A SYSTEMATIC APPROACH FOR ASSESSING CLIMATE RESILIENT BUILDINGS AND CITIES

Constantinos A. Balaras, PhD FASHRAE
Research Director IERSD-NOA
costas@noa.gr

ReMED | Interreg Euro-MED
Co-funded by the European Union

Acknowledgments

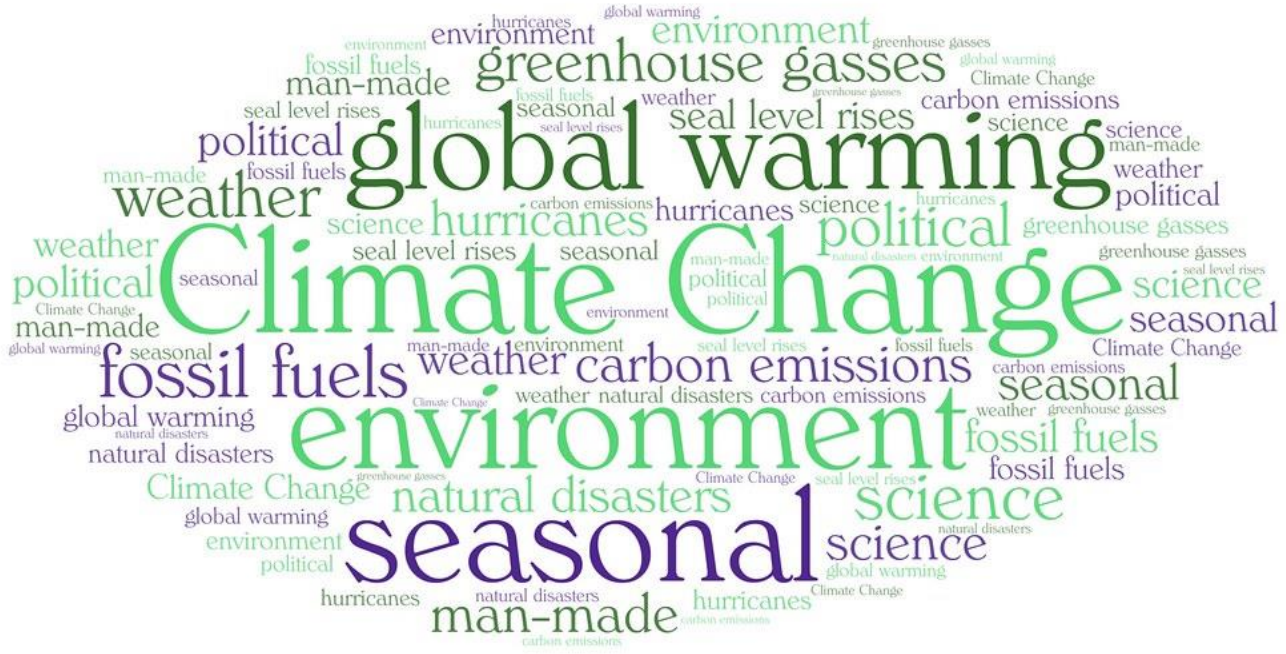
The work is performed in the frame of an INTERREG Euro-MED project **ReMED** - Towards Climate Resilient Mediterranean Cities (https://remed.interreg-euro-med.eu) in a collaborative effort of **9 partners** from **5 EU countries**, including *University of Malta* (***Malta***) as Lead Partner, *Ministry for Gozo* (***Malta***), *iiSBE ITALIA R&D* (***Italy***), *Municipality of Genova* (***Italy***), *National Observatory of Athens* (***Greece***), *Municipality of Crikvenica* (***Croatia***), *Foundation CIEDES* (***Spain***), *Municipality of Malaga* (***Spain***), *Municipality of Fylis* (***Greece***).

The thematic project (**1/2024 – 9/2026**) is Promoting Green Living Areas, in the Interreg Euro-MED Programme Priority 2: Greener MED for promoting climate change adaptation and disaster risk prevention, resilience, taking into account eco-system based approaches.

Problem(s) …

There is growing scientific evidence that

Human activities** have been & are **impacting climate change** resulting to **long-term shifts** in **temperatures** & **weather patterns



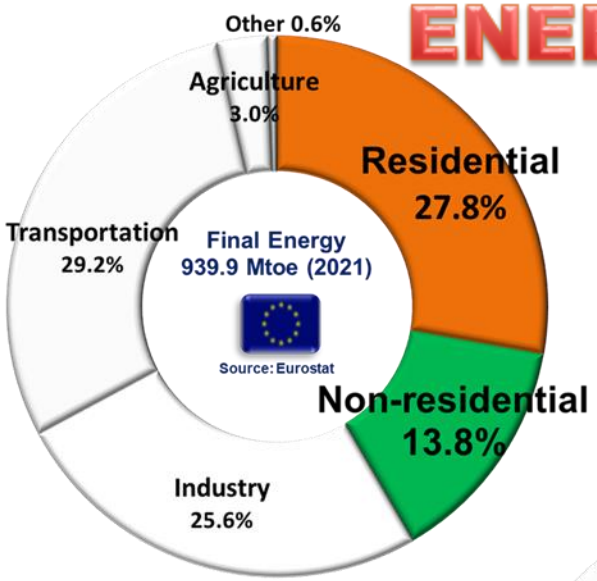
Ref: Field, C.B. et al., Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation, The Intergovernmental Panel on Climate Change (IPCC). https://www.ipcc.ch/report/managing-the-risks-of-extreme-events-and-disasters-to-advance-climate-change-adaptation

