Developing climate risk and adaptation services for coastal zone managers: the CLIM-RUN bottom-up approach.

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CLIM-RUN Winter School
Trieste, 5th December 2013

Outline

- Climate services;
- CLIM-RUN project;
- WP8: North Adriatic case study;
- Climate risk and adatpation services in CLIM-RUN;
- DESYCO and Regional Risk Assessment;
- Examples of products.

CLIMATE SERVICES: definitions

The simplistic:
"The **timely production** and **delivery** of useful **climate data**, information, and knowledge to **decision makers**" (NRC, 2010)

The complex:

"A mechanism to **identify, produce**, and **deliver authoritative and timely information** about **climate variations** and **trends** and **their impacts on built, social-human, and natural systems** on regional, national, and global scales to support decision making." (NRC, 2009)

CLIMATE SERVICES: definitions

- The definition of climate services
  - Is ambiguous in the scientific world
  - Has evolved, even within the same organisations
  - Is complex and constantly refined

Guiding Principles:

- Bridge **the gap** between climate forecasters and users (WMO, 2013);
- Engage a **diversity of users** in meaningful ways to ensure their needs are being met (Jacob, 2011);
- Enable a better management of **vulnerabilities** and **risks** through the incorporation of science-based climate information and prediction into land planning, policy and practice on the global, regional and local scale (GFCS, 2013).

CLIMATE SERVICES

- **Climate services** aims **to provide a wide variety of** resources (e.g. data, products, decision support) directly used by stakeholders.
- Play the role of an **interface** between the **needs** (sphere of **stakeholders**) and **resources** (sphere of **research**).

Climate services provide information on:

Basic parameters

Climate observations (e.g. extreme event frequency and intensity)

Climate scenarios (e.g. Precipitations, temperature)

Derived parameters

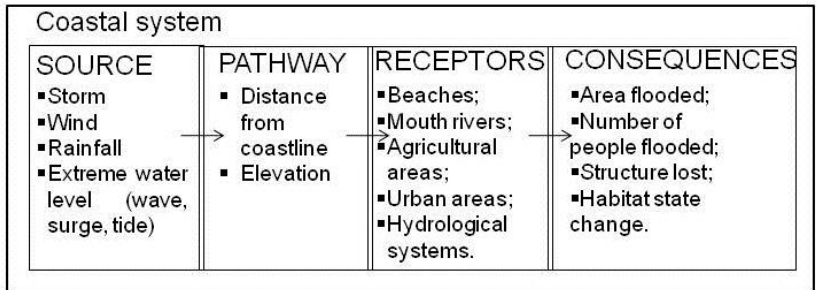
Impacts and risks on natural and human systems (e.g. droughts, intense precipitations, heat waves)

Regional/local scale

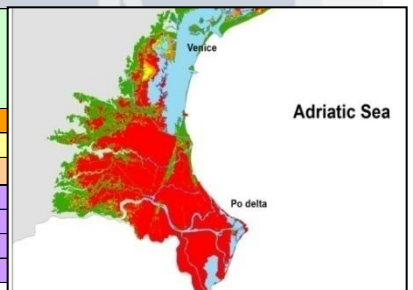
Tools for the analysis of derived parameters

- **Conceptual frameworks** providing information about the **cause/effect relationship** among **climate** related **hazards** and **natural** and **human receptors** (e.g. DPSIR framework);
- **Indicators** that allow to represent the degree to which each **receptor** may be **vulnerable** or at **risk** from different **climate change impacts**;
- **Multi-scale GIS-maps** representing the **spatial** distribution of climate change **vulnerabilities** and **risks** in the examined coastal territory;
- **Decision Support Systems** that facilitate climate change impact/vulnerability/risk assessment in order to support **decision making processes** for the implementation of adaptation strategies.

Stakeholders opinion is relevant to improve indicators and visualization tools and support decision-making processes.



RECEPTORS / IMPACTS	BEACHES	RIVER MOUTHS
HYDRODYNAMIC IMPACTS		
Sea Level Rise Inundation	- Elevation	- Elevation
	- Water body configuration	- Water body configuration
	- Protection level	- Protection level
	- Population density	- Population density
	- Urban typology	- Urban typology
		- Agricultural typology



CLIM-RUN – Climate Local Information in the Mediterranean region: Responding to User Needs

Objectives:

- To develop new **methodologies** and improved **modeling and downscaling tools** for adequate climate information at the **regional to local scale** that is relevant to and usable by **different sectors** of society;
- To develop a **protocol** for providing improved climate services to stakeholders in the Mediterranean area.

Bottom-up approach:

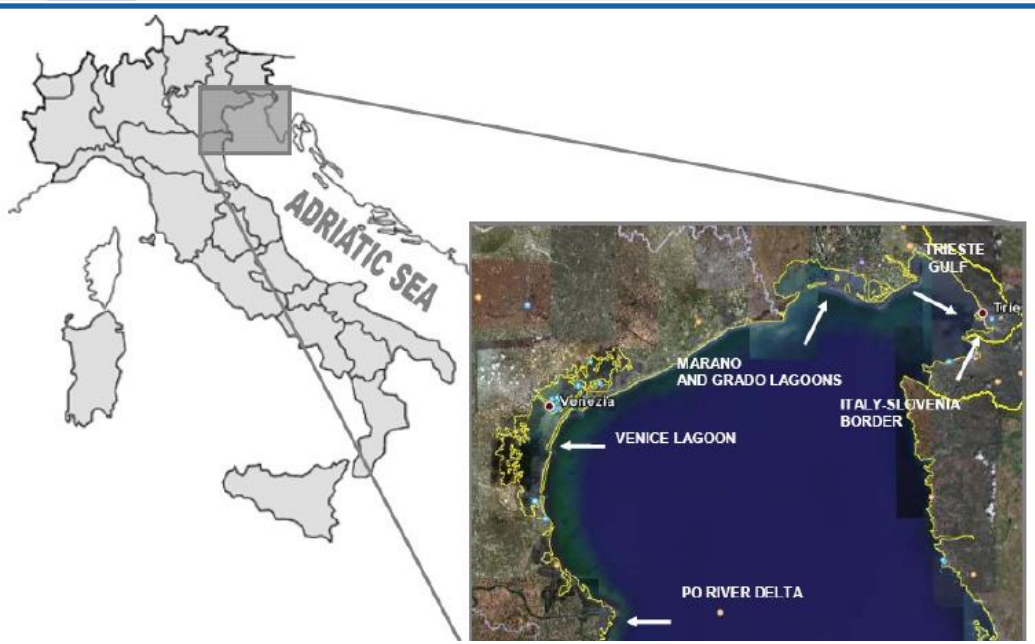
Stakeholder involvement early in the process, in order to:

- identify well defined **needs at the regional to local scale;**
- **utilize the improved modeling and downscaling tools** to optimally respond to these specific needs.

Focus on **case studies** in the greater Mediterranean area (**tourism, energy, coastal zones, wildfires).**

CLIM- RUN - WP8 Integrated case study

Integrated analysis of several systems and sectors (e.g. natural ecosystems, water resources, etc.) in the **Italian coast** of the **North Adriatic Sea.**



Objectives:

- **Impact** and **risk indicators** for coastal zones based on wide stakeholder involvement;
- Construction of climate change **hazard scenarios based** on **climate modelling** and downscaling methods;
- Definition of **vulnerable targets and vulnerability indicators** associated to climate change impacts for each sector of interest;
- **GIS-based visualization tools** to transfer climate information from the climate tier to the stakeholders tier.

