CLIMATE CHANGE RESILIENCE FRAMEWORK FOR HEALTH SYSTEMS AND HOSPITALS

EU LIFE RESYSTAL Project

Training Program 1

2023

CLIMATE CHANGE RESILIENCE FRAMEWORK FOR HEALTH SYSTEMS AND HOSPITALS

1. Welcoming session & Agenda

Introduction

Content : The toolbox training program is an initiative designed by the LIFE RESYSTAL project technical partners, to **equip participants with a deep understanding of climate adaptation issues for hospital infrastructure** and guidance to effectively navigate the features and tools of the LIFE RESYSTAL project.

Objectives: This program lays the ground for the implementation of the methodologies and tools developed during the LIFE RESYSTAL project. The aim of this first training session is to test the methodologies and tools developed by the LIFE RESYSTAL project before they are finalized in the first half of 2024. A second training session in the use of the tools may be organized at the end of 2024.

Target participants: Technical and administrative staff of pilot hospitals / additional potential participants : medical staff.

9h00 - 9h15	**1. Welcoming session** Round table discussion Ice-breaker activity (on the theme of resilient hospital infrastructures)
9h15 - 10h00	**2. Introduction on climate adaptation challenges for healthcare facilities** Issues, risks and impacts for the healthcare sector and healthcare establishments
10h00 - 11h00	**3. General presentation of the LIFE RESYSTAL Toolbox** Overview of the LIFE RESYSTAL toolbox
11h00 - 11h15	**BREAK**
11h15 - 12h30	**4. Workshop 1: Testing the climate risk assessment Tool**
12h30 - 13h30	**LUNCH BREAK**

13h30 - 14h30

5. Review of current practices and introduction to the hospital structural adaptation inventory

Examples of strategies/solutions implemented in healthcare establishments (UCAM)

Presentation of ways of adapting (ACTERRA)

14h30 - 17h00

6. Workshop 2: Prioritization of actions and construction of adaptation pathways

Collaborative session on defining risk levels, adaptation objectives, adaptation measures and co-construction of adaptation pathways

17h00 - 17h30

7. Conclusion & Next steps

Introduction of the participants

Each person introduces themselves and answers one of the following questions:

1. Do you agree with the saying "there are no more seasons"?
2. Have you ever been personally affected by certain manifestations of climate change?
3. How complicated do you think it is to talk about adapting to climate change?
4. How is your hospital trying to adapt to climate change?
5. Do you believe that your hospital has the resources to adapt to climate change right now?

CLIMATE CHANGE RESILIENCE FRAMEWORK FOR HEALTH SYSTEMS AND HOSPITALS

2. Introduction on climate adaptation challenges for healthcare facilities

Evacuation of Brooklyn's Woodhull Hospital due to a storm

September 2023

A view of a flooded street as people walk with an umbrella in Williamsburg, New York, United States on September 29, 2023. (Photo by Fatih Aktas/Anadolu Agency vía Getty Images)

Spectrum News NY1
https://www.ny1.com › 2023/10/01

Woodhull Hospital patients evacuated after flooding

30 sept. 2023 — What You Need To Know. Flooding from Friday's **storm** damaged Woodhull **Hospital's** electrical system, forcing the **hospital** to use a backup ...

Shut down of the CH de Saint Affrique due to a flood

November 2014

A view of the hospital staff at the St-Affrique hospital cleaning up the flood damage. Photo by DDM

Midi Libre
https://www.midilibre.fr › Aveyron › Millau

Saint-Affrique/Inondations : les patients de l'hôpital évacués

Vingt-six ambulances ont été envoyées par l'ARS pour évacuer sur d'autres **hôpitaux** de l'Aveyron les malades les plus fragiles." Trente malades ...