Buildings & Cities: Major Part of the Problem(s) …

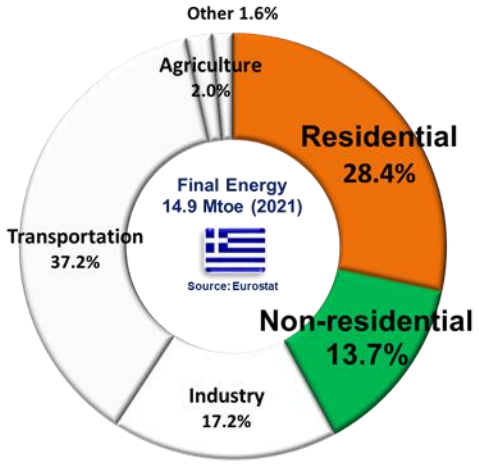
41.6%(EU) 42.1%(GR)

Final Energy Consumption

ENERGY



1 Mtoe = 41.868 GJ = 11,630 kWh

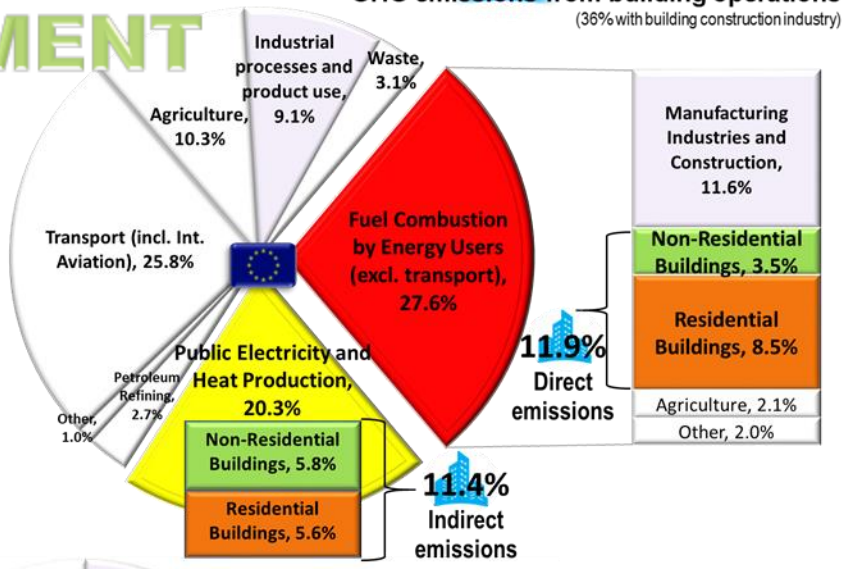


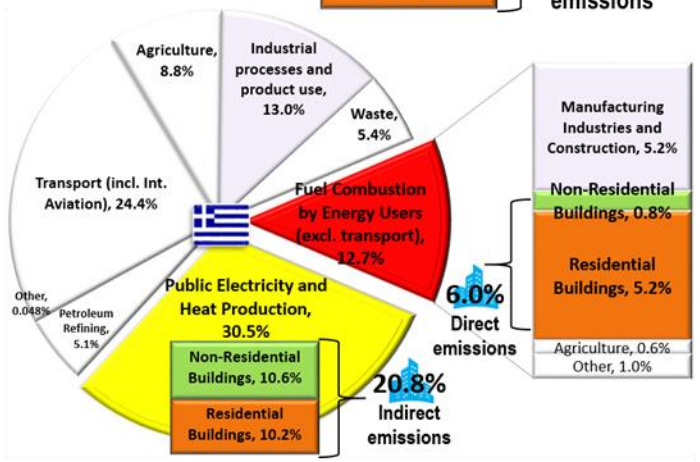
23%(EU) 27%(GR)

GHG emissions from building operations

(36% with building construction industry)

