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Climate change vulnerability and risk - key concepts -

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INTRODUCTION

The terms **VULNERABILITY** and **RISK** are often used to describe the potential (adverse) effects of climate change on ecosystems, infrastructure, economic sectors, social groups, communities and regions.

These terms are attractive because they are both intuitively understandable to a large audience…but this fact can give rise to **misunderstandings** (EEA, 2012).

Vulnerability and risk has no universally accepted definition, and there is no single "correct" or "best" conceptualization that would suite all assessment context (i.e. each community has its own definitions). **It is therefore necessary to specify clearly which terms are used in a specific context**.

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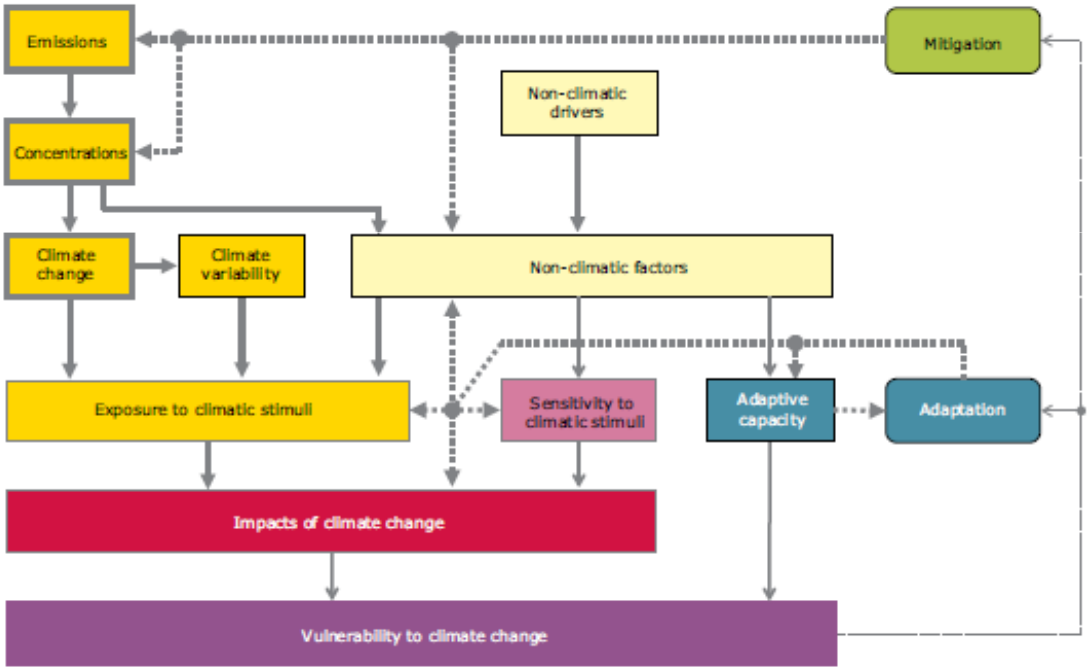
VULNERABILITY - DEFINITION (1)

VULNERABILITY TO CLIMATE CHANGE (IPCC): *is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude and rate of climate change and variation to which a system is* ***EXPOSED****, its* ***SENSITIVITY****, and its* ***ADAPTIVE CAPACITY****.*



Source: EEA, 2012

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VULNERABILITY - DEFINITION (2)

VULNERABILITY = function [exposure (+); sensitivity (+); adaptive capacity (-)]

VULNERABILITY = potential impact (sensitivity x exposure) – adaptive capacity

EXPOSURE (IPCC): *the presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social or cultural assets in places and settings that could be adversely affected*.

SENSITIVITY (IPCC): *the degree to which a system or species is affected, either adversely or beneficially, by climate variability or change. The effect may be direct (e.g. a change in crop yield in response to a change in the mean, range or variability of temperature) or indirect (e.g. damages caused by an increase in the frequency of coastal flooding due to sea level rise).*

POTENTIAL IMPACT (IPCC): *impacts of climate change are the effects of climate change on natural (e.g. water resources, biodiversity, soil, etc) and human systems (e.g. agriculture, health, tourism, etc). Potential impacts are all impacts that may occur given a projected change in climate, without considering adaptation*.

ADAPTIVE CAPACITY (IPCC): *the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantages of opportunities, or to cope with the consequences*.

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HOW CAN I ASSESS VULNERABILITY? (1)

Based on the previous definition, vulnerable regions or sectors can be therefore identified by linking the potential impacts and adaptive capacity.