WP8 Activities:

- **Stakeholder analysis** and **identification**;
- Organization of a **first workshop** with stakeholders focusing on the comparison between data demand and supply (Venice, September 2011);
- Preparation and administration of an investigative **questionnaire** to stakeholders;
- Identification of the main sectors and of the **critical climatic variables** for the North Adriatic case study;
- Tailoring of **Regional Risk Assessment (RRA)** addressing stakeholder needs;
- Development of climate products (basic and derived) and information material for stakeholders;
- Organization of a **second workshop** with stakeholders to present preliminary climate products (Trieste, May 2013);
- Organization of a **focus group** with stakeholders to present and discuss final climate products in (Venice, September 2013).

Stakeholder involvement

Climate services/ products

Stakeholder involvement

Climate risk and adatpation services in CLIM-RUN:

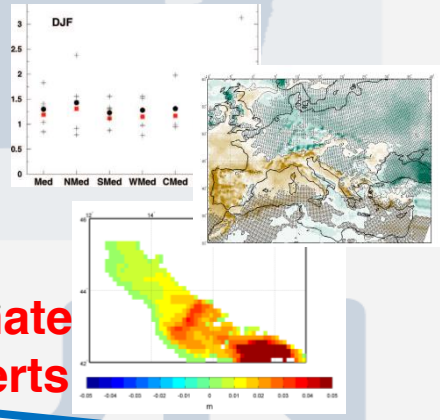
1. Participative process

Aimed at understanding the needs and requests of the stakeholders for what concern climate services and information.

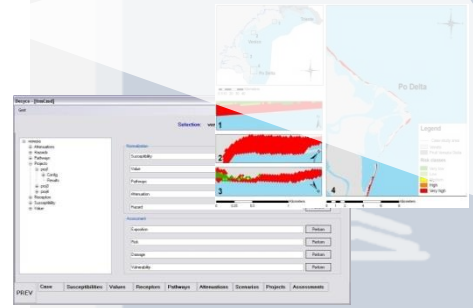
Stakeholders experts

2. Climate information

It provides forecasts and projections on future climate change scenarios applying climatic models and statistical downscaling.



Climate experts



PARTICIPATIVE PROCESS

CLIMATE INFORMATION

CLIMATE IMPACTS AND VULNERABILITY

Risk experts

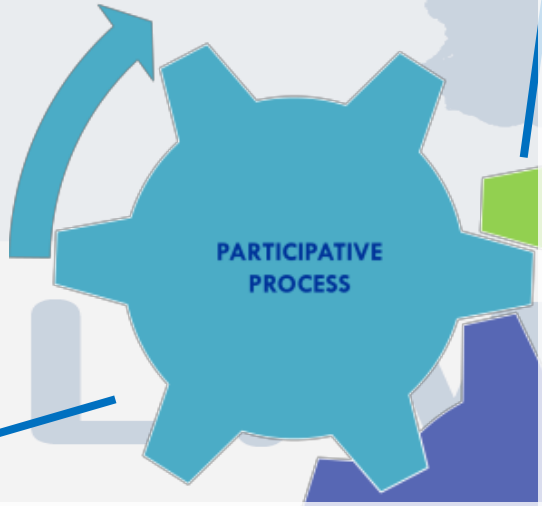
3. Climate impacts and vulnerability

It integrates climate data and end-users requests in order to evaluate climate-related risks for different natural and human systems.

Research areas for the development of climate risk services

1. Participative process

Aimed at understanding the needs and requests of the stakeholders for what concern climate services and information.



2. Climate information

It provides forecasts and projections on future climate change scenarios applying climatic models and statistical downscaling.

3. Climate impacts and vulnerability

It integrates climate data and end-users requests in order to evaluate climate-related risks for different natural and human systems.

Participative Process - Phases

13 September 2011
1° Workshop with local stakeholders

28 May 2013
2° Workshop with local stakeholders

26 September 2013
Focus Group

2011 → **Development of preliminary climate risk services** → **Development of definitive climate risk services** → **2014**

Discussion on stakeholders's information needs in terms of:
- Type of impacts and receptors;
- Key climate variables;
- Temporal resolution and horizon;
- Spatial resolution.

Discussion on:
- Testing area for application;
- Hazard scenarios selection;
- Vulnerability factors to be adopted;
- Outputs layout (e.g. type of statistics, legend of maps)

- Presentation of the definitive climate risk services developed by risk experts to stakeholders;
- Cross cutting conclusions

(Giannini et al. 2011, 2013)

Participative process – Stakeholders involved

Level	Istitution
Supranational	Adriatic Euroregion
National	Institute for Environmental Protection and Research
	Civil Protection regional office Friuli Venezia Giulia
Veneto	Public works office Rovigo
	Soil conservation service
	Integrated hyrdric service
	Regional Metereological service Teolo
	Venice Water autority
	Venezia Nuova Consortium
	Po River Delta irrigation consortium
	Veneto Orientale irrigation consortium
	Venice port autority
	Geologic service
	Venice municipality
	Tidal Forecasting Centre Venice
Friuli Venezia Giulia	Geologic service
	Regional Agency for the Protection of the Environment
	Regional Metereological service Friuli Venezia Giulia
	Marine protected area of Miramare
	Ledra Tagliamento irrigation consortium

Criteria for stakeholder identification: institutions which have mandate for ICZM (Giannini et al. 2011, 2013):

- **40 offices were selected** and invited to participate to the workshops.

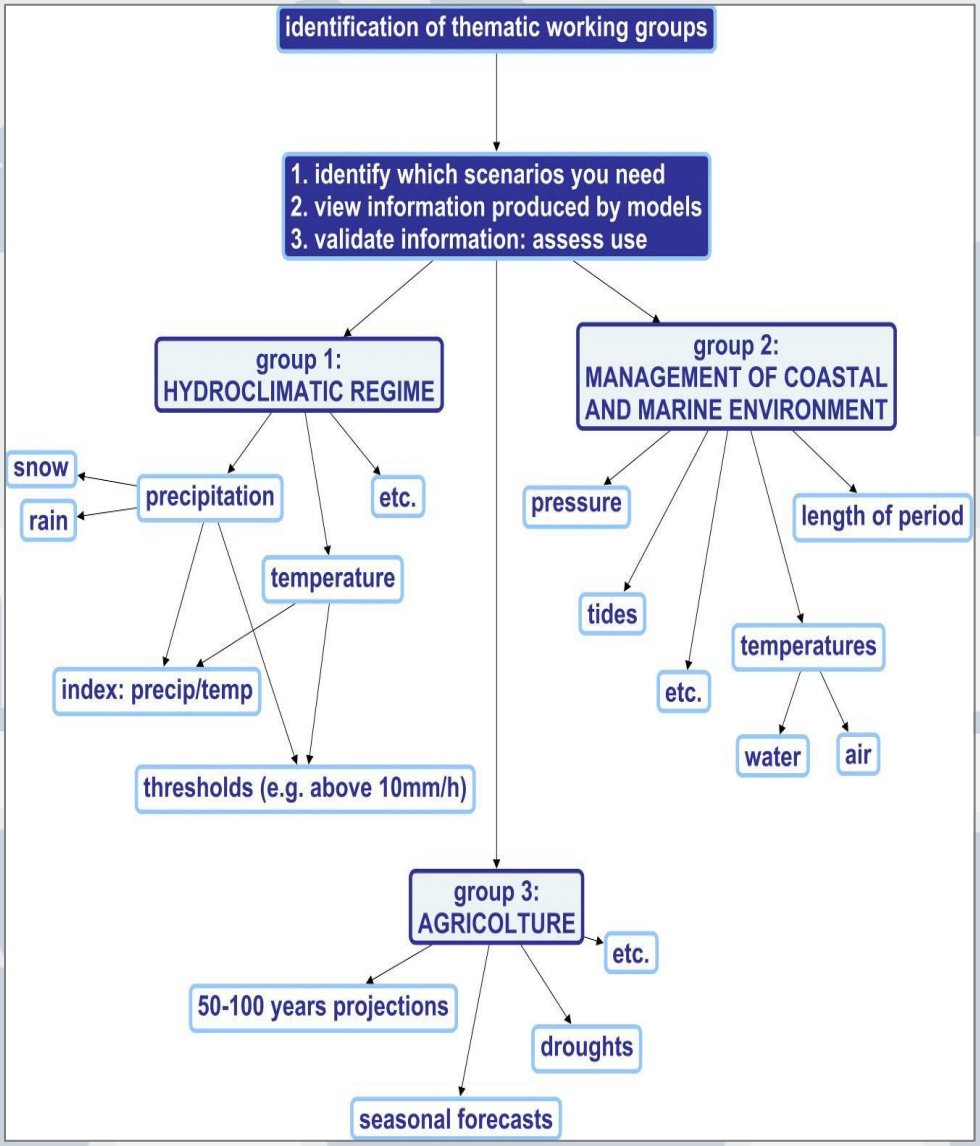
- **20 offices** participated at the first WS.

