

08/05/2019

Barbara Zanuttigh

Tecnologie innovative per coste europee più sicure in un clima che cambia

METTIAMOCI IN RIGA





Title: Innovative technologies for safer European coasts in a changing climate (THESEUS)

Instrument: Large Integrated Project - FP7

Total Cost: 8.519.726 €, EC Contribution: 6.530.000 €

Duration: 48 months, Start Date: 01/12/2009

Consortium: 31 partners from 18 countries

Project Coordinator: Barbara Zanuttigh, Università di Bologna (Italy)



Outline

- Planning interventions
- Decision-making: concise information and support tools
- THESEUS contribution to risk management: the GIS based Decision Support System
- Steps and challenges for R&I



management

health
Coastal
area
climate
tourism
extreme risk
fishery
energy
events
water
change
transportation

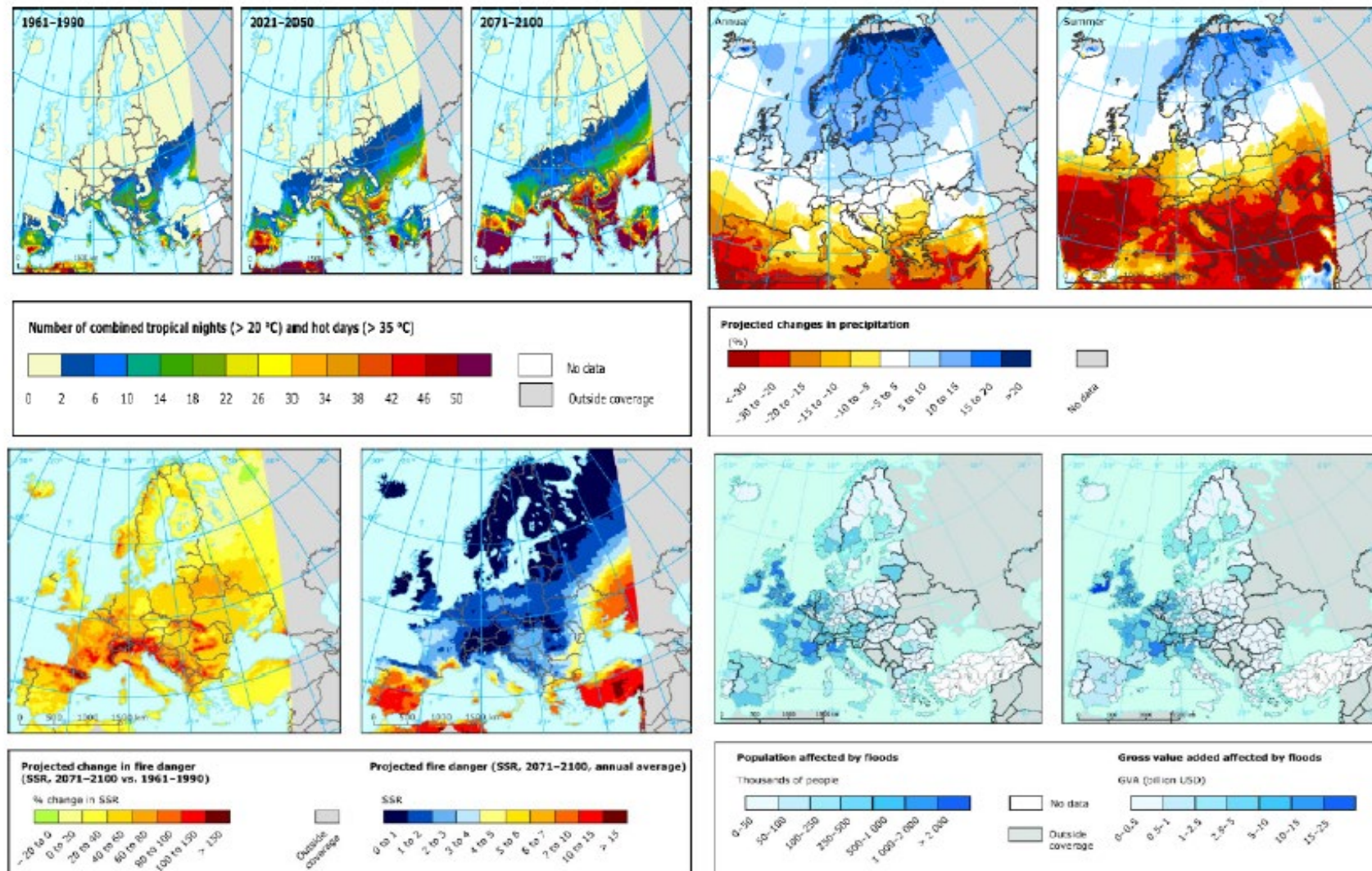


Where? *Prioritisation of intervention on an impact basis*

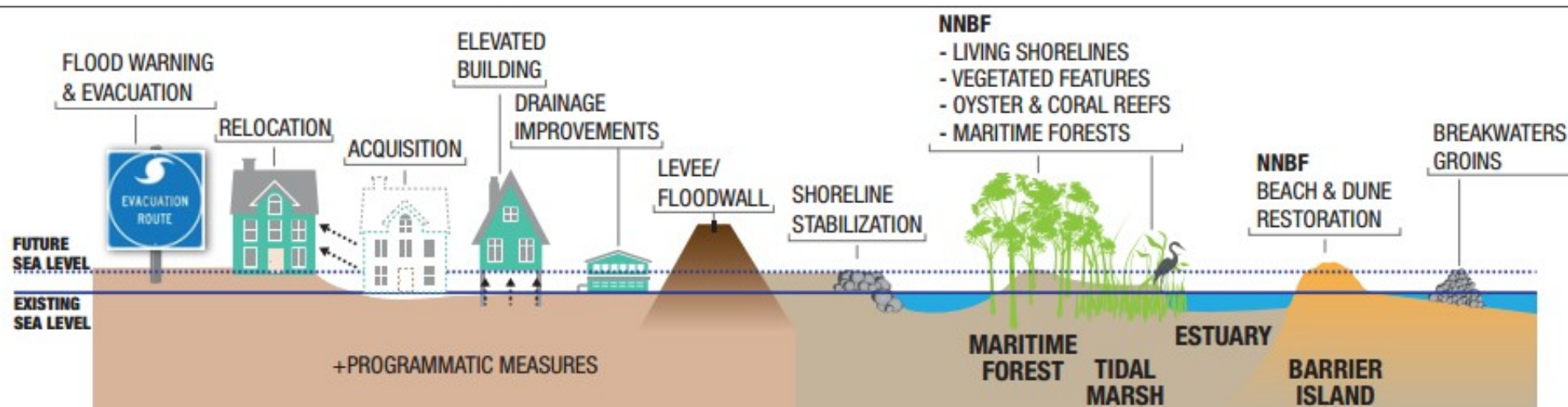
How? *Best portfolio of adaptation solutions considering sustainable development*



Uncertainty: quantitative scenarios?