- by identifying the potential impacts (= reducing exposure and/or sensitivity)

- by measuring the adaptive capacity (=increasing adaptive capacity)

Assessing vulnerability to climate change is therefore more complicated than simply assessing the potential impacts of climate change, due to the "adaptive capacity" component.

Estimating ADAPTIVE CAPACITY is a key element of vulnerability assessment.

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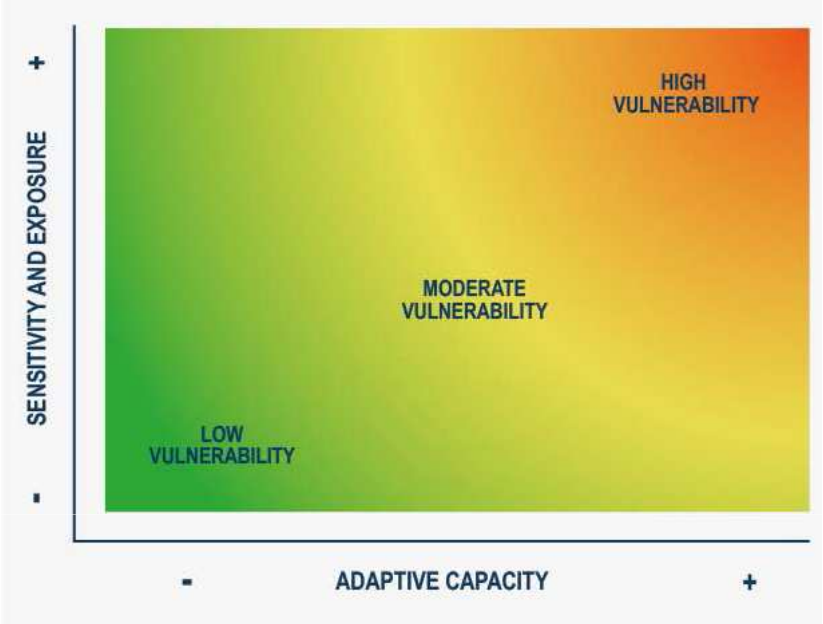
HOW CAN I ASSESS VULNERABILITY? (2)



Source: adapted from Alberta Sustainable Resource Development, 2010 and http://www.adaptingtorisingtides.org/vulnerability-and-risk/).

Assets with high adaptive capacity and low sensitivity/exposure can tolerate impacts to a greater degree and therefore have an overall **low vulnerability**.

Assets with high sensitivity/exposure and low adaptive capacity are more susceptible to impacts, and therefore have an overall **high vulnerability**.

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HOW CAN I ASSESS VULNERABILITY? (3)

The assessment of vulnerability requires the identification of:

vulnerability of something/someone to something in a certain time period

namely a potential climatic event or related harm (e.g. flood damage or drought) in a specific time (now or in the future).

Assessing vulnerability does not mean necessarily calculating a specific number, nor measuring something with a specific instrument (the "vulnerometer" does not exist) but it rather means **describing a situation or a condition** through a certain number of factors or elements related to its characteristics (e.g. **INDICATORS**).

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EXPOSURE - example

Different geographical locations can be exposed to different climate hazards as well as different frequencies and intensities.

CHANGING CLIMATE HAZARD	PARTICULARLY EXPOSED LOCATIONS
• average temperature rise and increased risk of heatwaves	• regions where average temperatures are already high • regions where temperature thresholds may by crossed (e.g. permafrost zones, etc) • urban centres, where the Urban Heat Island effect will exacerbate high temperature
• mean sea level rise, increased storms surge heights, coastal flooding and erosion	• areas already at or below sea level • coastal zones and islands • offshore locations

Source: EC, 2011

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SENSITIVITY(1)

If a system is likely to be affected as a result of projected climate change, it should be considered sensitive to climate change.

Which are the factors that could influence sensitivity to climate change?

- physical and mental health and age (for socio-economic groups);
- extent to which products and services are affected by climate stimuli (for sectors);
- extent to which physical structure and their services are affected by climate stimuli (for assets and infrastructure);
- health, connectivity and robustness of the ecosystems (for ecosystems)

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SENSITIVITY – examples of indicators (2)

BIODIVERSITY	Species with narrow environmental tolerance Species dependent on specific environmental triggers
TOURISM	Percentage of population annually affected by extreme weather events
COASTAL AREAS	Geomorphological coastal types

Source: LIFE ACT

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POTENTIAL IMPACTS (1)

Assessing the **potential impacts of climate change** means evaluating the magnitude of potential effects of climate change which strictly depends on exposure and sensitivity.