- **11 offices** participated at the second WS.

Veneto
Regional Met office
Municipality of Venezia: urban sustainability
Municipality of Venezia: PAES and C40
Municipality of Venezia: energy agency
Friuli Venezia Giulia
Regional geologic service
Regional environmental agency
Regional environmental agency
Regional environmental agency
Regional Met office
Extension service Ledra Tagliamento
Marine Protected Area of Miramare

Participative process – First workshop results

PARTICIPATIVE PROCESS



Thematic groups of interest for stakeholders (Giannini et al., 2011).

Participative process – First workshop results

PARTICIPATIVE PROCESS

First workshop questionarrie

Specification of climate data needs: Region(s) required

Specification of climate data needs: Spatial scale required

Gridded >1 km

Gridded 10 km

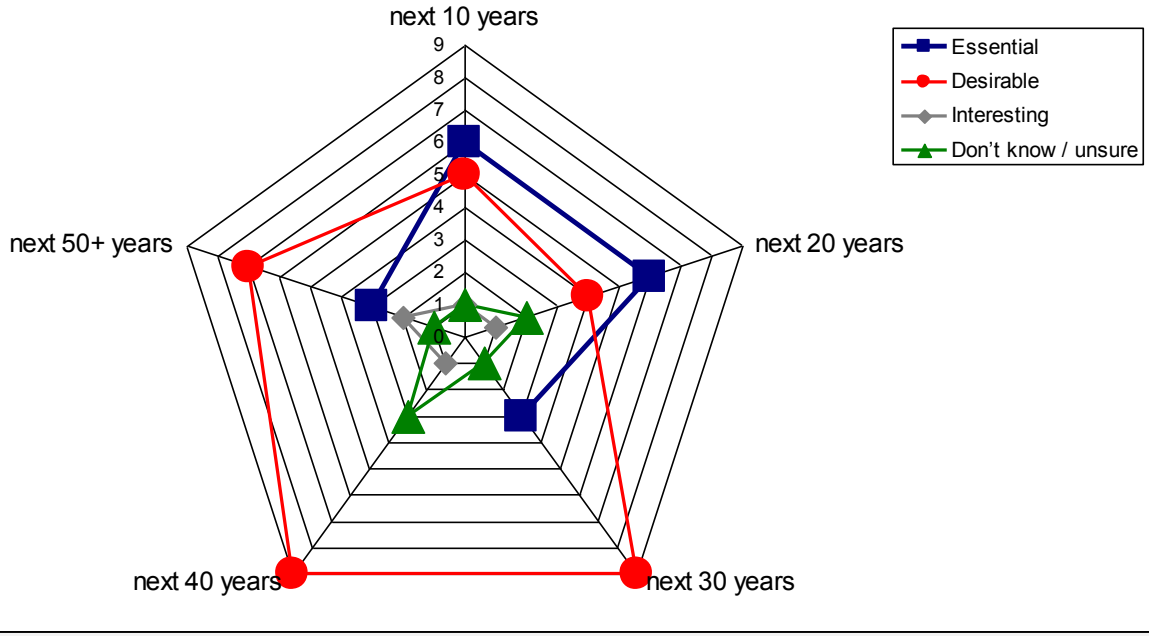
Specification of climate data needs: Temporal resolution required

annual

Specification of climate data needs: Timescale required

Essential

Specification of climate data needs: Do you want climate change projections?



(Giannini et al. 2011)

1. Partecipative process- Results

PARTICIPATIVE PROCESS

Second workshop questionarrie

1. Is the proposed area (Province of Venice) appropriate for the study?

□Yes □No

2. If not, which areas should be included?_____

3. Are the proposed receptors appropriate for the study?_____

4. If not, which other receptors would you suggest to include?_____

5. Are the proposed vulnerability factors appropriate?_____

6. If not, suggest which others factors should be included?_____

7. Is the time scale proposed (number of events in the decade 2041-2050) appropriate?

□Yes □No

8. Which should be the most appropriate time scale for the study?

□ Monthly number of events;

□ Seasonal number of events;

□ Annual number of events;

□ Others_____

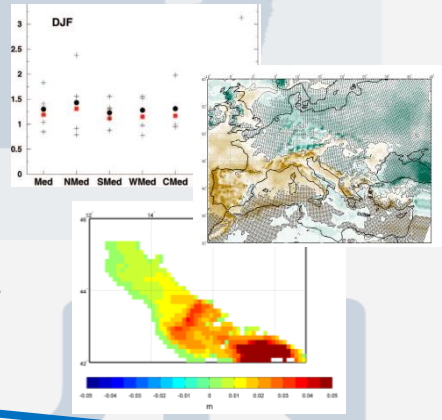
Research areas for the development of climate risk services

1. Participative process

Aimed at understanding the needs and requests of the stakeholders for what concern climate services and information.

2. Climate information

It provides forecasts and projections on future climate change scenarios applying climatic models and statistical downscaling.

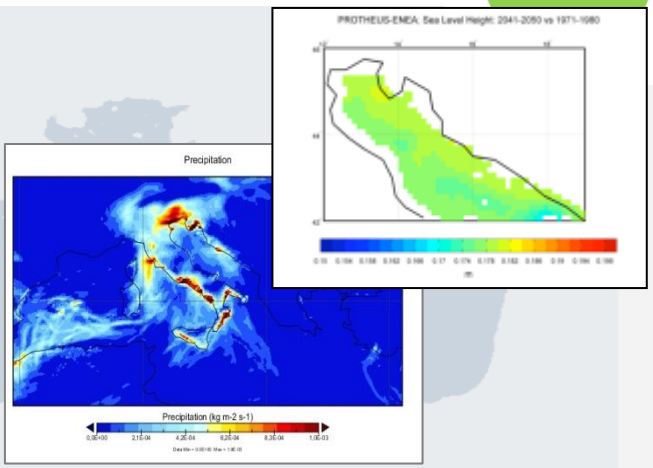


3. Climate impacts and vulnerability

It integrates climate data and end-users requests in order to evaluate climate-related risks for different natural and human systems.