Postponement of surgeries in the Milton Keynes Hospital due to a heatwave

July 2022

A spectator receives water from paramedics amid scorching temperatures at a cricket match. Chester-Le-Street, UK. Photo by Action Images

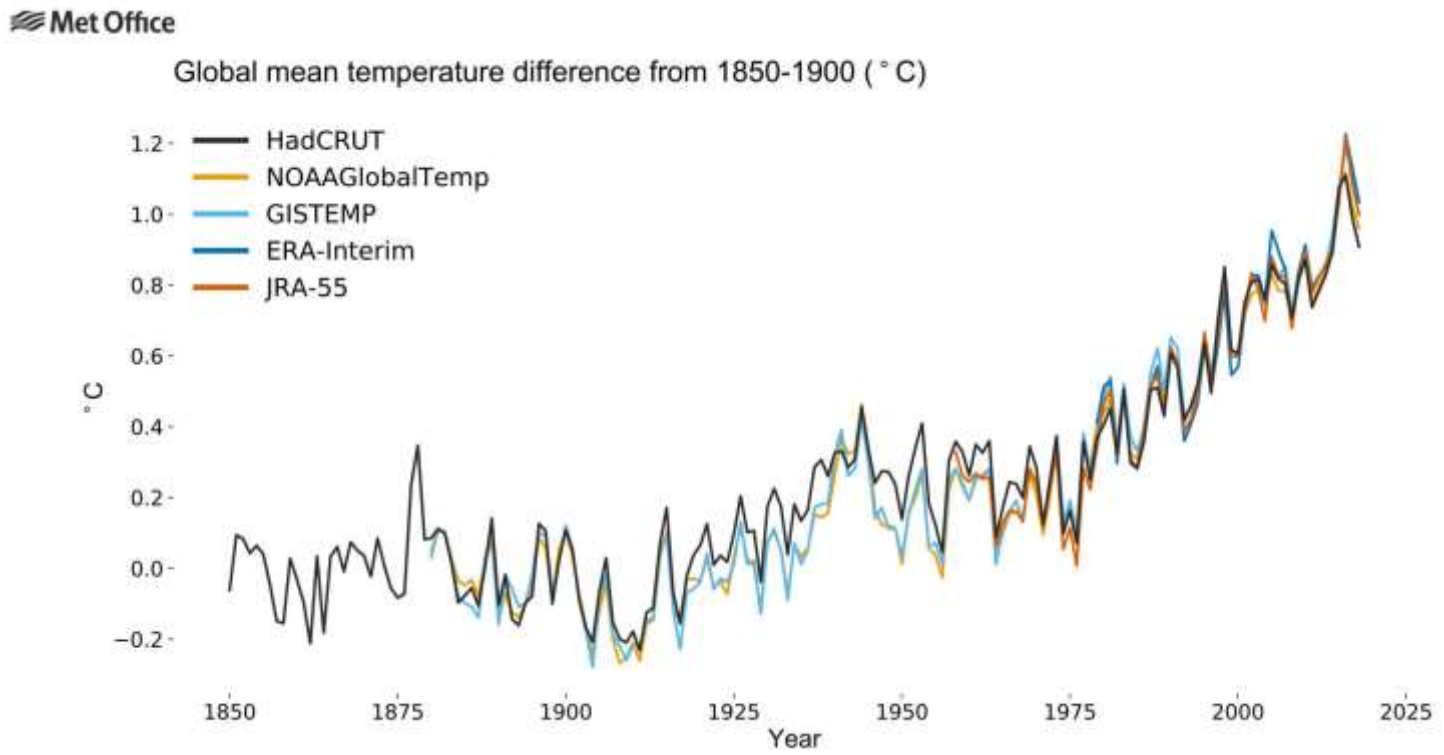
The Independent
https://www.independent.co.uk › h...

Hospital cancels surgeries due to 'significant heatwave ...

15 juil. 2022 — **Hospital** surgeries have made the decision to cancel surgeries **due** to "very high temperatures" after the Met Office issued its first red ...

Why ?