ENVIRONMENT

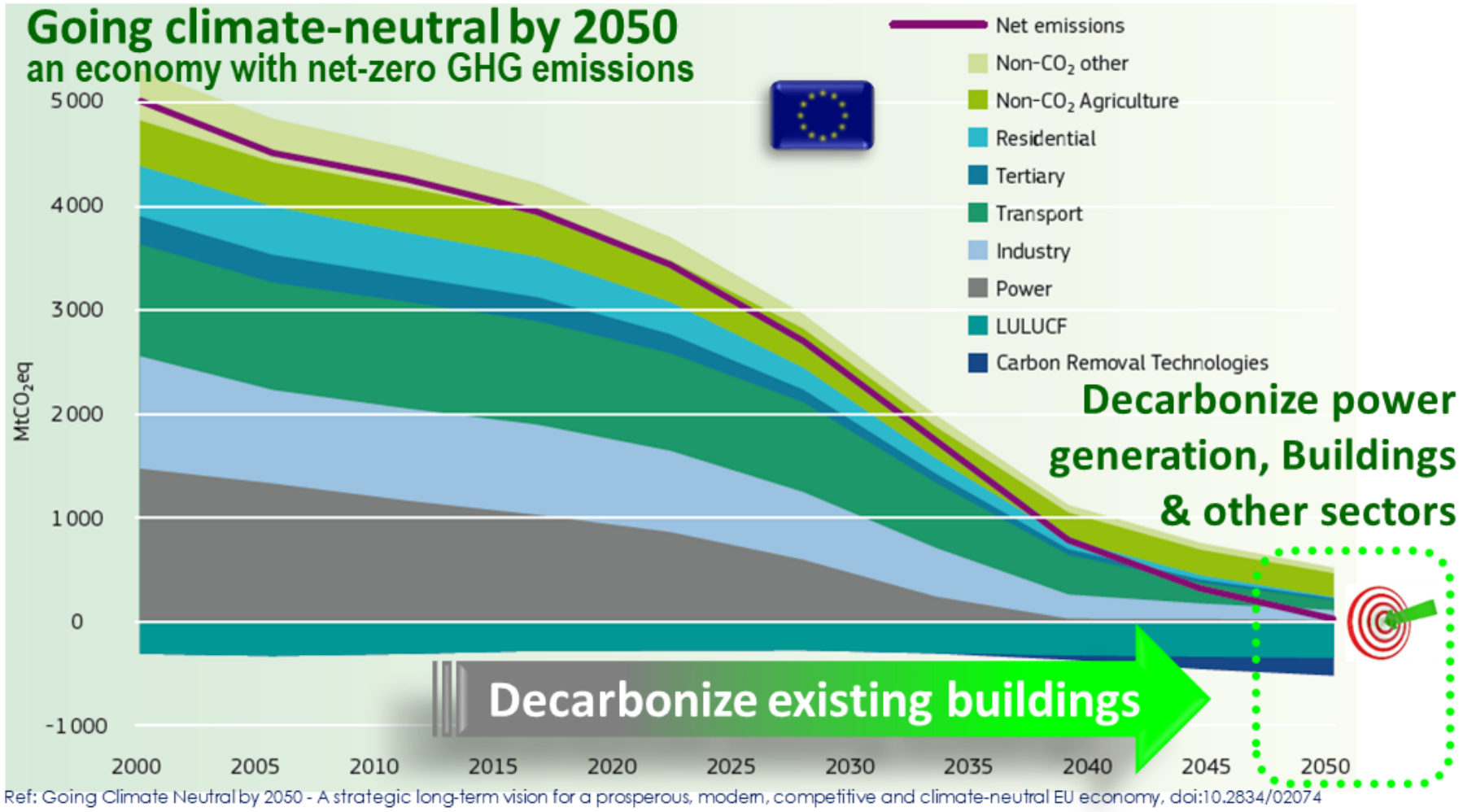




Source: EU Country datasheets, July 2021

Buildings & Cities: Major Part of the Solution …

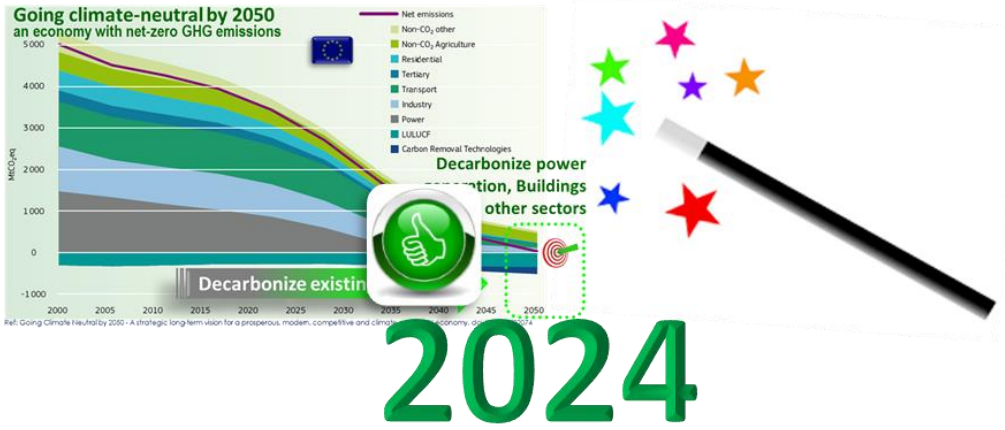
MITIGATION



Ref: Going Climate Neutral by 2050 - A strategic long-term vision for a prosperous, modern, competitive and climate-neutral EU economy, doi:10.2834/02074

Buildings & Cities are at Risk from Impacts of Climate Crisis (a long-term problem-crisis)

MITIGATION ... *ADAPTATION to the impacts that we can expect now & in the future*



Long lifetimes of GHG in the atmosphere ranging from a few to several decades, will have near & long term implications

DISASTERS: *severe **alterations in the normal functioning** of a community **due to hazardous physical events** as a result of natural climate variability and anthropogenic climate change.*

HAZARDS: *potential occurrence of climate-related physical events or trends that may cause damage and loss, e.g. the **frequency** and/or **magnitude** of **floods**.*