Flood risk reduction strategies



- Multiple lines of defences
- More combinations of (types of) interventions
- More complex risk models required for screening and evaluation



Innovative technologies



**METTIAMOCI
IN RIGA**



THESEUS Decision Support System

Theseus DSS - Start Window

File Help

Active Site Map

Protecting our coasts

Vistula delta plain
Elbe estuary
Scheldt estuary
Plymouth sound to Eke estuary
Gironde estuary
Santander spit
Po delta and adjoining coast
Varna spit



CLIMATE, SOCIAL, ECONOMIC AND ENVIRONMENTAL DATA & SCENARIOS



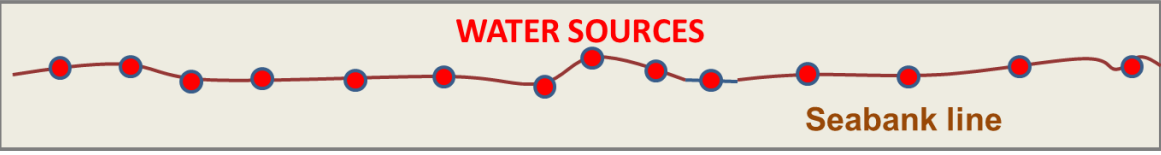
MITIGATIONS @SEA (ENGINEERING, ECOLOGICALLY BASED)

WAVE TRANSFER



EROSION MODEL

MITIGATIONS @BEACH (ENGINEERING, ECOLOGICALLY BASED)



FLOODING MODEL (WATERHSED SEGMENTATION ALGORITHM)

**FLOODING MAPS (DEPTH, VELOCITY, DURATION)
HYDRAULIC VULNERABILITY MAP (EROSION, FLOOD)**

**MITIGATIONS @LAND
(ENGINEERING, ECOLOGICALLY BASED, SOCIAL, ECONOMIC)**

**ECONOMIC IMPACT
FUNCTION**

**SOCIAL IMPACT
FUNCTION**

**ECOLOGICAL IMPACT
FUNCTION**

**ECONOMIC
VULNERABILITY MAP**

**SOCIAL
VULNERABILITY MAP**

**ECOLOGICAL
VULNERABILITY MAP**

INTEGRATED RISK ASSESSMENT MAP





The steps

- First step: identify and collect (harmonised!) data
- Second step: define scenarios and reconstruct them in a simple way
- Third step: identify and represent adaptation solutions
- Fourth step: identify criteria for building integrated vulnerability maps from impact maps (different units!)
- Fifth step: identify criteria for integrated risk assessment maps from vulnerability maps (same 'weights')?
- Iteratively through the development: discuss with end users!



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Data: dtm model

Theseus DSS - Site Viewer

File Layers Help

Theseus DSS - Protecting the Coasts of Cesenatico

Home New Analysis Compare Analysis

Map Viewer

Map Coordinates
X: 773.333,07
Y: 896.784,59

Table of Contents

- Map Layers
 - habitat
 - CriticalFacilities
 - Population
 - LAND_USE
 - Shore500
 - Sea_Bank500
 - dtm4ws_ces_full_2m
 - 0,0 - 265,5
 - 265,5 - 531,0
 - 531,0 - 796,5
 - 796,5 - 1062,0
 - CesenaticoTheseus600dpi_imagery.jpg

0 1000 2000 3000 m

1 : 53.014,18

Innovative technologies for safer European coasts in a changing climate (THESEUS)
FP7 ENV2009-1 Large Integrated project - Contract n. 244104 - December 2009 / November 2013

EUROPEAN UNION

CIAMOCI
SA

Data: population

Theseus DSS - Site Viewer

File Layers Help

Theseus DSS - Protecting the Coasts of Cesenatico

Map Viewer

Map Coordinates
X: 771.212,24
Y: 896.436,73

Identify

dtm4ws_ces_full_2m = 187,699996948
Sea_Bank500
Shore500
LAND_USE
Population
38
CriticalFacilities
habitat

Field Name	Value
MAIN_DEST	Zone di com...
POP_ID	94
TOT_POP	228
YOUNG_POP	13
OLD_POP	99
Area	2.64601328...
PopSqm	8.61673679...
PopSqmX2	1.72334735...
*	

imagery.jpg

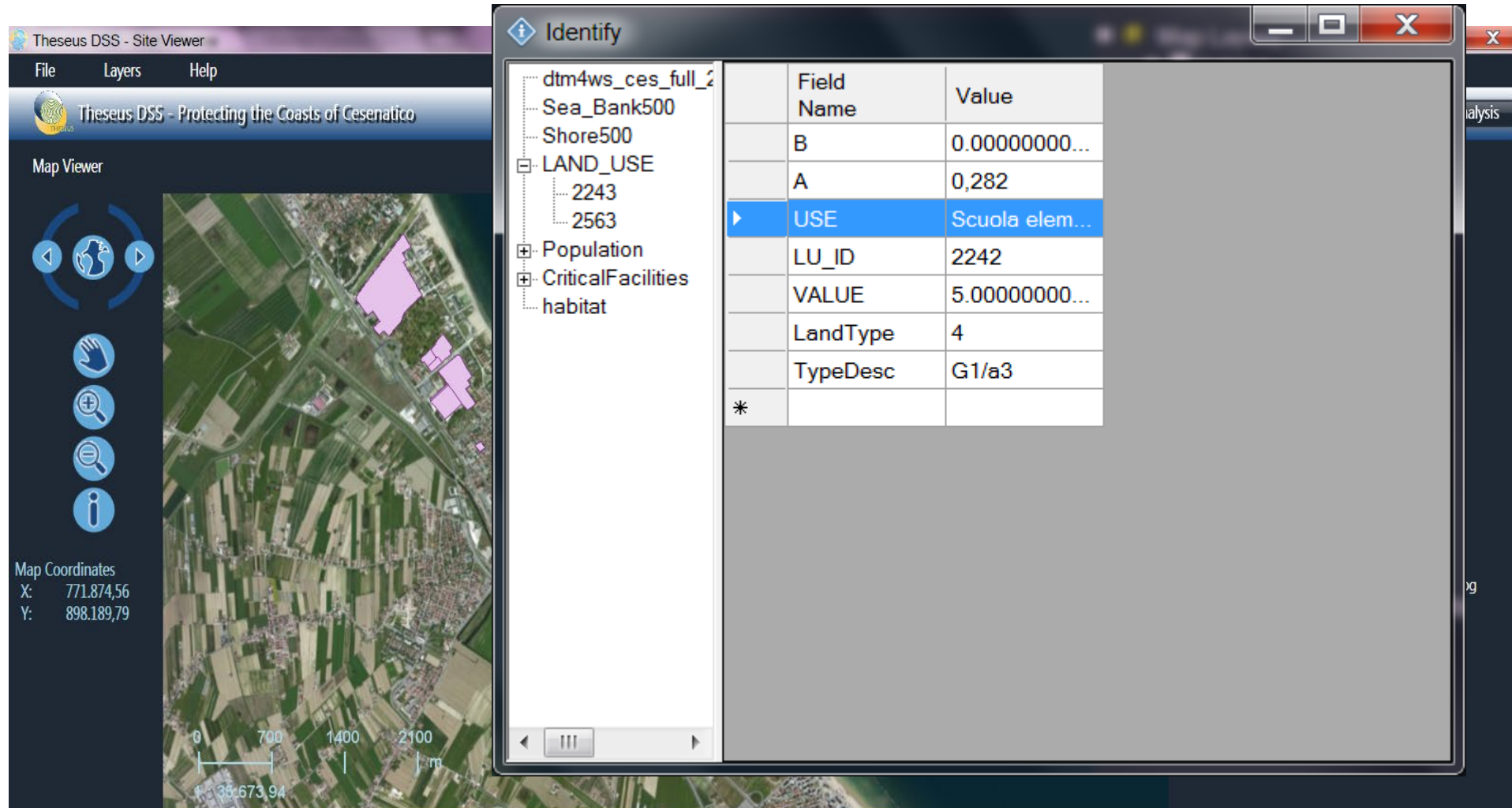
Data: land use

The screenshot displays the 'Theseus DSS - Site Viewer' application. The main window shows a map of a coastal area with various land use patterns. A pink polygon is highlighted on the map. An 'Identify' window is open, showing a tree view of layers on the left and a table of attributes on the right. The 'LAND_USE' layer is expanded, and the '2059' feature is selected. The table shows the following attributes:

Field Name	Value
B	0.00000000...
A	0,4
USE	Residenzial...
LU_ID	2056
VALUE	1.30000000...
LandType	1
TypeDesc	B1
*	

The map viewer includes navigation controls (back, forward, home, pan, zoom in, zoom out, info) and map coordinates: X: 773.759,48 and Y: 898.580,01. A scale bar at the bottom indicates 0, 1000, 2000, and 3000 meters.

Data: critical facilities



The screenshot shows a GIS application window titled "Theseus DSS - Site Viewer". The interface includes a menu bar (File, Layers, Help), a title bar ("Theseus DSS - Protecting the Coasts of Cesenatico"), and a "Map Viewer" section. The map displays an aerial view of a coastal area with a pink highlighted polygon. The "Identify" window is open, showing a tree view of layers and a table of attributes for the selected feature.