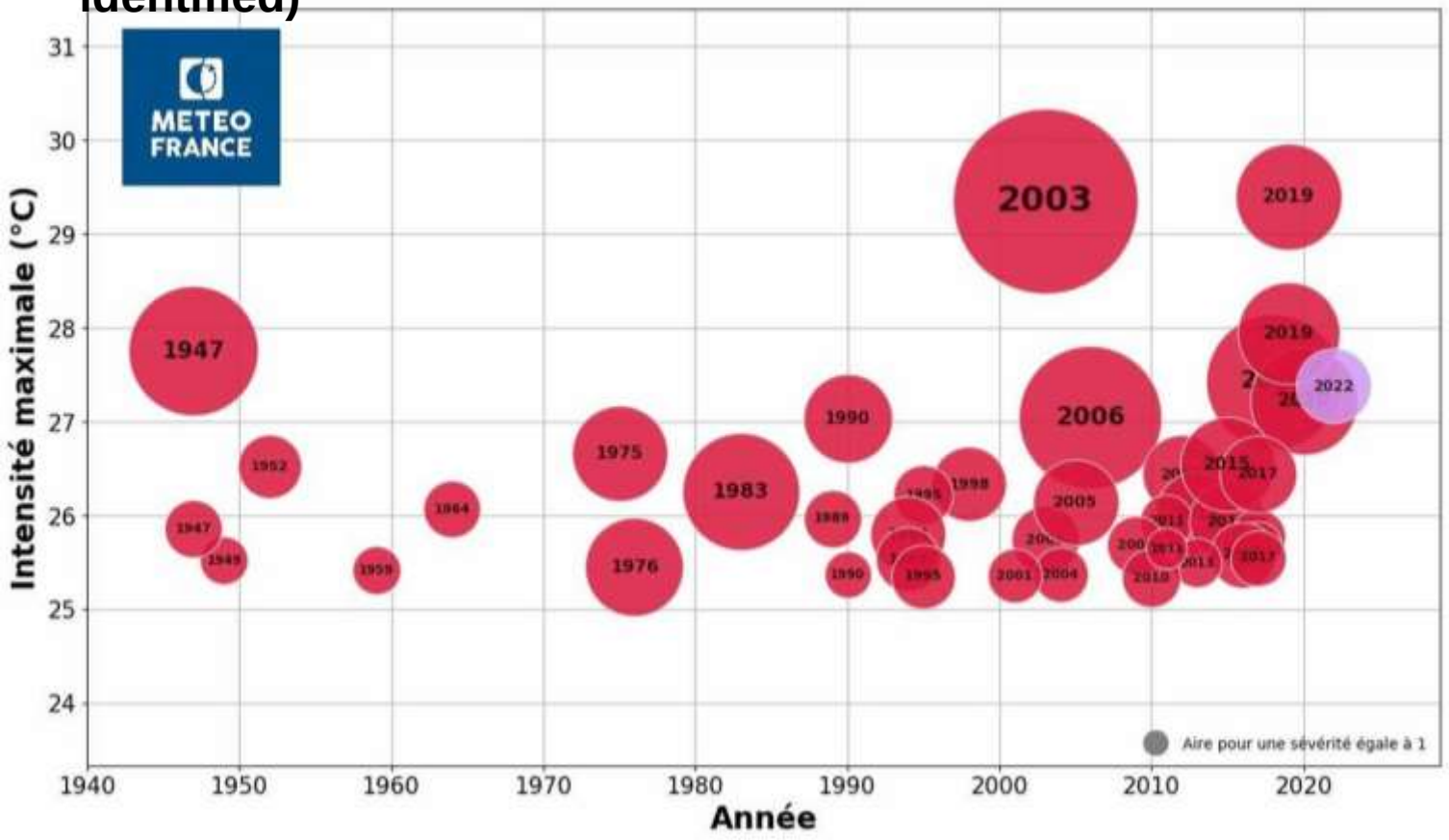
Rising temperatures …



Global mean temperatures difference from 1850-1900 (for the 5 main global climate data sources)

In France :

Heat waves* observed in France from 1944 to 2022 (44 episodes identified)



Over the summer periods from 2014 to 2022, in all French départements:

Nearly 33,000 deaths are attributable to heat between June 1 and September 15 each year, including 23,000 deaths of people aged 75 and over.