EXPOSURE: *presence of **people**, **infrastructure**, or other **assets** in places that could be **adversely affected by physical events** and are **subject to** potential future **harm**, **loss**, or **damage**.*

VULNERABILITY: *natural tendency or predisposition to **be adversely affected** as a **result** of **their capacity** to **anticipate**, **cope** with, **resist**, and **recover from adverse effects** of physical events.*

Natural Hazards

INTENSE
EXTREME More FREQUENT

Natural hazards **due to climate change** are among the main challenges that **urban systems are facing throughout the world**, including:

- Heatwaves
- Extreme temps
- Droughts
- Flooding
- Forest fires
- Sea-level rise
- Saline intrusion

etc

- Temperature
- Wind speed
- Precipitation patterns
- Snow storms

etc

Urban Resilience

The **capacity of cities to function** regardless of the encountered **climatic stresses** or **shocks**, enabling **people** (particularly the poor and vulnerable) to **survive & thrive safely**.

- *Ability of urban systems to **anticipate**, **prepare** for and **respond** to climate-related disruptions, while **maintaining essential functions** & **recovering** swiftly.*

How do we decide?  How do we assess?

- *Encompass a **multifaceted approach** that includes **enhancing physical infrastructure**, fostering **social cohesion**, and promoting **economic stability**.*

Building Resilience – The first step

Withstand impacts of **extreme natural events**, maintain sufficient **services through & after** the events, **maintain critical MEP services** & **structural** integrity.

- *The ability of a building to **maintain required functionality** during & after **extreme weather** and **extraordinary events**.*

How do we decide?  How do we assess?

- ✓ ***High performance buildings** & **sustainability contribute to resilience** of energy grids to withstand disruptions.*

  ***Lower building demand** for HVAC & lighting, increase share of **on-site renewables**, higher **on-site energy storage**, higher equipment **efficiency**, automatic **controls** & **demand response** with smart technologies, building-integrated **micro-grids**, etc.*

Building Resilience

(7.6.3). A new long-run marginal emission rates (LRMER) jurisdictional option is added with the calculation guidelines and tables in Normative Appendix D.

f. ***Indoor Environmental Quality:*** *Soil-gas control requirements are improved to reflect current industry practices that incorporate ANSI/AARST mandated soil-gas control measures in new building construction projects. This adds new requirements associated with soil-gas testing and mitigation standards for multifamily buildings. The resilience of a building is improved with the ability to adjust ventilation quickly and easily in response to air-quality-related emergency conditions. This requirement is for a control system that will provide a centralized method of either shutting down, minimizing, or maximizing the ventilation supplied to a building in response to conditions such as nearby wildfires or chemical spills (shutdown) or a pandemic (maximize). MERV 13 filters are now required in outdoor airstreams for all buildings located in nonattainment areas.*

g. ***Materials and Resources:*** *Prescriptive and performance paths are eliminated and are now alternatives under "Material Selection." A consideration for reusing materials is added to Section 9.3. Standard*

Moving Forward – Need Method/Tool

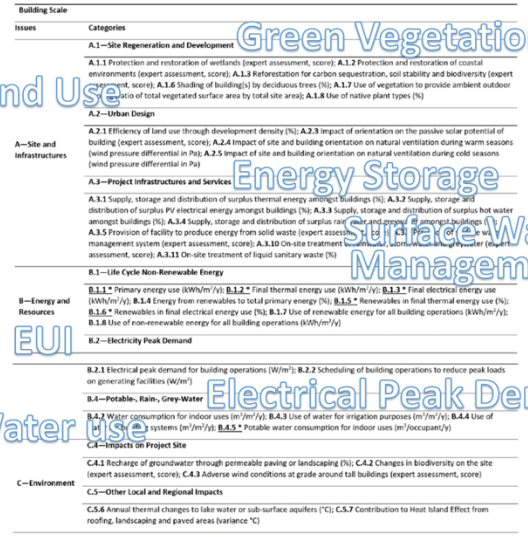
- Develop innovative **methods** & open access **tools** to raise the capacity of public authorities in **developing**, **implementing** and **monitoring** **adaptation measures** at building and urban scale

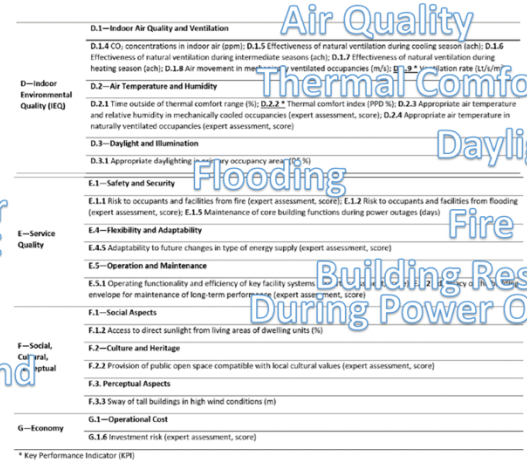
Sustainability Assessment Method-Tool

Assessment systems & indicators in EU to assess the risk & vulnerability to climate change at urban scale