Map Coordinates
X: 771.874,56
Y: 898.189,79

Field Name	Value
B	0.00000000...
A	0,282
USE	Scuola elem...
LU_ID	2242
VALUE	5.00000000...
LandType	4
TypeDesc	G1/a3
*	

Data: habitats

The screenshot displays the 'Theseus DSS - Site Viewer' application. The main window shows a map of a coastal area with various layers. An 'Identify' window is open, displaying a list of layers on the left and a table of field values on the right. The 'habitat' layer is expanded to show feature '64', which is selected. The table shows the following fields and values:

Field Name	Value
Habitat_ID	63
Descriptio	Benthos
H_CODE	1
Width	
Submerge	
FID0	63
height	
*	

The map viewer includes navigation controls (back, forward, home, pan, zoom in, zoom out, info) and map coordinates: X: 770.809,87 and Y: 898.001,01. A scale bar at the bottom indicates 0, 700, 1400, and 2100 meters.



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Definition

Scenario

Mitigations

Execute

Theseus DSS - Analysis Editor



Scenario

Meteorarine Climate Scenario ?

Preset Time Slice: 2010 - Present

User Defined Return Period: 2 Years

Name: Year:

Sea Gate open (Failure Scenario)

Hs (m): 1.5 6.5 2.204

Sop (%): 1 5 1.305

Zm (m): 0.8 2 1.143

Zr (m): 0 1 0.00

Nh (hours): 3 36 24.0

Environmental Scenario

S (cm/year): 0 2 1.000

Erosion Scenario

Include Erosion

1 - Line Model

User Defined Shore Line

Economic Scenario

Preset No Growth

User Defined

Name:

GDP Rate: -0.005 0.01 0.000

Social Scenario

Preset No Growth

User Defined

Name:

POP Rate: -0.005 0.01 0.000

Previous

Cancel

Next

Definition

Scenario

Mitigations

Execute




Theseus DSS - Analysis Editor





Engineering Mitigation 

- Wave Energy Farm (DEXA)   
- Wave Energy Farm (Wave Dragon)   
- Wave Energy Farm (Blow-Jet)   
- Floating Breakwaters   
- Sea Walls/Dike   
- Barriers   
- Emerged Nourishment   
- Submerged Nourishment   







Economic Mitigations

- Land Use Change   
- Insurance Scheme

Ecologically based Mitigations


- Dunes   
- Biogenic Reefs   

Spatial Planning

- Infrastructures Change   
- Water Storages   

Social Mitigations

- Evacuation Plan
 - Use Calculator
 - Estimated % of evacuated people

0  100
0.0

Previous

Cancel

Next



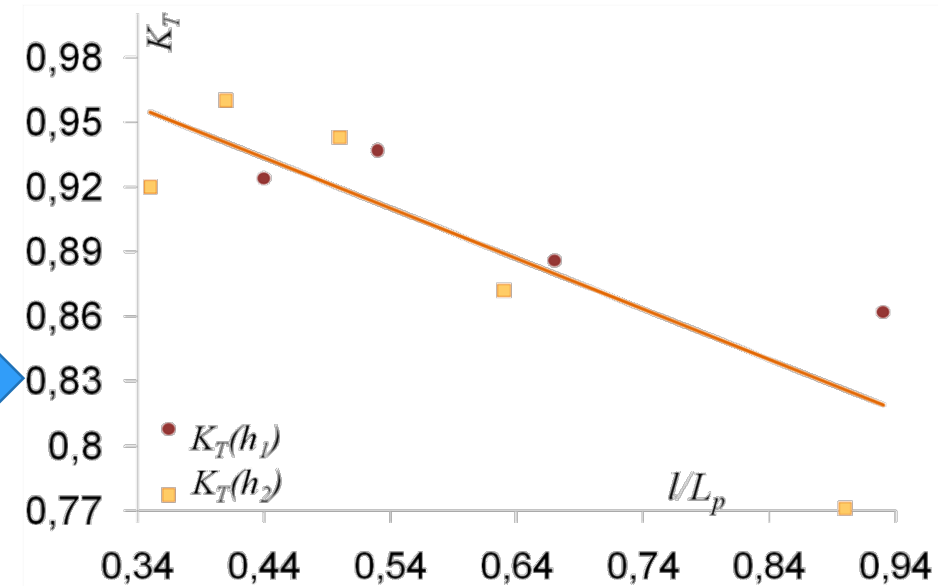
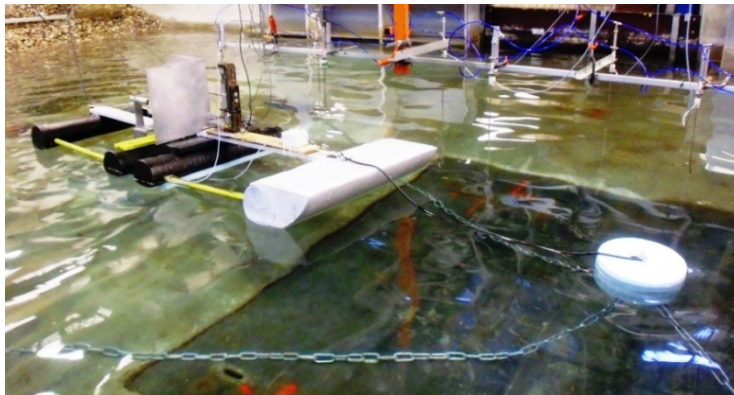
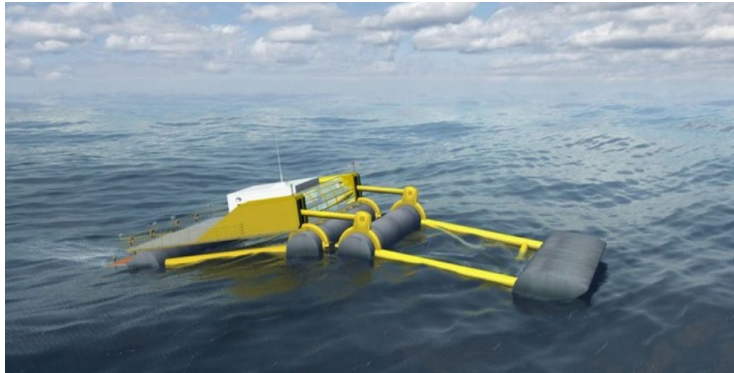


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Synthesise through analytical functions or Fuzzy bayesian models or metamodels



$$K_{T,D} = -0.276 \cdot (l/L_p)^2 + 0.4304 \cdot (l/L_p) + 0.6781$$















Engineering Mitigation

- Wave Energy Farm (DEXA)   
- Wave Energy Farm (Wave Dragon)   
- Floating Breakwaters   
- Sea Walls   
- Barriers   
- Emerged Nourishment   
- Submerged Nourishment   

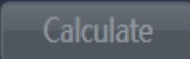
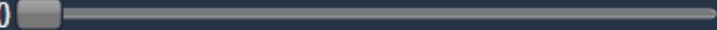
Economic Mitigations