2. Climate information from the dialogue between climate experts and risk experts.

How to develop hazard scenarios from climate data provided by different climate models, projections and observations?



Discussion with climate experts in order to identify the most appropriate hazard metrics and stressors to be adopted in the risk assessment:

- How to define maximum precipitation thresholds to assess pluvial flood risk?
- How to deal with uncertain projections of sea level rise in the Mediterranean?
- Is the spatial resolution of climate models approriate to study CC impacts at the coastal/regional scale?

Research areas for the development of climate risk services

1. Participative process

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DESYCO
DEcision support SYstem for COastal climate change impact assessment
MAIN OBJECTIVE:
Identify, prioritize and visualize areas and targets at risk from climate change impacts on coastal areas and related ecosystems.
Sfax
Gulf of Gabes
Medenine
Case study area
Vulnerability classes
CMCC-CVR
File
Config
CasiDiStudio
venezia
Attenuations
Hazards
Pathways
Projects
Scenarios
General Coefficient
Hazard Weight
Hazard Classification
Susceptibility Classification
Susceptibility Weight
Value Classification
Value Receptors
Calcola
Attenuazione
Distanza
Hazard
Susceptibility
C:\Python26\python.exe
Done

DESYCO: aims

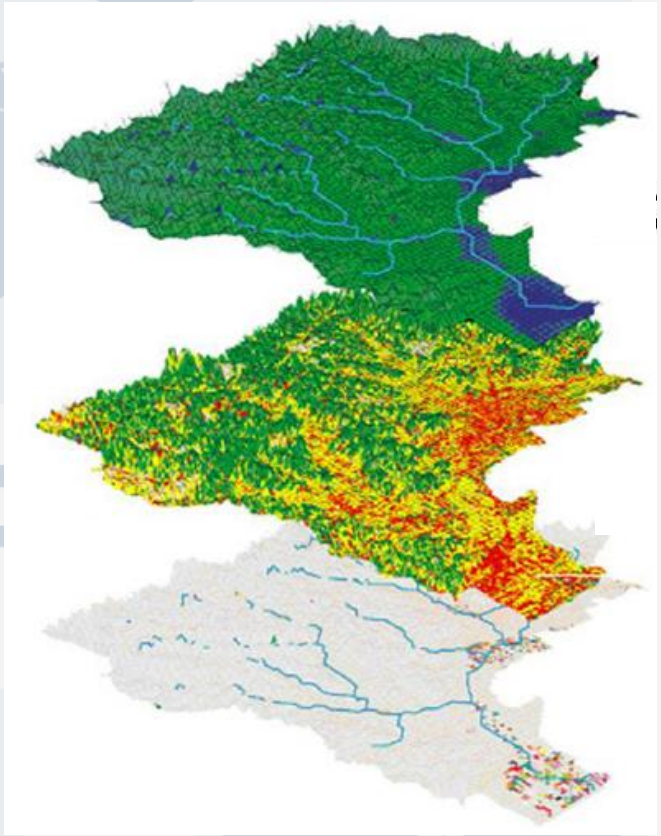
DESYCO AIMS:

To integrate different components:

- Physical-environmental, geological, socio-economic characterization;
- Future climate scenarios (e.g. sea-level rise, variations of T and P).

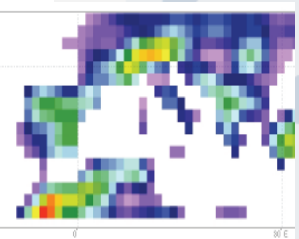
In order to develop information about:

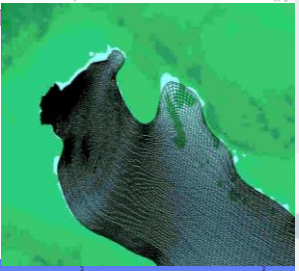
- Climate change impacts;
- Targets affected by climate change;
- Relative risk estimation for the targets affected by climate change.

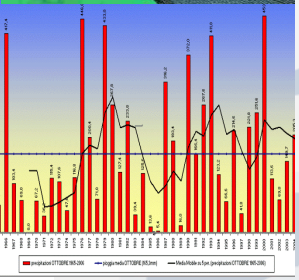


To provide information/climate services for the implementation of **adaptation strategies to stakeholders** and **decision makers** that are responsible for coastal planning.

DESYCO: a tool to bridge the gap







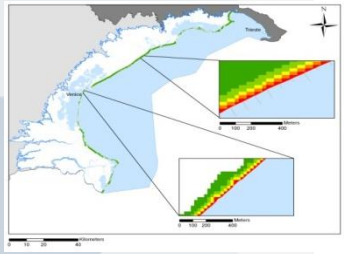
DESYCO

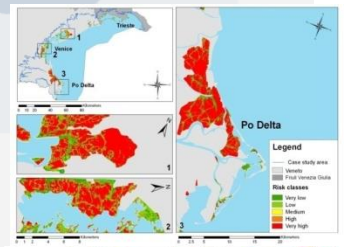
Climate Impact Data

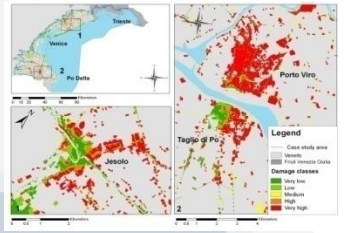
Users needs

CLIMATE INFORMATION

PARTICIPATIVE PROCESS







DESYCO can be used to:

CLIMATE IMPACTS AND VULNERABILITY

- Analyse long-term **climate change hazard scenarios** at the regional/local scale.
- **Rank** coastal **receptors** and **areas** vulnerable to or at risk from different climate change impacts.
- Produce **interactive GIS-based maps** (i.e. exposure susceptibility, risk and damage maps).
- **Transfer information** about potential climate change impacts for **adaptation actions** to different sectors of society**.**