National methods-tools-indicators

Sustainability Indicators that Support Building Resilience



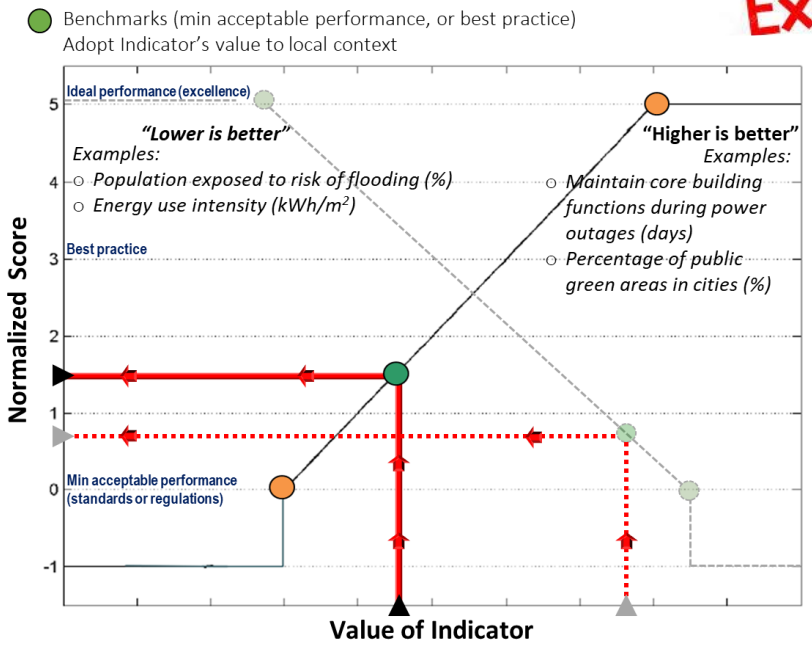


Existing Knowledge

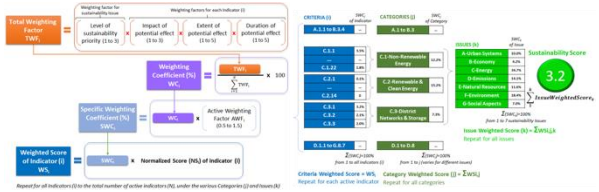
Sustainability Assessment Method-Tool

Benchmarking & Normalizing

- **Handle diversity of indicators**
  (e.g. different units & orders of magnitude)
- **Adapt to local conditions**
  (e.g. climate, building practiced, standards, advancement)



Weighting & Scoring



$$HV^{W_{HV}} \times EV^{W_{EV}} \times VV^{W_V}$$

- **HAZARD Value** = 0.8
- **EXPOSURE Value** = 0.9
- **VULNERABILITY Value** = 0.61

W_{HV} weight of HV → 0.25
W_{EV} weight of EV → 0.25
W_V weight of VV → 0.50

RISK LEVEL = **0.72**

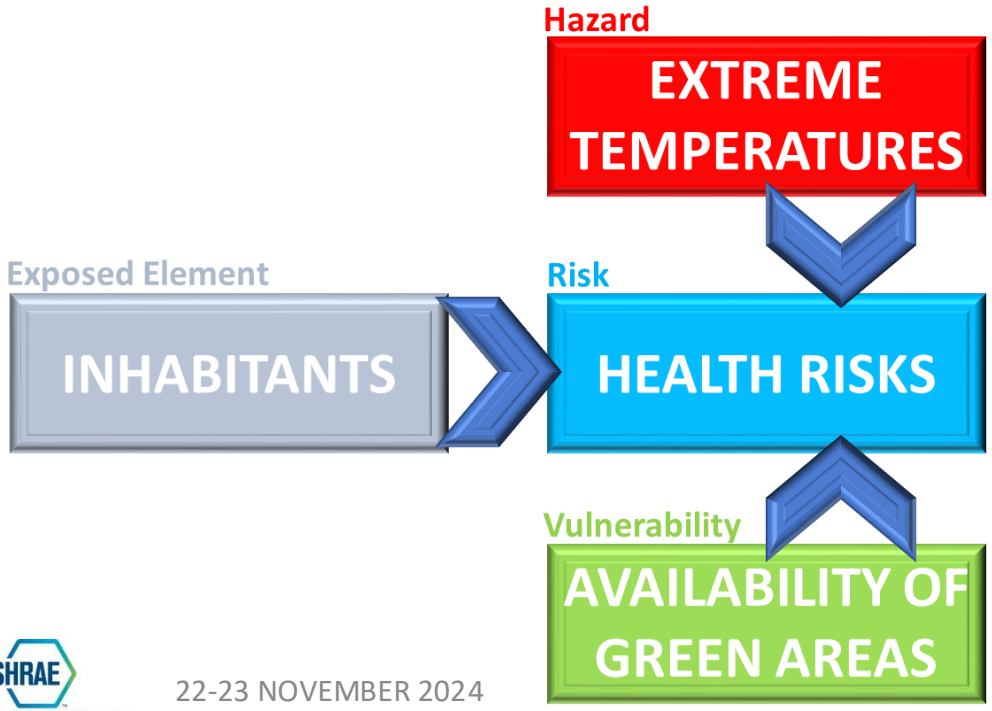
(rather negative)

