main activities:

- data acquisition and input,
- data storage,
- data retrieval,
- data manipulation and analysis,
- data output, and
- system management.

Data acquisition and input involves the acquisition of data in both digital and analogue form, map data for processing, digitizing and editing and the transformation of theses data into standardized format.

Data storage involves data formats, hardware configurations, storage media and storage structure and is closely related to the input and to the data retrieval sub-systems.

Data retrieval is a critical component since it directly affects the user's ability to get at the information behind the data and to structure the information to give insight in a specific request. Different forms of data are retrievable in different ways. Map data are structured around the cartographic objects (points, lines or areas). Non-map data may consist of values for attributes (variables) ordered by entity (observation or record). The proposed CIS will be used to manage both types of data.

Data manipulation and analysis operations are embedded into the CIS by use of SPANS-EXPLORER specifically and GMS-DECIDE in general. Spatial analysis may for example consist of analysis of Flooding Zones.

Output of information involves maps, histograms, databases, graphics, etc.

System management (read database management) should address the requirements for evaluation, and the organizational aspects of the use and effectiveness of the information transferred through the system. This includes the preservation of accuracy and reliability of data in order to avoid the production of misleading results.

4.2 Geo Management System-DECIDE

GMS DECIDE is chosen as the first important step in the implementation of a CIS of Vietnam, as a systematic compilation, interpretation, and display of general and site specific information linked to a selected set of coastal issues. The proposed GMS will focus on the management of the information stream of the already gathered data and data that will come available during the execution of the VA Vietnam.

GMS-DECIDE is a full-featured PC-WINDOWS application designed for decision-makers such as project managers, engineers and planners who need to access, store, manage and use various data and information resources, especially those that are geographically related. Conceived as a *Multi-Media* system, the package is very open and handles all kinds of file formats and data structures such as statistical data sets, images, reports, scanned maps, monitoring data, documents, GIS files etc, and brings them into the users' processing and decision-supporting software.

Using the geo management system, it is possible to create and maintain several *Catalogues of data and electronic documents* and make them easily accessible through multiple searching criteria (e.g. locations, topics, dates,). The purpose is to provide on the screen simultaneous access to the various data and documents related to a given area and/or subject, as well as to further process and combine them for decision-supporting and reporting. A general sketch of the data stream of the geo management system is presented in Figure 1

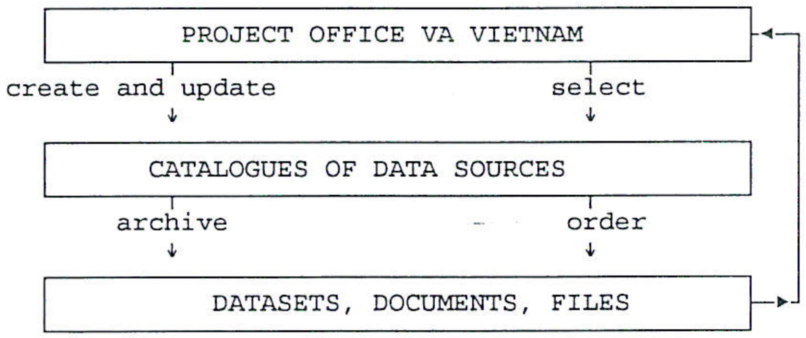


Figure 1 General data stream of geo management system

In general GMS-DECIDE allows the user to:

- describe, document, and georeference databases, maps, images, reports, statistics, projects, lists of professional contacts into an unlimited number of catalogues of data, in several software formats under MS *Windows* (Word Perfect, MS-Excel, WinGif, etc.);
- search for and select information sources, datasets, catalogues, using a number of different user-defined search criteria, and then retrieve the documents themselves;
- view, edit and manipulate the extracted data or files in the appropriate application for word processing, spreadsheet and image processing (SPANS-EXPLORER).

The program is composed of two main parts:

i) a *database management system*, and
ii) a user-friendly *geographical interface* for data selection and retrieval.

The key concept of GMS-DECIDE is that an information base may be separated into three parts:

i) *markers*: points, lines and/or polygons can be drawn in front of scanned maps in an atlas, giving a spatial dimension to the database.

ii) *meta information*: the descriptive and referential content, stored in the multi-index catalogues.

iii) *factual content*: electronic documents in various standard formats (ASCII, MS Word, WordPerfect, MS Excel, Lotus, TIFF, PCX, BMP, etc).