The effects of climate change may be **beneficial or harmful**, with most observations and projections showing a range of effects on the environment, economy and society (examples):

- agriculture
- forestry
- water resources
- hydrogeological risk
- tourism
- soil
- biodiversity and ecosystems
- cultural heritage
- coastal environment

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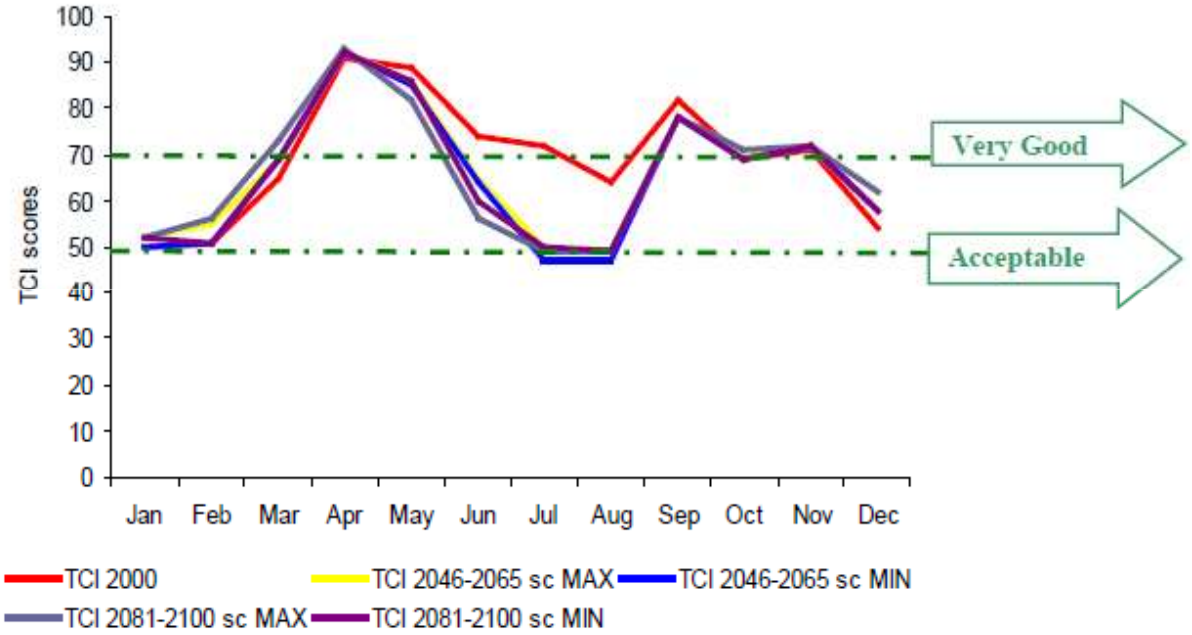
POTENTIAL IMPACTS OF CLIMATE CHANGE ON TOURISM (2)

In order to assess the potential impact of climate change on tourism in Patras, the **Tourism Comfort Index** (Mieczkowski, 1985) has been calculated for the year 2000 (baseline) and the periods 2046-2065 and 2081-2100.



The TCI is based on the notion of "human comfort" and consist of five sub-indices :

-**Daytime Comfort Index (DCI)**,
- **Daily Comfort Index (CIA)**,
- **Precipitation (P)**,
- **Sunshine (S)**,
- **Wind (W)**.

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ADAPTIVE CAPACITY (1)

Adaptive capacity can reflect the intrinsic qualities of a system that make it more or less capable of adapting (e.g. the cooperative relationships between species in an ecosystem, the presence of effective leaders and organizers in a community or the relative abundance of shaded parks in an urban environment), but can also reflect the abilities of an organization responsible for managing an ecosystem or leading a community to collect and analyze information, communicate, plan, and implement adaptation strategies that ultimately reduce vulnerability to climate change impacts.