Risk Assessment

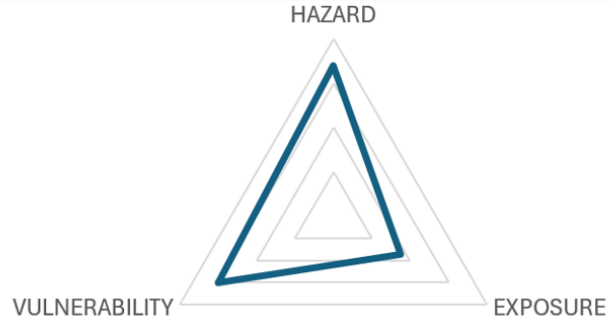
Adapt indicators to consider

- **HAZARD:** *Extreme Hot Temperatures*
- **EXPOSURE:** *Inhabitants*
- **VULNERABILITY:** *Availability of green areas*

to calculate the RISK: *on health of inhabitants*



HAZARD	EXTREME HOT TEMPERATURES	
RISK CATEGORY	RISK FOR INHABITANTS' HEALTH	
Risk Components	Value	Weight
Hazard	0.80	0,25
Exposure	0,90	0,25
Vulnerability	0,61	0,50
CATEGORY RISK LEVEL	RATHER NEGATIVE 0,72	

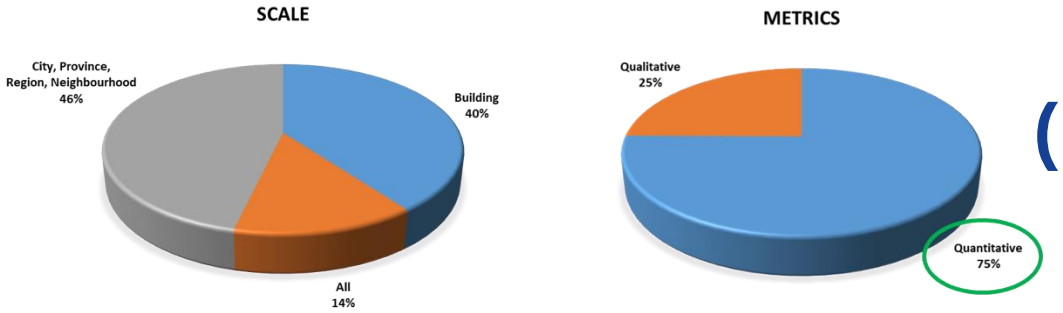


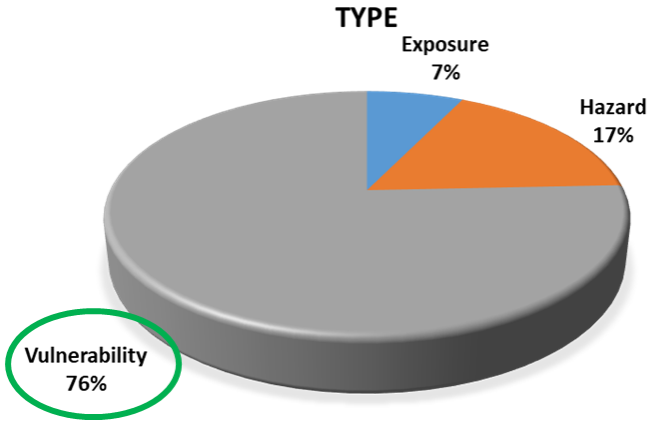
Existing Knowledge

Assessment systems & indicators in EU to assess the risk & vulnerability to climate change at urban scale