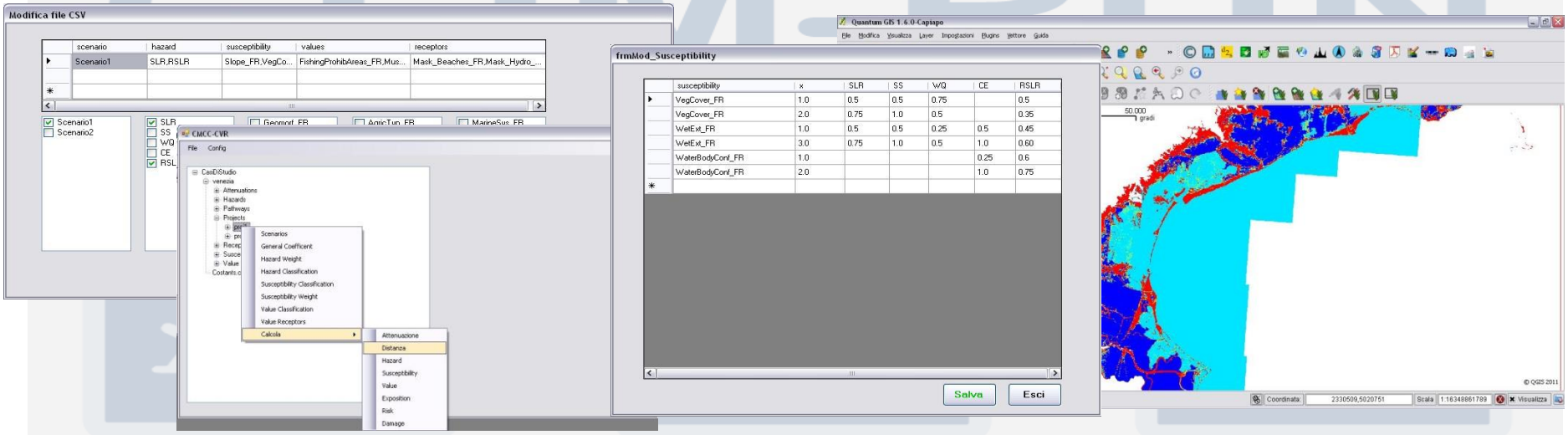
Specific technical features of DESYCO

- **Two-dimensional visualization** of vulnerability and risk based on raster maps;
- **Multi-target** vulnerability and risk assessment;
- Analysis of **different** climate change **impacts** (e.g. sea level rise inundation, storm surge flooding, water quality variations);
- Integrates **GIS spatial analysis** to calculate indicators: distance and surface calculation, vector analysis (e.g. intersection, union, merge);
- **MCDA module** integrating multiple vulnerability indicators with **expert** and **stakeholder judgment**;
- Flexibility to manage **different input** data (i.e. raster or shape files) provided by different **scenarios models** and **vulnerability datasets**.

DESYCO: structure:

The structure of DESYCO consists of 3 main components:

- **A GEODATABASE with bio-physical and socio-economic data for the investigated coastal area.**
- **Multi-scale SCENARIOS Module, provided by numerical models simulations or time series analysis.**
- **A Relative Risk Model (RRM) for the application of the Regional Risk Assessment (RRA) methodology.**



Regional Risk Assessment

Objectives:

- To identify potential **HAZARDS** related to future scenarios of **climate change** (e.g. sea-level rise, storm surges variations , heat waves, extreme precipitations);
- To visualize **AREAS POTENTIALLY EXPOSED** to climate change impacts;
- To identify potential **TARGETS** (e.g. agricultural areas, beaches, wetlands) and their **VULNERABILITIES;**
- To identify the **RELATIVE RISK** (e.g. risk erosion for beaches, risk of wetland loss) which provide at the regional scale information about the areas/targets within a region likely to be affected more severely than others;
- To provide a **RELATIVE ESTIMATE** of areas/targets where the potential social, economic and environmental losses would be greater than others.

Useful decision support tools useful to guide decision makers in the prioritization and localization of management and adaptation strategy.

Regional Risk Assessment- Outputs

HAZARD METRICS
PATHWAY FACTORS
ATTENUATION FACTORS
SUSCEPTIBILITY FACTORS
VALUE FACTORS

Exposure maps

Susceptibility maps

Risk maps

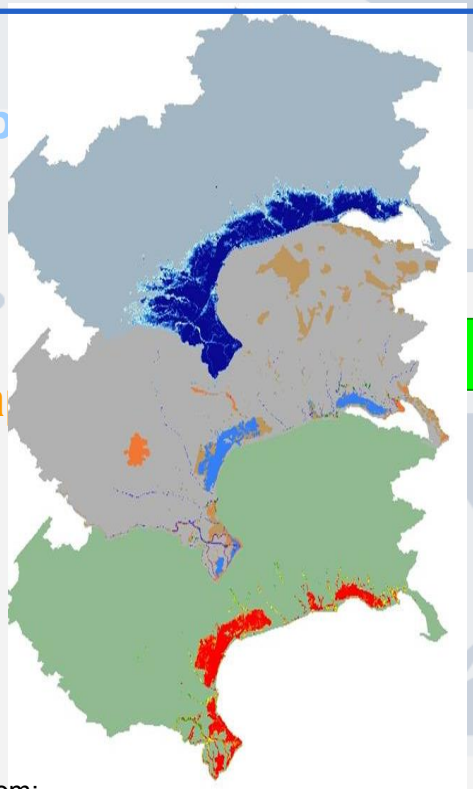
Value maps

Damage maps

Exposure map

Susceptibility ma

Risk map



decision support tools useful to guide the impact/risk management phase.

Adapted from:
http://www.adrc.or.jp/publications/Venten/HP/herath4.jpg

Climate impact and vulnerability- Outputs

Development of climate risk services for the case study area of the north Adriatic coast appling the Regional Risk Assessment methodology integrating stakeholders requested and climate information:

Assessment of pluvial flood impacts in urban areas

Assessment of sea level rise impacts

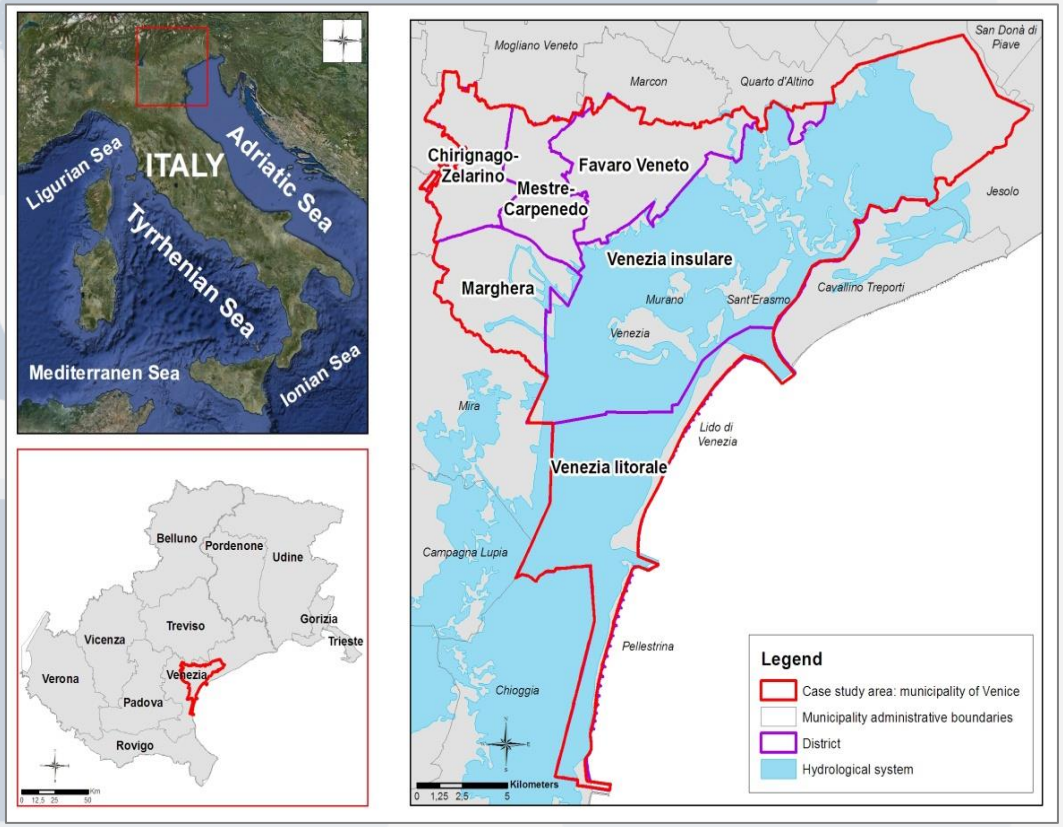
Assessment of pluvial flood impacts in urban areas

Objective:

Development of a Regional Risk Assessment methodology for the identification of urban areas that could be more affected by pluvial flood events in view of climate change.