- Land Use Change   
- Insurance Premium

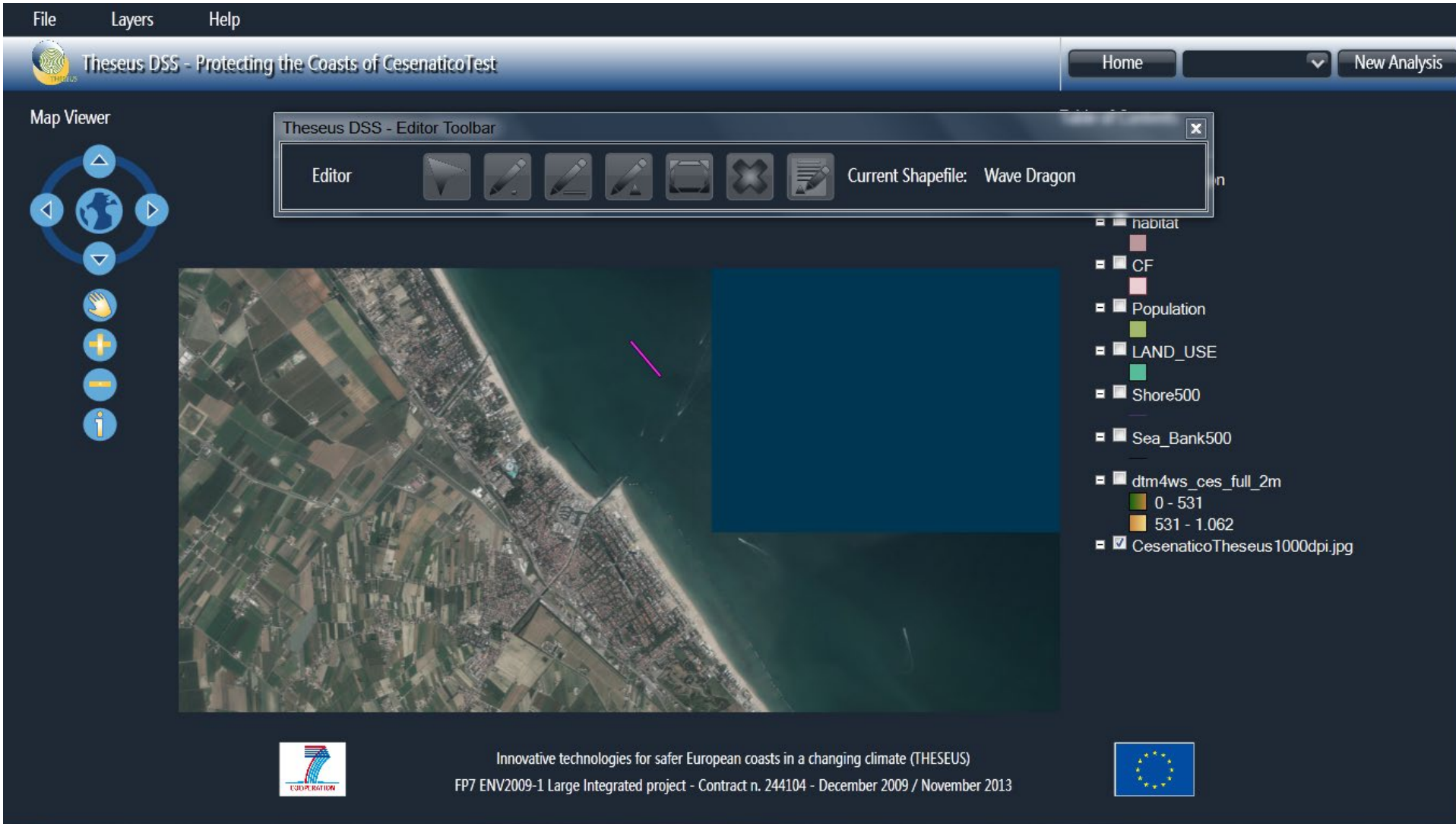
Environmental Mitigations

- Dunes   
- Biogenic Reef   
- Saltmarsh creation/management   
- Seagrasses   

Social Mitigations

- Evacuation Plan
 - Use Calculator 
 - Estimated % of evacuated people
- 0  100
0.0

Mitigations: editing



The screenshot displays the 'Theseus DSS - Protecting the Coasts of CesenaticoTest' application. The interface includes a menu bar (File, Layers, Help), a toolbar with navigation and editing tools, and a map viewer showing an aerial view of a coastal town. A 'Theseus DSS - Editor Toolbar' window is open, displaying various editing tools and the text 'Current Shapefile: Wave Dragon'. The map viewer shows a coastal area with a pink line indicating a mitigation feature. The legend on the right lists several layers, including 'habitat', 'CF', 'Population', 'LAND_USE', 'Shore500', 'Sea_Bank500', 'dtm4ws_ces_full_2m', and 'CesenaticoTheseus1000dpi.jpg'.

File Layers Help

Theseus DSS - Protecting the Coasts of CesenaticoTest

Home New Analysis

Map Viewer

Theseus DSS - Editor Toolbar

Editor Current Shapefile: Wave Dragon

- habitat
- CF
- Population
- LAND_USE
- Shore500
- Sea_Bank500
- dtm4ws_ces_full_2m
 - 0 - 531
 - 531 - 1.062
- CesenaticoTheseus1000dpi.jpg

Innovative technologies for safer European coasts in a changing climate (THESEUS)
FP7 ENV2009-1 Large Integrated project - Contract n. 244104 - December 2009 / November 2013

EUROPEAN UNION

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Mitigations: editing



The screenshot displays the 'Theseus DSS - Editor' window. At the top, there is a menu bar with 'File', 'Layers', and 'Help'. Below the menu bar is a title bar that reads 'Theseus DSS - Protecting the Coasts of CesenaticoTest'. On the right side of the title bar, there are buttons for 'Home' and 'New Analysis'. The main interface is divided into several sections:

- Map Viewer:** Located on the left, it contains a circular navigation pad with arrows and a globe icon, and a vertical toolbar with icons for pan, zoom in, zoom out, and information.
- Editor Toolbar:** A floating window titled 'Theseus DSS - Editor Toolbar' is positioned over the map. It includes an 'Editor' label, a yellow arrow icon, a pencil icon, a yellow pencil icon, a yellow square icon, a yellow 'X' icon, and a yellow notepad icon. To the right of these icons, it says 'Current Shapefile: Wave Dragon'.
- Map:** The central area shows an aerial satellite view of a coastal town. A red rectangle is drawn on the water area, and a blue rectangle is drawn on the land area.
- Legend:** On the right side, there is a legend panel with a list of layers and their corresponding colors:
 - habitat
 - CF
 - Population
 - LAND_USE
 - Shore500
 - Sea_Bank500
 - dtm4ws_ces_full_2m
 - 0 - 531
 - 531 - 1.062
 - CesenaticoTheseus1000dpi.jpg