Using GMS-DECIDE, one can:

- Create and up-date meta-information catalogues on various kinds of data sources: descriptions of databases, maps, reports, spreadsheet tables, projects, satellite images, contacts, etc. The contents of the meta-databases (the catalogues) may be easily adapted to each specific use. A basic structure is provided, but the name and contents of the fields is up to the catalogue author. More fields may be added if necessary. A simple catalogue may contain, for example, four character fields (acronym, short description, etc), two numeric fields, one field for key words of a thesaurus, and one field for free key words.

- Merge different kinds of data in the same catalogue. There are no restrictions upon what kinds of data can be referenced in each catalogue - for example, a catalogue on "Coastal dynamics" may contain satellite quick looks, statistics in Excel tables, and reports in Word - all accessible through the same search and retrieve mechanism.

- Georeference data sources, select and display them in front of base maps. Geographical data is referenced to a point, a line or an area and each data source can be easily linked to such a graphic object, which can then be displayed in front of any map in the Atlas (read maps of provinces).

- Display the results of searches from several catalogues simultaneously over the same base map, allowing the comparison of data from different themes and data sources integration.

- Link a thesaurus to each catalogue. A user-defined multilingual and multi-theme thesaurus of key words allows users who are unfamiliar with the contents of the database to search for data entries. It is a classification of key words contained in the catalogue, defined by the author.

- Classify the data sources according to dates or periods. The program uses character, numeric, date and descriptive fields to classify data.

4.3 Coastal Analysis System by SPANS-EXPLORER

The Coastal Analysis System "SPANS-EXPLORER" will be used for the detailed geographical analysis of data on land use and elevation Data must be pre-processed, digitized and geographically related to each other both in space and in time. The results of the analysis will be linked to the GMS. More about this package in the reports of Mr van Veldhuizen.

4.4 Stand alone models

Analysis of site specific hydrological data and the flood risk analysis, an important activity of the VA Vietnam, will be executed by running models such as EFC (option) and FFR. Relevant results of these analyses will be analyzed with SPANS EXPLORER and/or stored and visualized in the GMS.

4.5 Summary CIS

In summary, figure 2 presents the main streams of information in the proposed CIS.

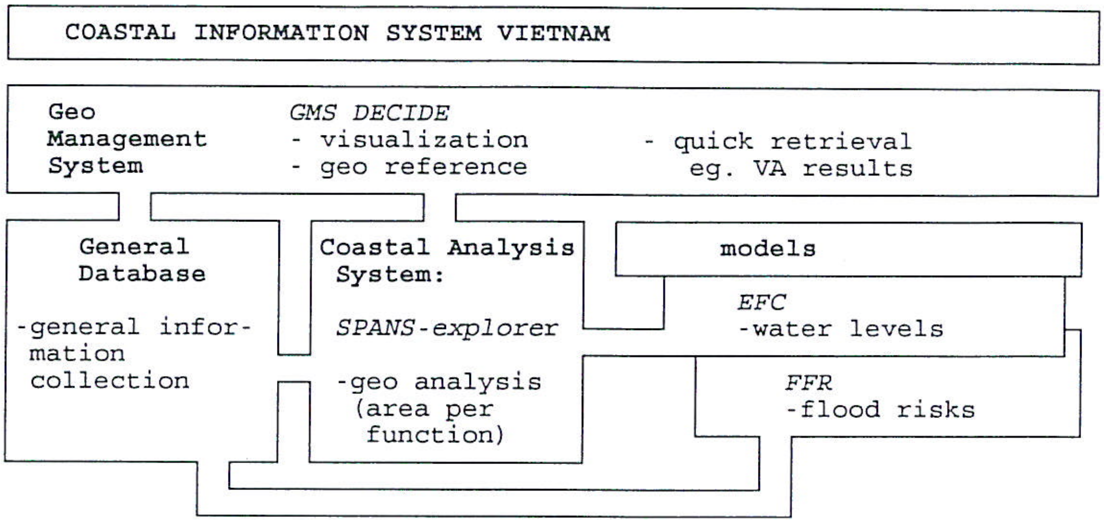


Figure 2 Main stream of information of the CIS

The remaining part of this report will strictly focus on the role of GMS-DECIDE as part of the CIS and the necessary basic procedures to built a CIS.

5. Overview of types of information as input for the GMS-DECIDE

The GMS-DECIDE proposed for this project will include 6 types of information, as there are:

1 thematic maps
2 reports
3 numerical data
4 drawings
5 photos
6 graphics

To make these types of information suitable as input for the GMS-DECIDE, several operations on the basic data will be carried out, such as the developing of specific databases and spreadsheets, the scanning of maps and photographs and the drawing of data on maps. One type of data can be presented in several formats: a selection of specific features of beach dynamics data stored in spreadsheets can also be presented in graphics, maps and reports.