Case study area:
Municipality of Venice

Time horizon of the analysis: 2041-2050



Case study area of the municipality of Venice

Assessment of pluvial flood impacts in urban areas

ISSUE:

- **Pluvial floods:** rain-related floods which occur when intense rainfall cannot be drained away quickly enough through sewage or rivers;
- **Climate change** will lead in an increase of heavy precipitation events (e.g. above 95th percentile) (IPCC 2007, 2012) resulting in an increased risk of localized pluvial floods (Kundzewicz et al.; 2007; Bates et al.; 2008);
- **Changes in land use** (i.e. transformations from green areas to urbanized ones) result in an increase of urban floods frequency due to poor infiltration and reduction of flow resistance.

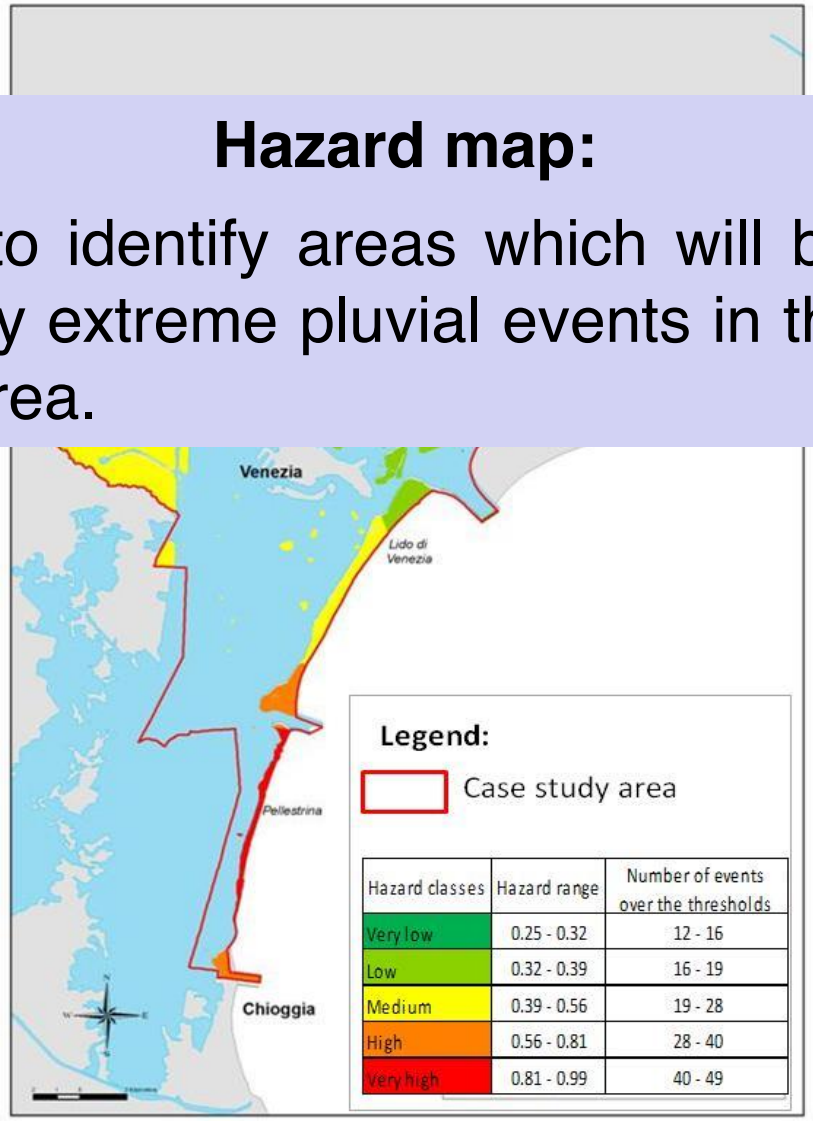
STAKEHOLDERS NEEDS:

- Identify **which areas will be flooded** due to extreme precipitation events and with which frequency;
- To know **pluvial thresholds** above which drainage system collapse;
- To know future **precipitation trends** in order to plan and localize drainage systems to avoid flood.

Assessment of pluvial flood impacts in urban areas - Outputs

Hazard map:

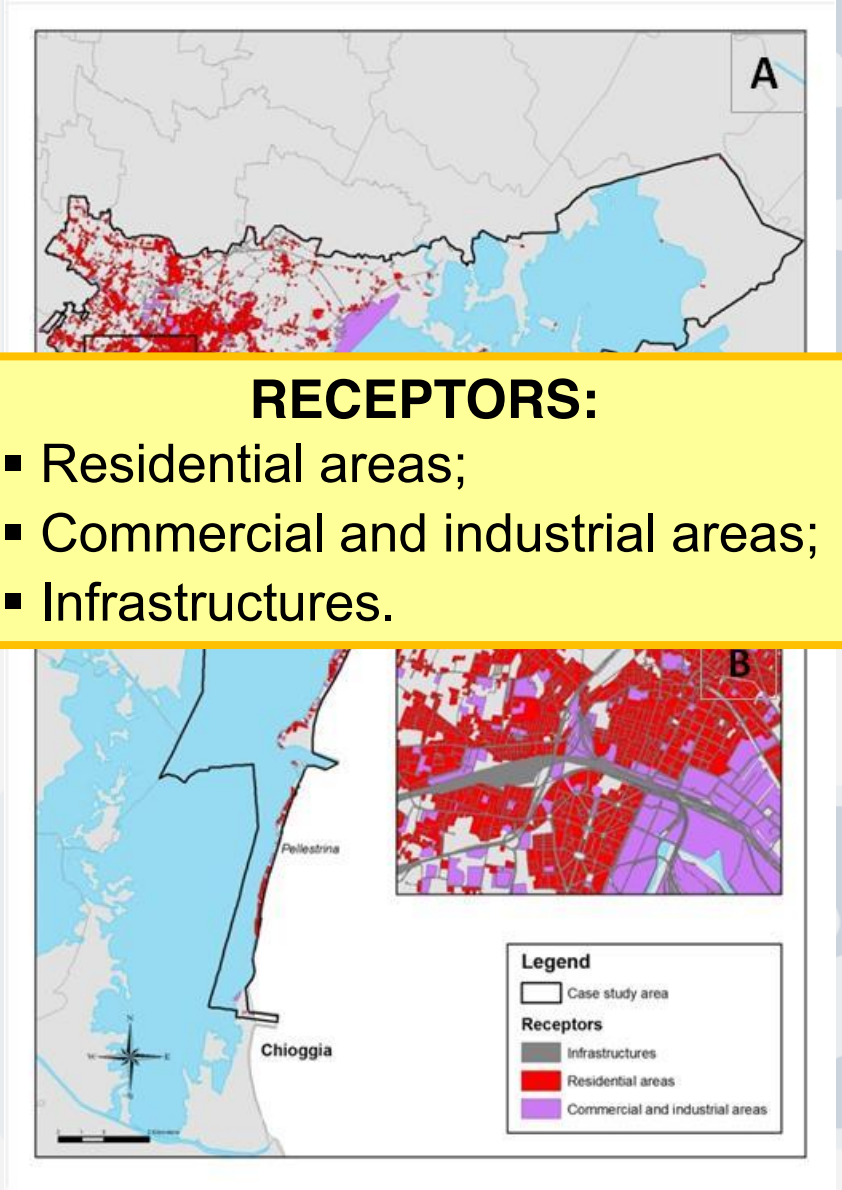
allows to identify areas which will be most affect by extreme pluvial events in the case study area.