Mitigations: editing

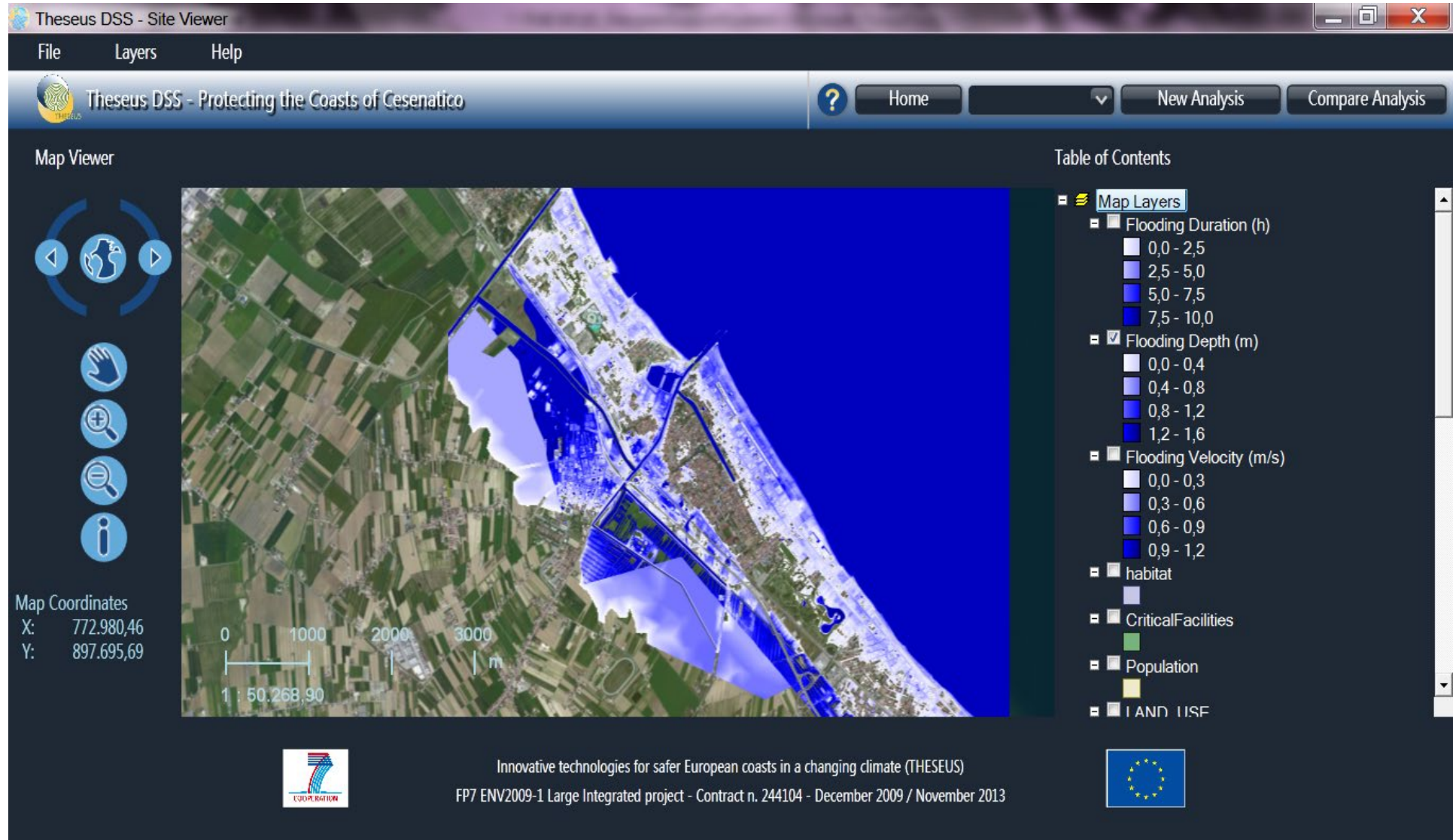


The screenshot displays the 'Theseus DSS - Editor' window. The main map area shows an aerial view of a coastal town with a pink arrow pointing to a specific feature. The 'Editor Toolbar' is visible above the map, containing various editing tools. An 'Attribute Table Editor' window is open on the right, showing a table with the following data:

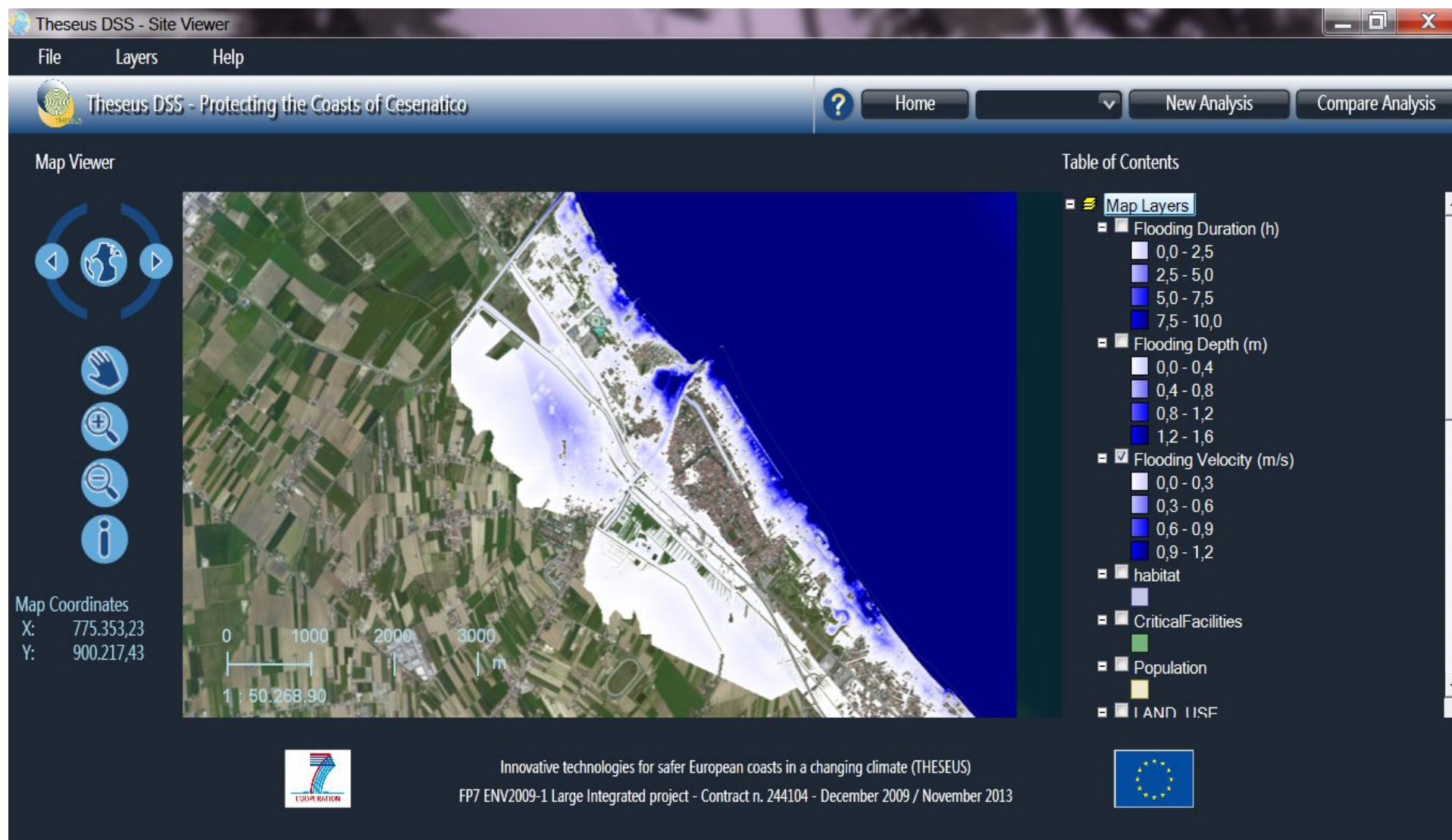
WDR_ID	LID	LcD	hD	FID0
1	2			0

Below the table, it indicates 'C:\TheseusProject\CesenaticoTest\Engineering 1 of 1 selected.' and a 'Close' button. The bottom of the interface features the THESEUS logo, the text 'Innovative technologies for safer European coasts in a changing climate (THESEUS)', the project details 'FP7 ENV2009-1 Large Integrated project - Contract n. 244104 - December 2009 / November 2013', and the European Union flag.