National methods-tools-indicators

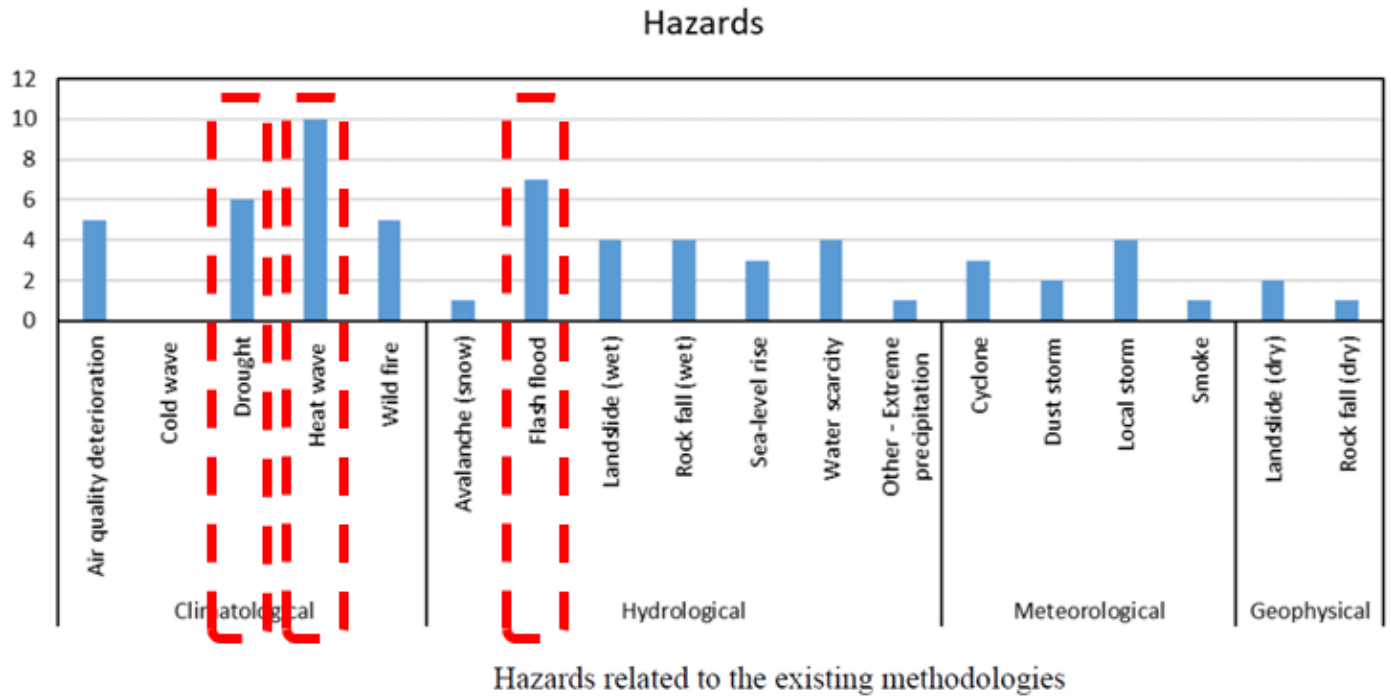
(181) Indicators





Most frequent hazards from existing methodologies:

- Heat waves
- Flash floods
- Droughts

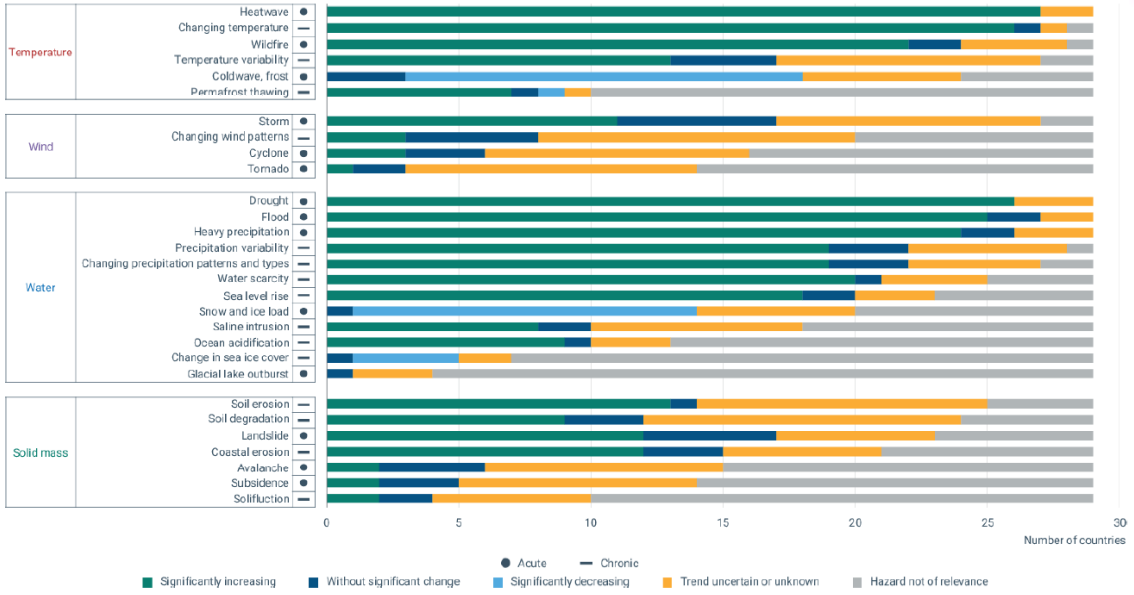


Hazards related to the existing methodologies

National Adaptation Actions

The EU Regulation 2018/1999 on the Governance of the Energy Union and Climate Action helps EU MS **organize national adaptation actions** in **support** of **national energy** & **climate plans**.

Ref: Regulation (EU) 2018/1999 http://data.europa.eu/eli/reg/2018/1999/oj



EU reported key future hazards

Ref: EEA. Is Europe on track towards climate resilience?