Hazard classes	Hazard range	Number of events over the thresholds
Very low	0.25 - 0.32	12 - 16
Low	0.32 - 0.39	16 - 19
Medium	0.39 - 0.56	19 - 28
High	0.56 - 0.81	28 - 40
Very high	0.81 - 0.99	40 - 49

Studied receptors

PARTICIPATIVE PROCESS



RECEPTORS:

- Residential areas;
- Commercial and industrial areas;
- Infrastructures.

Susceptibility Assessment

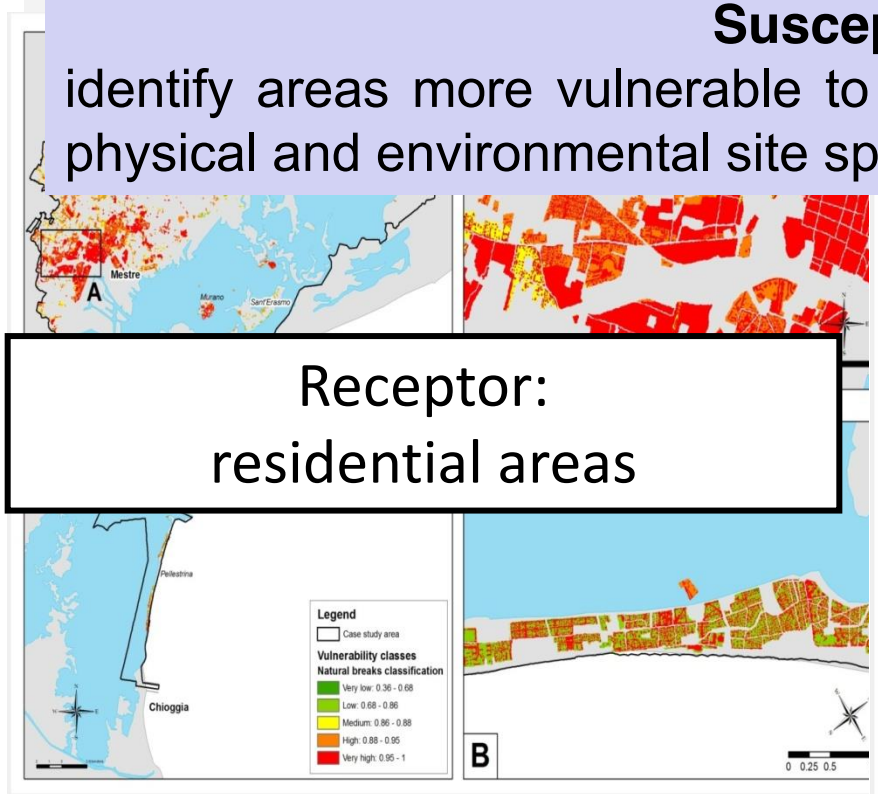
SUSCEPTIBILITY FACTORS

Vulnerability factor	Definition	Data source
Slope (degree)	Average topographic slope of the land.	5 m Digital Elevation Model (DEM) provided by Veneto Region, 2007.
Soil permeability	Soil permeability due both to geological characteristics and land use (urbanized areas)	Permeability Map 1:100.000 extracted from Geologic Atlas of the Province of Venice provided by the Province of Venice, 2011.
Flooded areas	Areas where in recent years have occurred floods due to heavy precipitations and consequent overflowing of the sewage and drainage systems .	Recently flooded areas Map 1:100.000 extracted from Geologic Atlas of the Province of Venice provided by the Province of Venice, 2011.

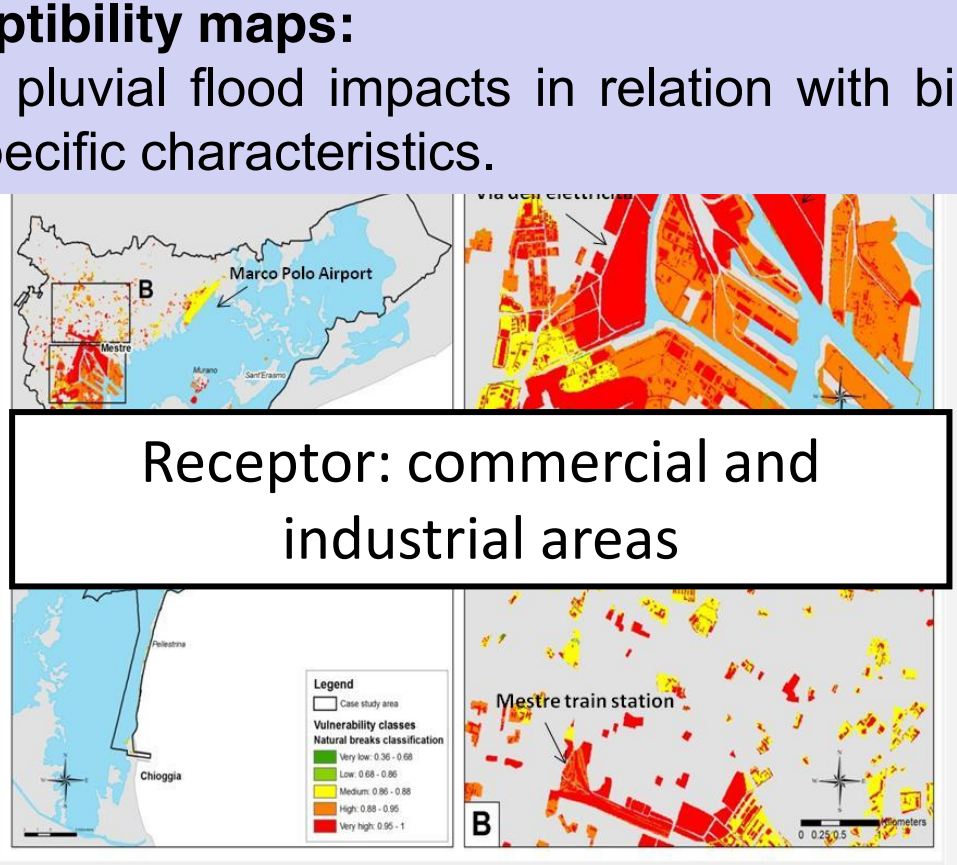
Assessment of pluvial flood impacts in urban areas - Outputs

Susceptibility maps:

identify areas more vulnerable to pluvial flood impacts in relation with bio-physical and environmental site specific characteristics.