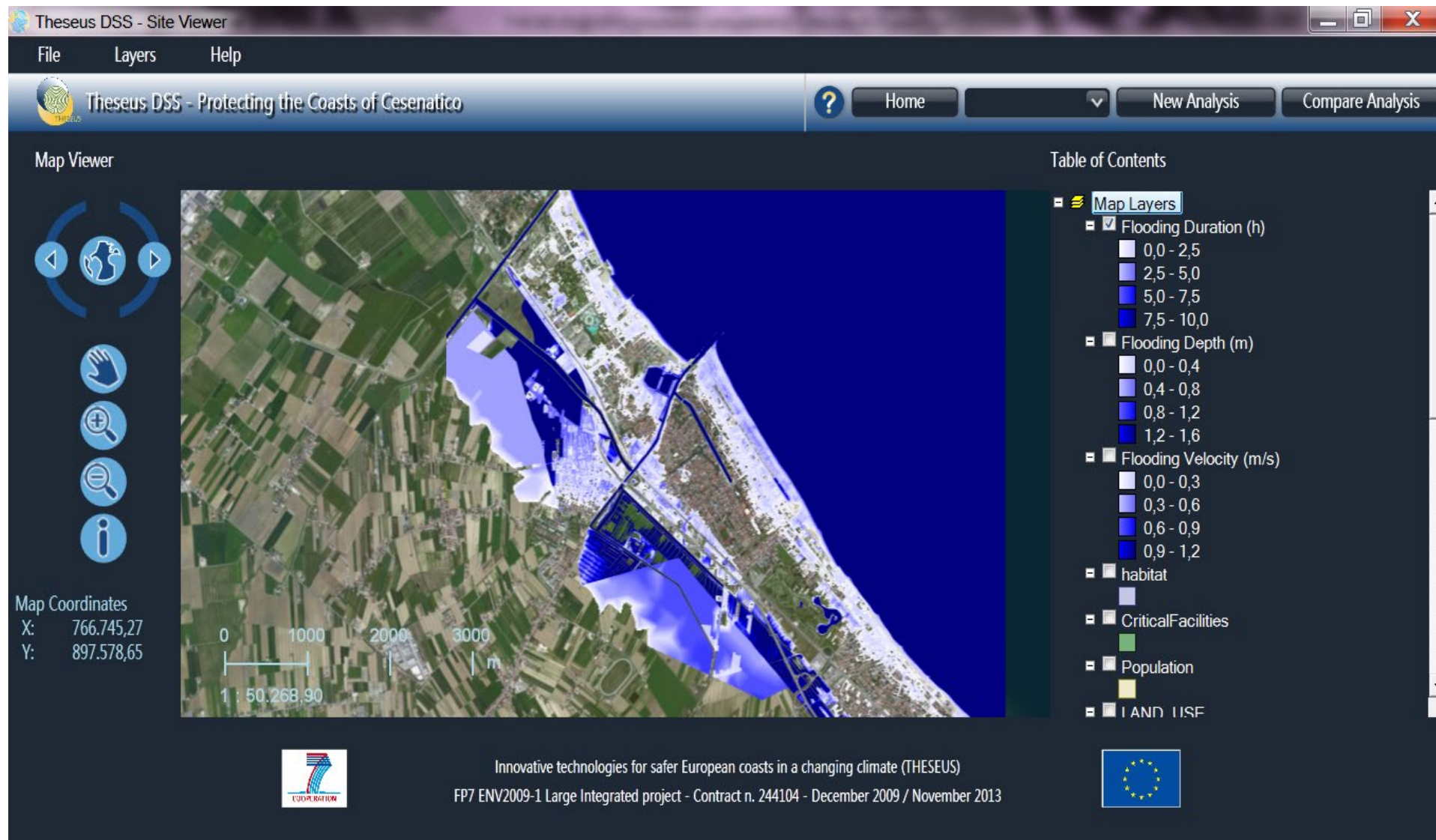
Flood Depth



Flood Velocity



Flood Duration



Critical Facilities Loss

The screenshot displays the 'Theseus DSS - Site Viewer' application. The title bar reads 'Theseus DSS - Site Viewer'. The menu bar includes 'File', 'Layers', and 'Help'. Below the menu is a navigation bar with a logo, the text 'Theseus DSS - Protecting the Coasts of Cesenatico', and buttons for '?', 'Home', 'New Analysis', and 'Compare Analysis'. The main interface is divided into three sections: 'Map Viewer' on the left, a central map, and a 'Table of Contents' on the right. The 'Map Viewer' section contains navigation icons (back, forward, home, pan, zoom in, zoom out, info) and 'Map Coordinates' (X: 776,407,73; Y: 897,682,54). The central map shows an aerial view of a coastal town with colored overlays representing different types of loss. A scale bar at the bottom of the map indicates 0, 900, 1800, and 2700 meters. The 'Table of Contents' lists several layers: 'Map Layers' (expanded), 'LifeLossNormal', 'LandValueLossNormal', 'EconLossNormal', 'CriticalFacilitiesLossNormal' (checked), and 'habitat'. Each layer has a legend with four color-coded categories (1, 2, 3, 4). The 'CriticalFacilitiesLossNormal' layer shows significant yellow and orange areas along the coast, indicating high levels of loss for critical facilities.

Theseus DSS - Site Viewer

File Layers Help

Theseus DSS - Protecting the Coasts of Cesenatico

Home New Analysis Compare Analysis

Map Viewer

Map Coordinates
X: 776,407,73
Y: 897,682,54

0 900 1800 2700 m

1 : 47,123,21

Table of Contents

- Map Layers
 - LifeLossNormal
 - 1
 - 2
 - 3
 - 4
 - LandValueLossNormal
 - 1
 - 2
 - 3
 - 4
 - EconLossNormal
 - 1
 - 2
 - 3
 - 4
 - CriticalFacilitiesLossNormal
 - 1
 - 2
 - 3
 - 4
 - habitat
 - 1

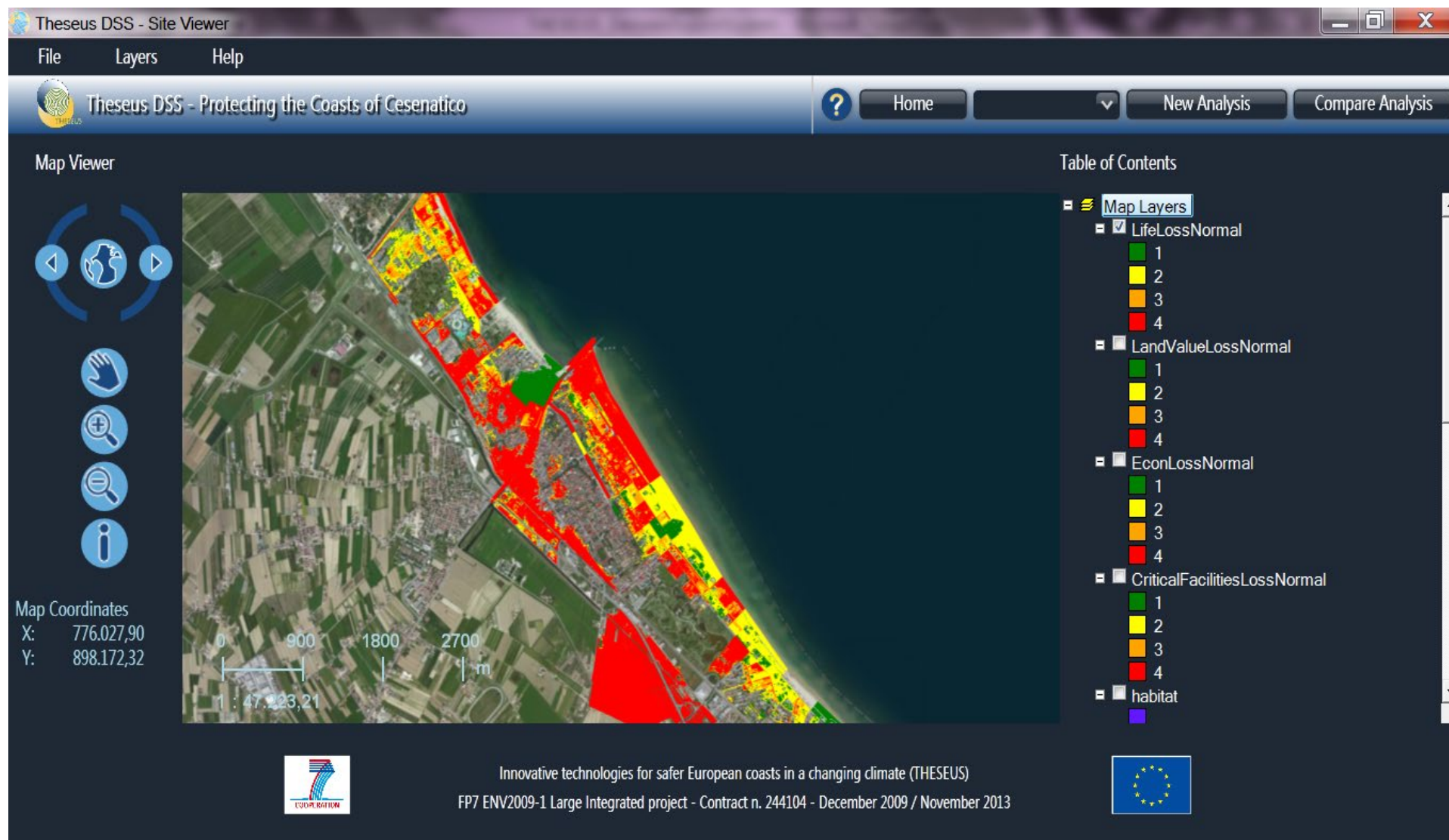
Innovative technologies for safer European coasts in a changing climate (THESEUS)
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COOPERATION