If necessary, more types of information might be taken into consideration at any stage of this project. The following overview of types of information is meant to give an impression of the information stream.

Ad 1 Type of thematic maps:
- a elevation (output of SPANS-EXPLORER)
- b land use (output of SPANS-EXPLORER),
- c topographical maps (scanned georeferenced maps)

Ad 2 Type of reports:
- a general information Vietnam,
- b data reports, manuals, journals on marine-hydrometeorological data, morphological, ecological, etc subjects related to the coast,

Ad 3 Type of numerical data:
- a wave climate data

Ad 4 Type of drawings/maps:
- a design-drawings of coastal structures,
- b detailed coastline ,
- c wave roses,
- d coastal dynamics (erosion/sedimentation),
- e location of coastal infrastructure (dikes and harbours) on map of detailed coastline,
- f location of types of problems on map of detailed coastline, and

The functional design of the GMS-DECIDE to be implemented in the VA Vietnam, is divided into several steps, as there are:

Atlas
As general guide of the GMS-DECIDE, the geographical maps of the coastal provinces of Vietnam on a scale of 1:1,000,000 will act as point of departure. As for the subdivision in 18 Coastal provinces, 18 geographical maps shall be used (including the two main delta's). Each map will be scanned and stored in a unique file.

Catalogue
As described above, catalogues are organized thematically and will contain references to data on the related topics.

For the VA VIETNAM 4 catalogues are proposed:

- Catalogue 1: Overview of relevant input data
- Catalogue 2: VA analysis
- Catalogue 3: Pilot studies
- Catalogue 4: General information Vietnam

Each catalogue is built up by one or more cards (similar to a card of a database). Each card may have one or more documents attached to it.

Markers

As described in Section 5, the parameters of interest which are stored selectively in the GMS-DECIDE may be symbolized with point, line or area markers on any thematical map. These markers can be activated (by using the mouse) to give an overview of information relevant for this marker. In the GMS-DECIDE, a marker might be expressed on three different scales:

- a **province** marker (following the boundaries of a province) for each of the 18 Coastal provinces referring to VA analysis output,
- a **general** marker to activate a menu of general information per province, and
- **geographical** markers for types of coastal structures, gauging stations, the location of erosion, etc.

An important aspect and advantage of the proposed GMS-DECIDE is that information relating to the markers may remain, if useful, in existing standard program formats such as Word Perfect, MS-Excel and MS-Word.

Depending on the active catalogue (1, 2, 3 or 4), a unique sets of markers will be created. Each card will be geo-referenced to a location on the map.

— Catalogue 1: Overview of relevant input data

Separate markers are chosen for:

General province data:
- Social data,
- Economical data,
- Marine hydrometeorological data,
- Ecological data,
- Remote sensing, and
- Photo's

Geographical province data:
- Gauging stations
- Location official coastal and river defence systems
- Areas of flooding (based on reports)
- Coastline dynamics
- pm (pm means: has to be explicitized in the coming weeks: action of Mr Thuyen and Mr van der Knaap)

— Catalogue 2: VA analysis

Only one separate marker is chosen:
- Provinces

— Catalogue 3: Pilot studies

Separate markers are chosen for:
- pm (should be defined in consultation with Mr van der Knaap)

— Catalogue 4: General information Vietnam

Separate markers are chosen for:
- Social data,
- Economical data,
- Marine hydrometeorological data,
- Ecological data,
- Remote sensing, and
- Photo's

Proposed documents under catalogue 3 *Pilot Studies*

For each of the 3 Pilot Studies:
- *Social data*
  - [psx]_pop95.xls file (eg ps1_po95.xls, indicating Pilot Study x, population density 1995, EXCEL-file)
- *Economical data*
  - [psx]_xxx.xls file (EXCEL file but yet to be defined)
- *Marine-hydrometeorological data*
  - [psx]_efc-0.pcx : efc-curve on sea
  - [psx]_rivst.pcx/xls/doc : data of river stations and watersheds
  - [psx]_anflo.pcx/xls/doc : data of peak river discharges, etc
  - [psx]_tide.pcx/xls/doc : data map of tidal characteristics
- *Ecological data*
  - [psx]_xxx.pcx/xls/doc: data of mangroves
  - [psx]_xxx.pcx/xls/doc data of water quality
- *Remote sensing data*
  - [psx]_xxx.pcx: scanned map of RS-images (option)
- *Photo's*
  - [psx]_xxx.pcx: selection of relevant photo's

Proposed documents under catalogue 4 *General Information Vietnam*:

- see catalogue 1.
- pm