Factors that could influence adaptive capacity:

- access and ability to process information
- resources to invest in adaptation
- flexibility of a system to change in response to climate stimuli
- willingness to change and adapt
- ability of species to migrate or for ecosystems to expand into new zones

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ADAPTIVE CAPACITY – examples of indicators (2)

Income indicators (e.g. GDP)
Education statistics
Availability (or lack) of data
Appropriate emergency response

Source: Climate-ADAPT Platform

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VULNERABILITY ASSESSMENT (1)

Findings (e.g. qualitative and/or quantitative) about exposure, sensitivity (potential impacts) and adaptive capacity can be then combined in order to determine how and where a community is **vulnerable to climate change.**

QUALITATIVE ASSESSMENT

Qualitative assessment of vulnerability aim at gathering information that produce results that can not be easily measured or translated into numbers.

QUANTITATIVE ASSESSMENT

Quantitative assessment express their results in numbers, by answering questions like "*How many?*" or "*How much?*" or "*How often?*"

QUALITATIVE ASSESSMENT (descriptive)
Stakeholders involvement, meeting, interviews, questionnaire

QUANTITATIVE ASSESSMENT
indicators, indices, maps

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VULNERABILITY ASSESSMENT – example of qualitative assessment (2)

POTENTIAL IMPACT	EXPOSURE	SENSITIVITY	ADAPTIVE CAPACITY	V
Change in seasonal tourist flow	Medium	S4 - Yes. Functionality will get worse	AC4 - Yes, but will require some slight costs ($$) and staff intervention	V3
Damage in tourist infrastructures due to more extreme events	Medium	S2 - Unlikely. Functionality will likely stay the same	AC3 - Maybe. Will require some costs ($$$) and staff intervention	V2
Water shortages	Medium-high	S4 - Yes. Functionality will get worse	AC2 - No. Will require significant costs ($$$$) and staff intervention	V4

SENSITIVITY AND ADAPTIVE CAPACITY MATRIX

	S1	S2	S3	S4	S5
AC1	V2	V2	V4	V5	V5
AC2	V2	V2	V3	V4	V5
AC3	V2	V2	V3	V4	V4
AC4	V1	V2	V2	V3	V3
AC5	V1	V1	V2	V3	V3

V1: Low Vulnerability
V2: Medium-Low vulnerability
V3: Medium Vulnerability
V4: Medium-High Vulnerability
V5: High Vulnerability

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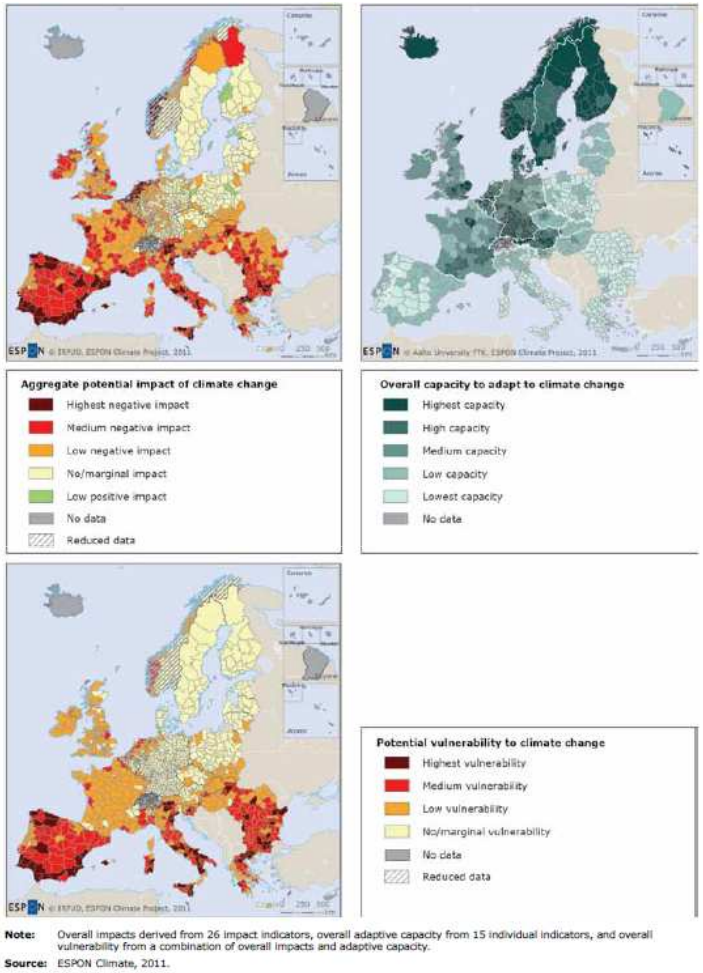
VULNERABILITY ASSESSMENT – example of quantitative assessment (3)



Note: Overall impacts derived from 26 impact indicators, overall adaptive capacity from 15 individual indicators, and overall vulnerability from a combination of overall impacts and adaptive capacity.