EUROPEAN UNION

SIAMOCI
SA

Life Loss

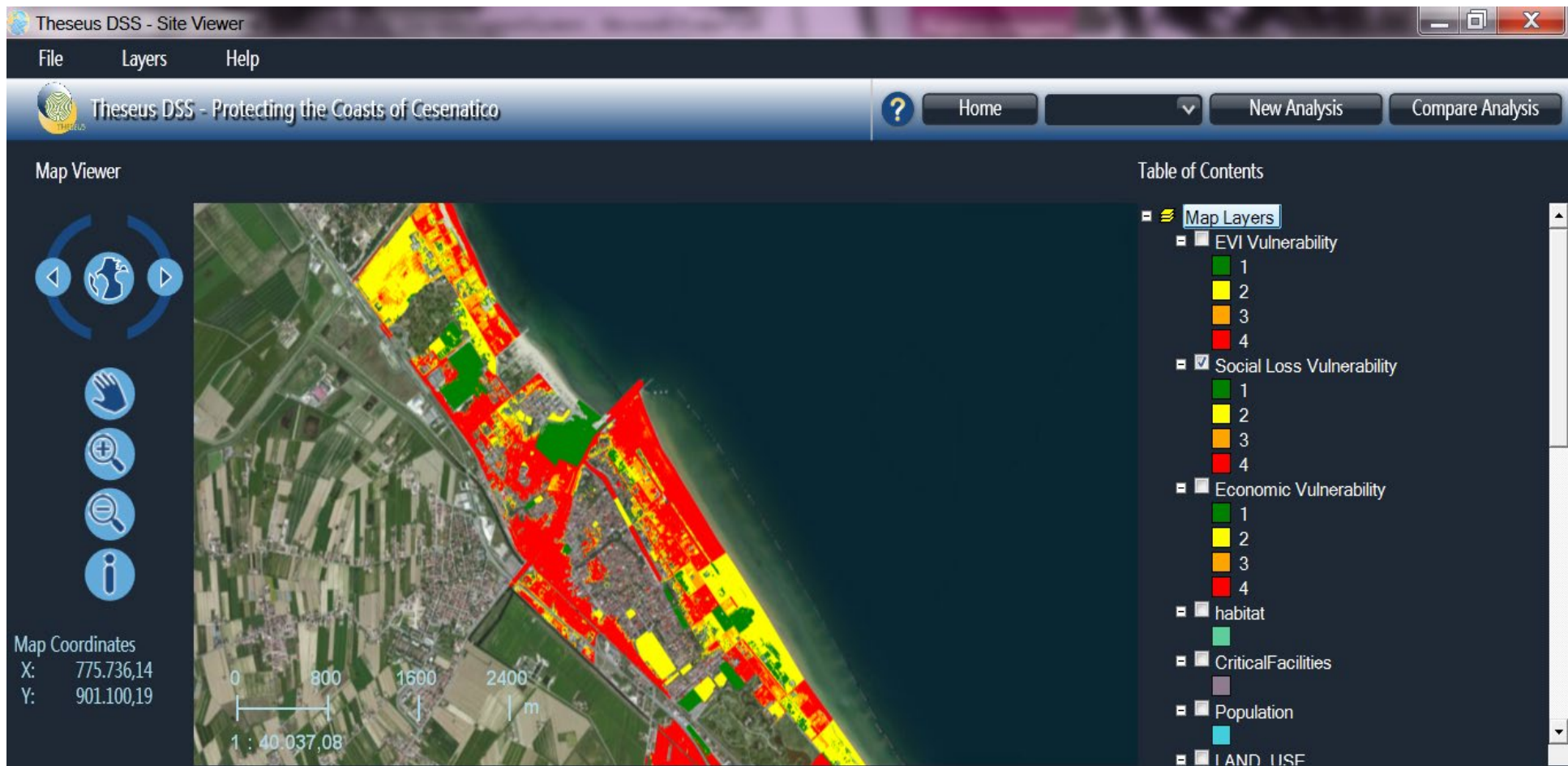




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Social vulnerability map





Environmental vulnerability

	Negligible	Transient effect (no long term change anticipated)	Moderate effect/Semi permanent change	Permanent effect/change
EVI Index	0	1	2	3
Habitat/ Key species	Negligible impact to habitats / species	Changes within the range of Receptor's natural seasonal variation and full recovery is likely within a season	Changes are beyond Receptor's natural seasonal variation. Partial recovery is possible within several seasons, but full recovery is likely to require human intervention, or greater than 20 years for natural recovery	Changes are so drastic that natural recovery of receptor is very unlikely without human intervention. Or natural recovery will take longer than 20 years



Environment vulnerability assessment

Sampling, Historical data

Temperature
Wind
Currents
Granulometry
Sediment transport
.....

FBEM learning algorithm



FBEM predictive algorithm

New sampling, Physical model, On line data

Δ Temperature
Δ wind
Δ currents
Δ granulometry
Δ sediment transport
.....