Receptor:
residential areas



Receptor: commercial and industrial areas

Risk Assessment

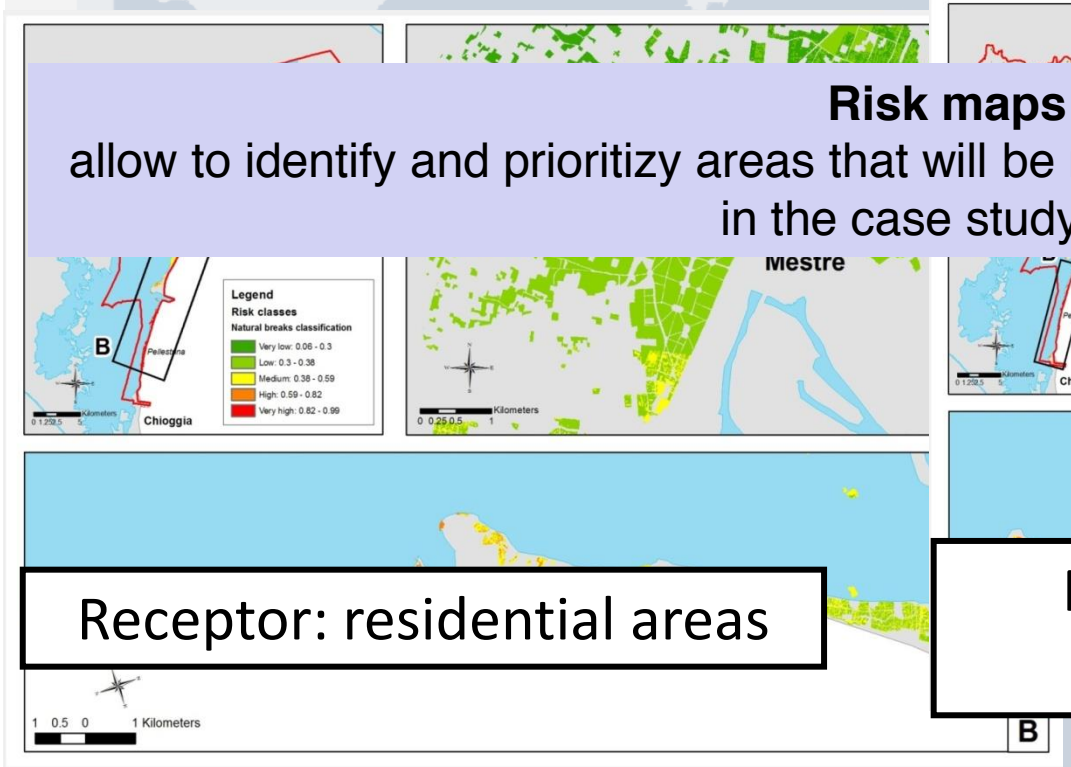
It is aimed at integrating information about the pluvial flood hazard of a given climate change scenario with the territorial vulnerability in order to identify and prioritize receptors and areas at risk of flooding in the case study area.

Risk score varies from 0 to 1 in which:

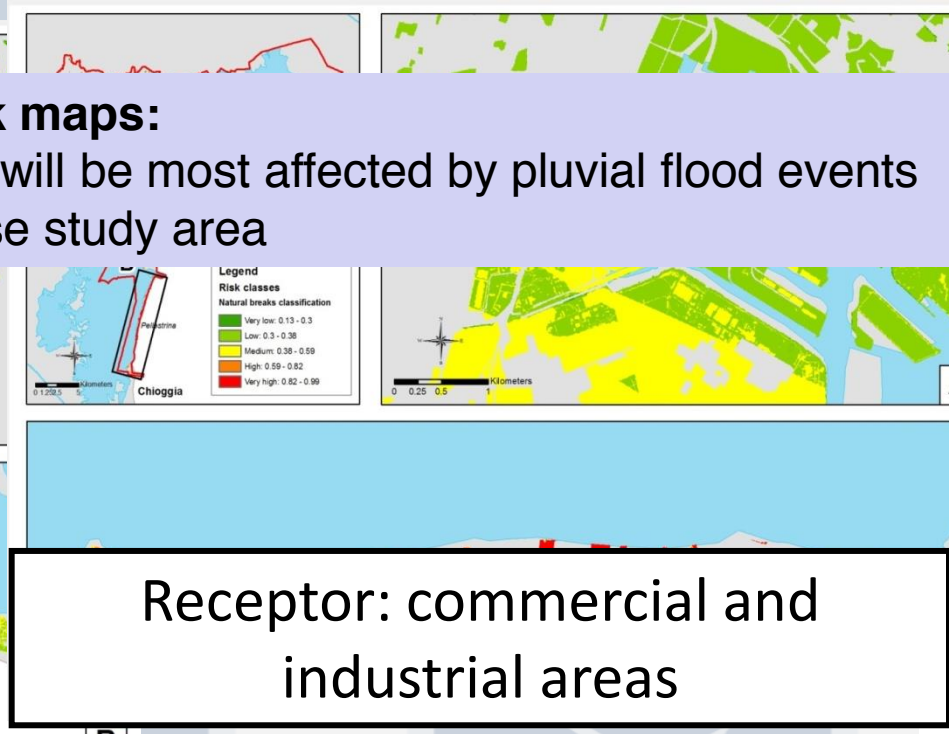
- 0 means that in the area the risk is null (i.e. there is no hazard or no physical and environmental vulnerability) ;
- 1 means maximum risk for the considered target/area in the considered region.

Assessment of pluvial flood impacts in urban areas - Outputs

Risk maps:
allow to identify and prioritizy areas that will be most affected by pluvial flood events in the case study area



Receptor: residential areas



Receptor: commercial and industrial areas

Pluvial flood risk maps in urban areas: feedback from stakeholders' questionnaire.

- **4/5 stakeholders** considered the **testing area** as **appropriate.**
- **1/5 stakeholder** suggested to include **urban** and **extra-urban areas** of **Udine** and **Pordenone** (Friuli Venezia Giulia provinces).
- **4/5 stakeholders** considered the proposed **receptors** and **vulnerability factors** as **appropriate.**
- **1/5 stakeholder** suggested a more detailed analysis of the slope influence on inundated areas.
- **The decade 2041-2050** was considered as **appropriate** time scale**, 2** stakeholders suggested a **more detailed analysis** of the outputs (i.e. monthly , annual or seasonal number of events).

(Giannini et al., 2013)

Conclusion – Lessons learnt

- **DESYCO** proved to **bridge the gap** between climate impact science and coastal zone policy/planning in order to support **decision making** and **climate proofing** in a wide range of situations (e.g. shoreline planning, land use and water resource management, flood risk reduction, strategic environmental assessment).

- **Climate services: not only climate projections** but also **projections on impacts of climate change** on natural and human coastal systems (e.g. beaches, wetlands, urban and agricultural areas).

- **Early stakeholders' involvement: 1. to get the right questions** - according to stakeholders' experties and expectetions - in terms of time scenarios, geographical scale and resolution, choice of receptors, vulnerability factors and thresholds; **2.** to develop **products** more **tailored** to their informations **needs.**

- **Data gap**: lack of detailed and homogeneous information about coastal artificial protection, LIDAR, DEM, presence and structure of urban dryanage systems.

Conclusion – Lessons learnt

- **Screening risk products:** useful as first-pass assessment of critical vulnerabilities => a more detailed analysis is required to respond to very specific needs of stakeholders (e.g. how to improve urban drainage systems, where to construct dikes);

- It is necessary to go beyond the traditional **impact** by **impact** approach and to implement **multi-risk assessment** considering that the same area would be potentially affected by several climate-related hazards (i.e. drought, risk of flood, groundwater salinization);

- There is a high level of **uncertainty** due both to unavoidable climate variability and to uncertain model projections: it is necessary to develop **adaptive policies and strategies** to cope with alternating situations (e.g. dry years followed by rainy years).

Thanks

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