Source: ESPON Climate, 2011.

Source: ESPON Climate Project

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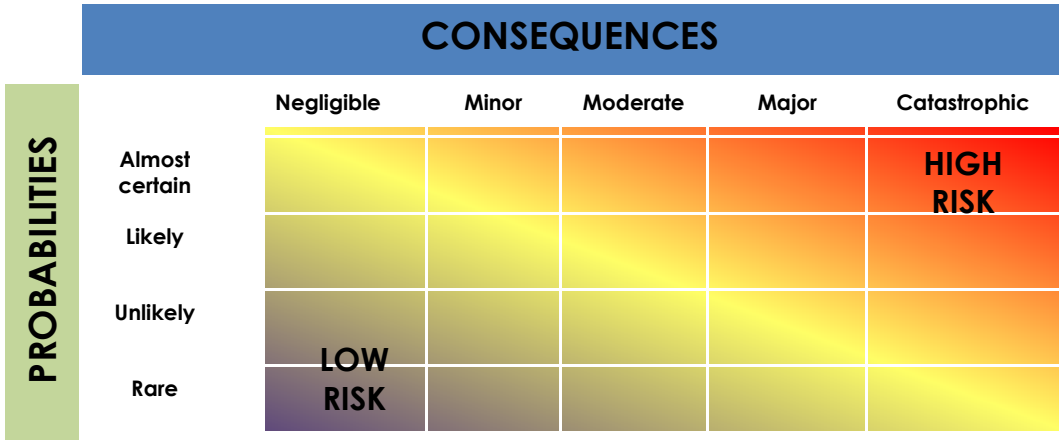
RISK – DEFINITION

The potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Risk results from the interaction of vulnerability and hazard.



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RISK ASSESSMENT (1)

QUALITATIVE ASSESSMENT

Qualitative assessment rely on descriptive information and expert knowledge and evaluation ranking into qualitative classes such as “high”, “medium” and “low”.

QUANTITATIVE ASSESSMENT

Where technical expertise and appropriate models are available, quantitative assessment of risk may be performed.

QUALITATIVE ASSESSMENT (descriptive)
Stakeholders involvement, meeting, interviews, questionnaire

QUANTITATIVE ASSESSMENT
indicators, indices, maps

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RISK ASSESSMENT - example of qualitative assessment (2)

SECTOR	Current and expected stresses	Projected climate change impacts to systems	RISK ANALYSIS		
			Consequence of impact – high, medium, low	Probability of impact – high, medium, low, unknown	Estimated risk to systems – high, medium, low
Water resources	Summer drought	More drought, summer water stress likely due to lower winter snowpack, and warmer, drier summers. Population growth will increase this problem.	**HIGH** – threat to public safety, loss in consumer confidence, lost revenue.	**HIGH** – already a concern and warmer, drier conditions expected	**HIGH**

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RISK ASSESSMENT - example of quantitative assessment (3)

COASTAL RISK ASSESSMENT: THE ANCONA CASE STUDY

LIFE ACT Project

(presentation of Mrs Chiara Vicini later on)

The analysis adopts an indicator based approach for a Coastal Risk Analysis

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RISK & VULNERABILITY

The combination of **VULNERABILITY** and **RISK** assessment is fundamental for the **prioritisation of impacts** on which the LAP will be primarily focused**.** Based on this prioritisation, actions and strategies will be therefore defined.

The lack of information and data could affect vulnerability and risk assessment and, consequently, priorities to be taken into account. For example, it could be decided that sectors that are highly vulnerable but lack of sufficient information on risk **SHOULD** be included among priorities.

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FINAL KEY MESSAGES

• **Gaps in the areas of research, data and technical skills** need to be addressed in order to improve our capacity to better assess climate change vulnerability and risk based on quantitative approaches.

• **Qualitative assessments** are not necessarily less accurate and less legitimate than quantitative ones: these methods produce results that are not always easy to compare or even to check for accuracy, but they are reliable and answer some questions that quantitative measure cannot (e.g. how and why) by involving the key stakeholders.

• **Quantitative assessments** are often requested by policy makers as they are considered more reliable than qualitative ones: they can be compared, leave less room for misinterpretations and are easy to communicate.

• **Qualitative and quantitative assessments** are complementary and when it is possible it is recommended to use both approaches for better results.

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THANKS A LOT!

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