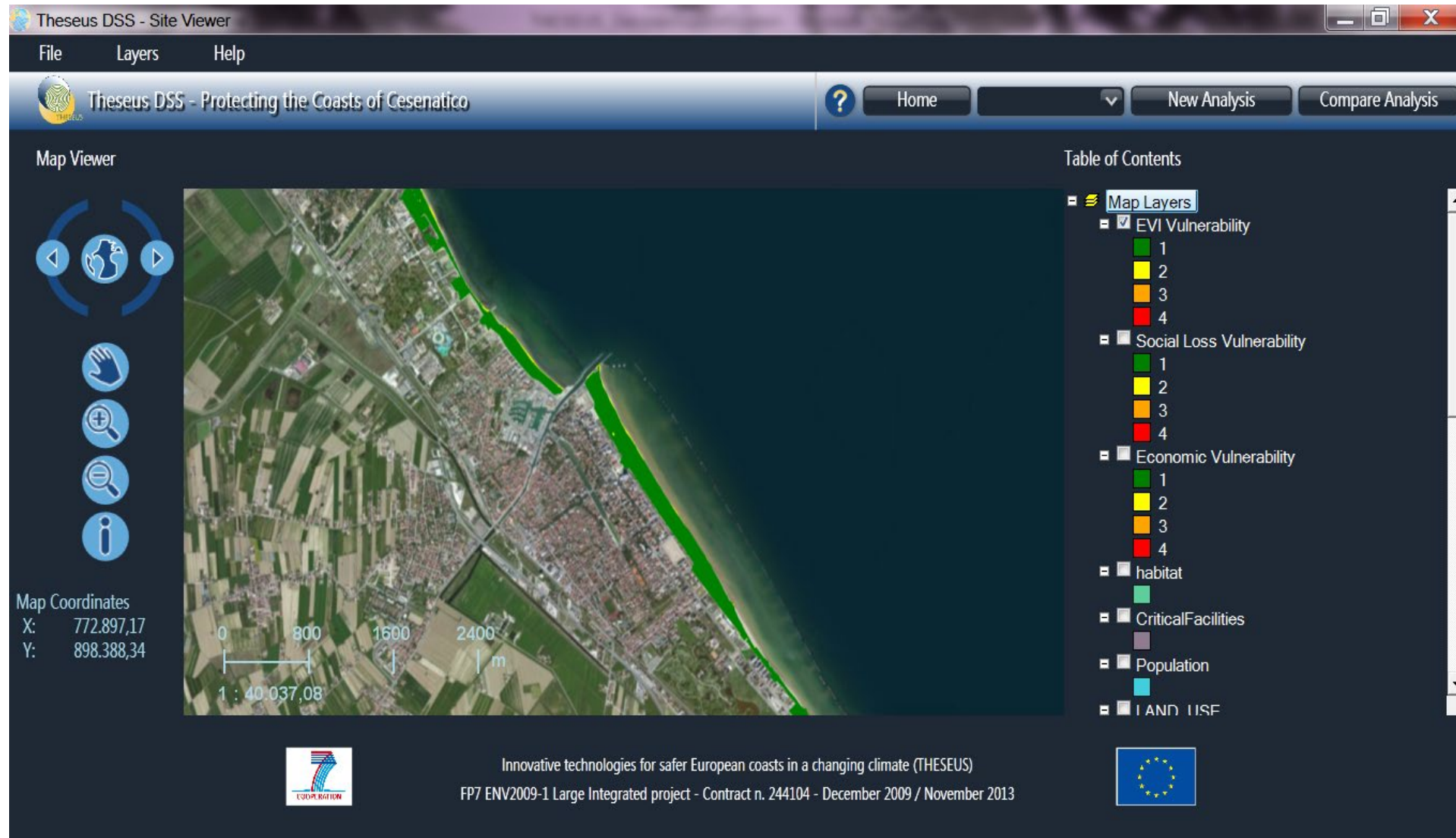


Biological variables



Δ biological variables
+ biological autocorrelation

Ecological Vulnerability map





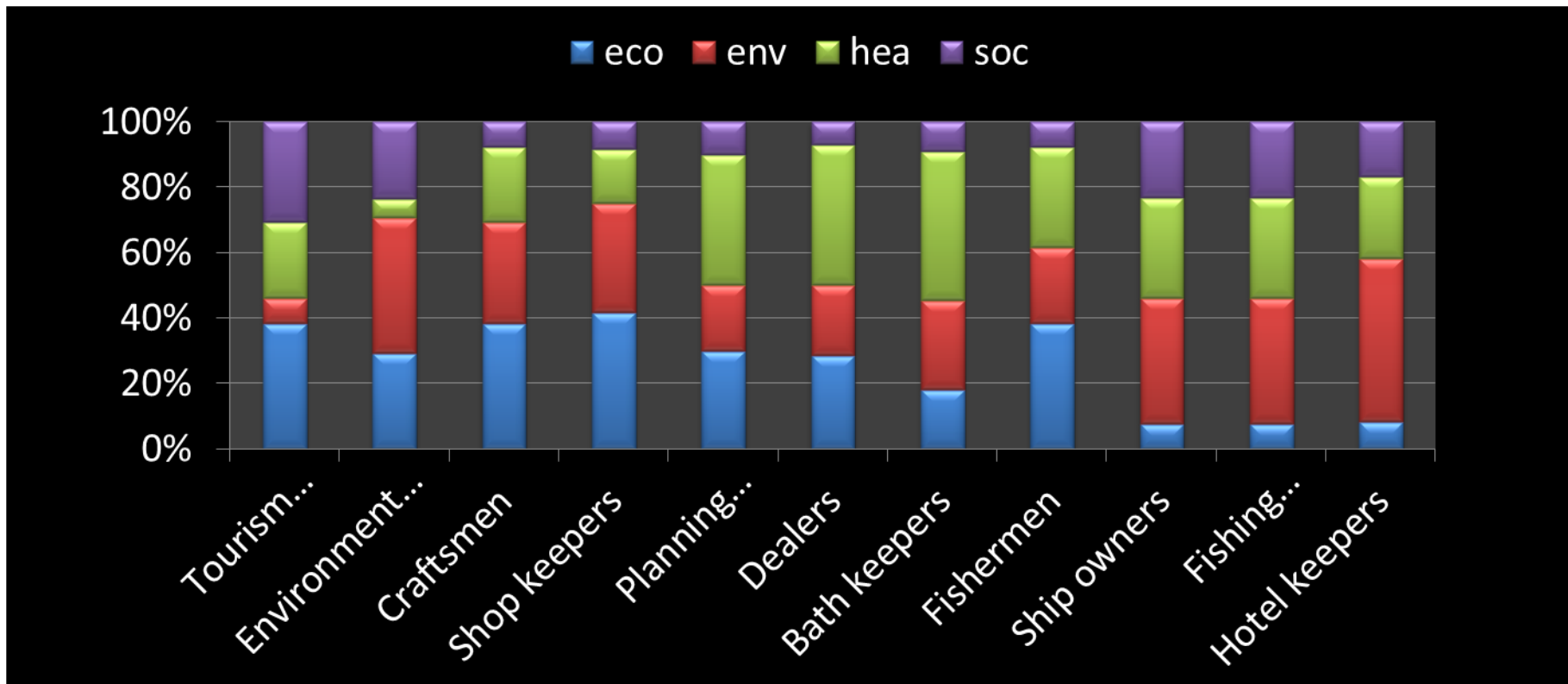
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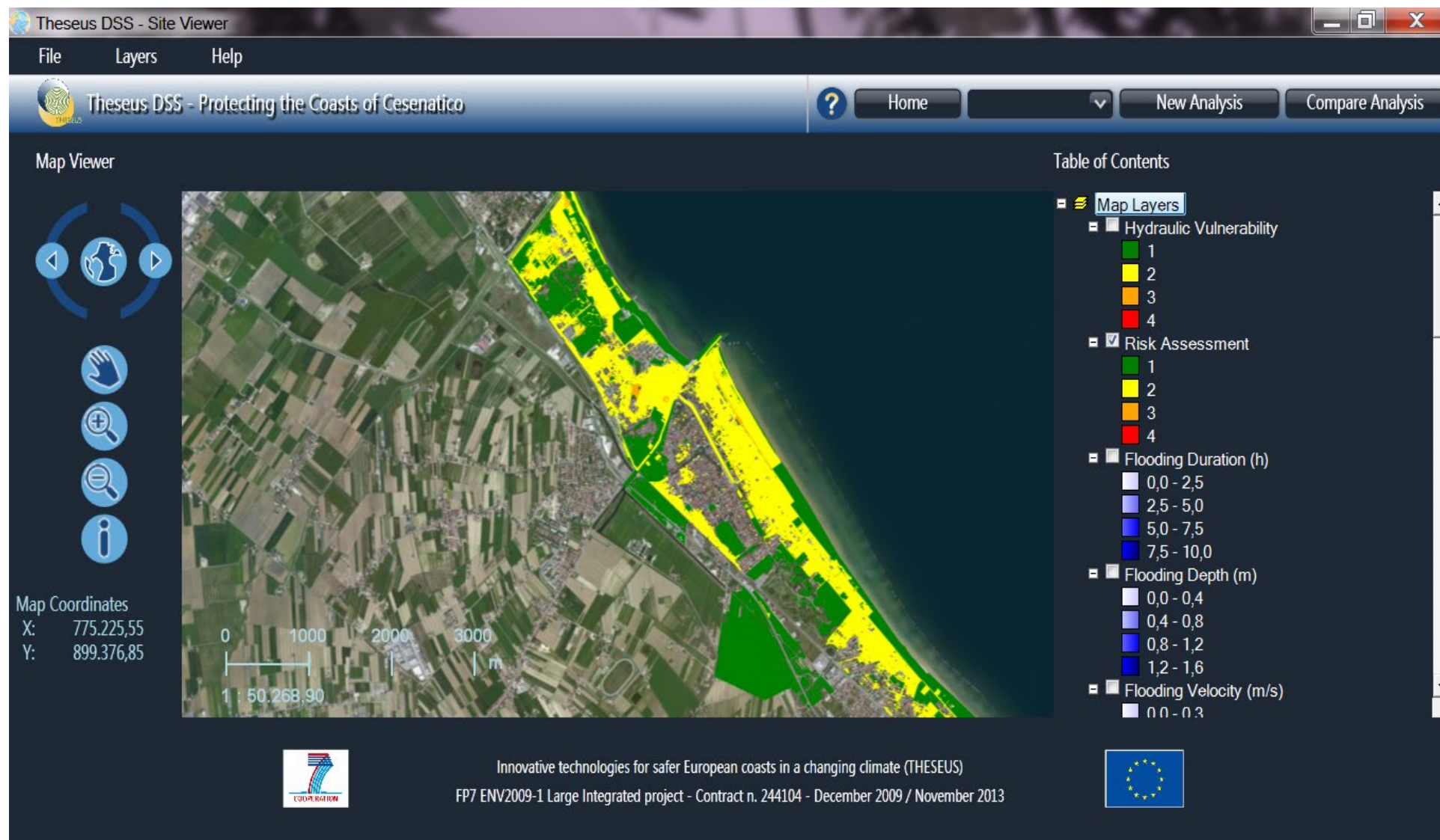


Stakeholder perception of damages

Priorities associated to injuries and social, environmental and economic damages



Risk map





Challenges?

- A common language
- Information sharing
- Harmonisation of data/methods
- Better assessment of uncertainty
- Better assessment of resilience
- Combination of different time scales (DRM & CCA)
- Combination of different spatial scales (different adaptation/mitigation solutions and cost-benefit assessments)
- Social risk component!



In progress...

- New hydraulic model: Inclusion of riverine discharges and representation of riverine floods; Inclusion of rainfalls and representation of combined extreme events



THANK YOU!

Barbara Zanuttigh

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