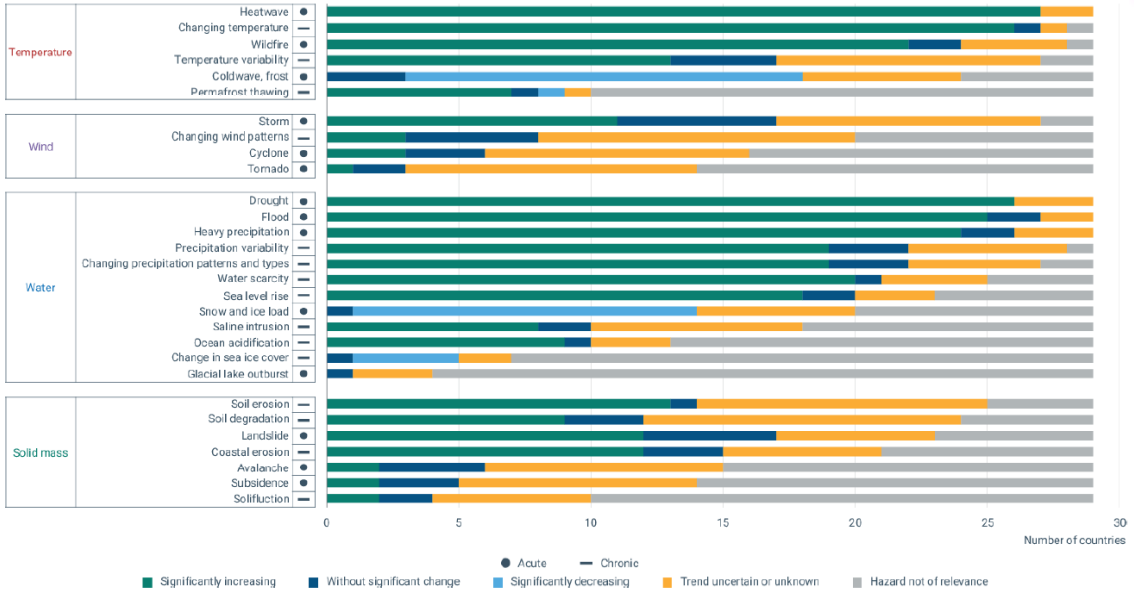
What are the most important hazards ?

- **Changing temperature**: *a chronic hazard (slow onset events) with the most significant change in the future*
- **Heatwaves**: *an acute chronic hazard (extreme weather events)*
- **Precipitation** and/or **hydrological variability**
- **Drought**

National Adaptation Actions

The EU Regulation 2018/1999 on the Governance of the Energy Union and Climate Action helps EU MS **organize national adaptation actions** in **support** of **national energy** & **climate plans**.

Ref: Regulation (EU) 2018/1999 http://data.europa.eu/eli/reg/2018/1999/oj



EU reported key future hazards

Ref: EEA. Is Europe on track towards climate resilience?

What does the future look like?

- Most EU MS **expect to increase** in frequency and/or intensity of most **temperature-** and **water-related hazards**, e.g.
  - Heat waves,
  - Wildfires,
  - Droughts,
  - Heavy precipitation,
  - Flooding,
  - Water scarcity

Where we are …

- Define **indicators** for Vulnerability Criteria & Exposure; **Benchmarks**
- Integrate in open access **Tools** for municipalities & professionals

Where we are going …

- *Perform four **Case Studies – Pilots; Validate** method-tools*
- Prepare **Training Material**
- Develop overarching **Decision Support Framework** to help cities:
  - ✓ **Understand** & **Assess** the level of **climate risk** at urban and building scale
  - ✓ **Design** optimal climate adaptation measures in relation to **local conditions**
  - ✓ **Implement** climate **adaptation measures** through suitable policy instruments
  - ✓ **Monitor** & **Evaluate** the results of adaptation measures over time

Project (1/2024 – 9/2026)

Bibliography

- **ReMED** - Develop Building & City open access **Tools** to support municipalities & professionals assess and understand the level of climate risk at urban and building scale. https://remed.interreg-euro-med.eu/
- ***SMC*** *- Sustainable Med Cities - Enhance the capacity of public administration in delivering, implementing and monitoring efficient measures, plans and strategies to improve the sustainability of cities, neighborhoods and buildings. https://www.enicbcmed.eu/projects/sustainable-med-cities*
- ***CESBA MED*** *Sustainable Mediterranean Cities - A common sustainability assessment framework at urban scale and an innovative decision making process to support the development of energy efficiency plans for public buildings in the context of their surrounding neighborhoods. https://cesba-med.interreg-med.eu/*

  CESBA MED Deliverables (in Greek) https://groupenergyconservation.com/cesba-med-deliverables-in-greek/
- ***EEA*** *– European Environment Agency, Climate change impacts, risks and adaptation. https://www.eea.europa.eu/en/topics/in-depth/climate-change-impacts-risks-and-adaptation*

ASHRAE Hellenic Chapter

ΤΕΕ

ENERGY IN BUILDINGS

EMEA 2024

Europe, the Middle East & Africa

FRIDAY - SATURDAY

NOVEMBER 22-23, 2024

@ 9:00-18:00

@ ATHENS GREECE

THANK YOU! Q & A

Constantinos A. Balaras

costas@noa.gr

GOLD SPONSOR

FUJITSU

AIRSTAGE

SPONSORS

AIRTECHNIC www.airtechnic.gr · ARISTON · AEROGRAMMI S.A. · BCT GROUP · Carrier · Clima Quest · GREE · CONTEC · DELPHIS CREATIVE CLIMATE · DIAMAR · STULZ · dimtech · ERGOTRAK · GEBERIT · IDATOR

interplast · KNAUF INSULATION · LG Business Solutions · Mechanical Solutions · AQUARK · menerga · Midea | MBT · ΟΜΙΛΟΣ ΤΟΥΡΝΙΚΙΩΤΗ · prihoda · systemair · TRANE · westnet · AUX · wilo · WOLF · zeb · KOKOTAΣ group · ΑΤΜ