***Heatwaves if :**

- At least 3 days above 23,4 °C
- At least 1 time 25,3 °C

A few key notions

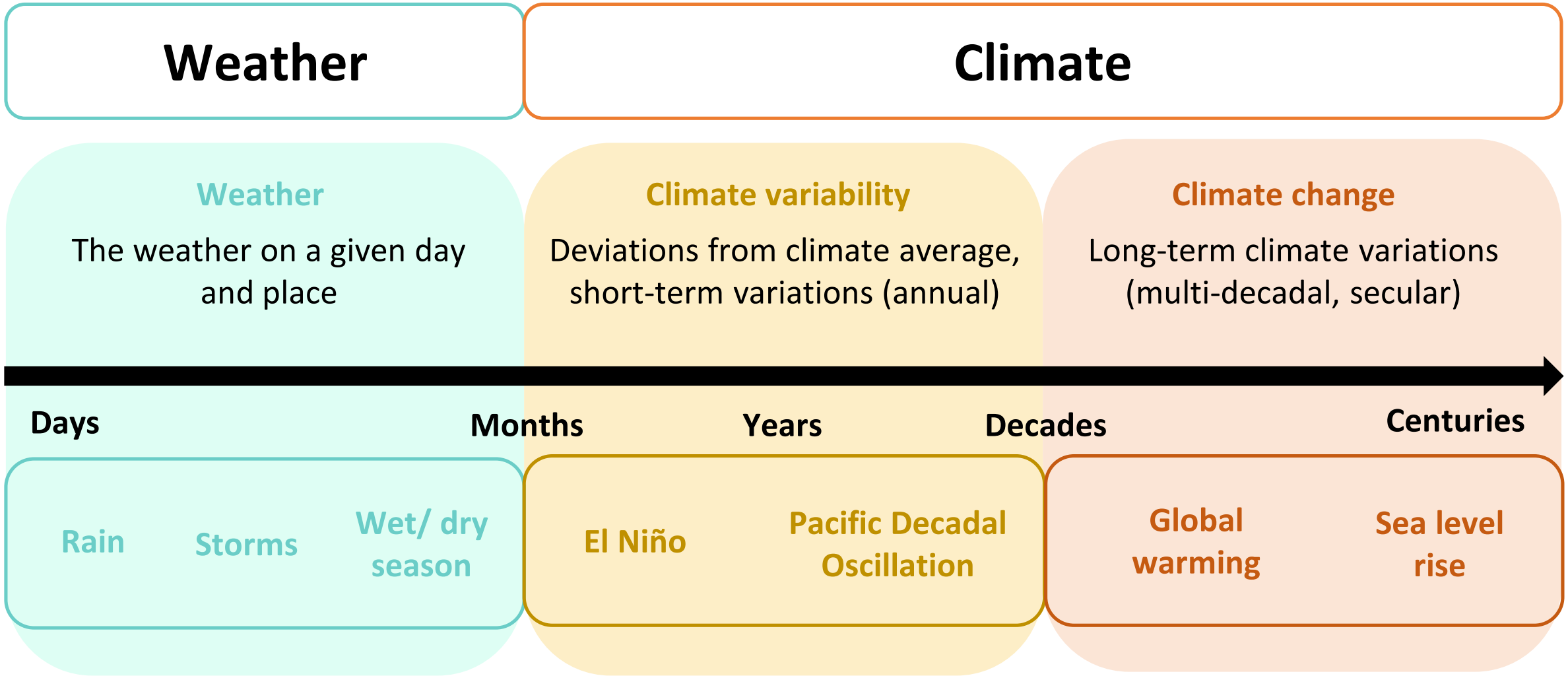
What's the difference between Weather and Climate?

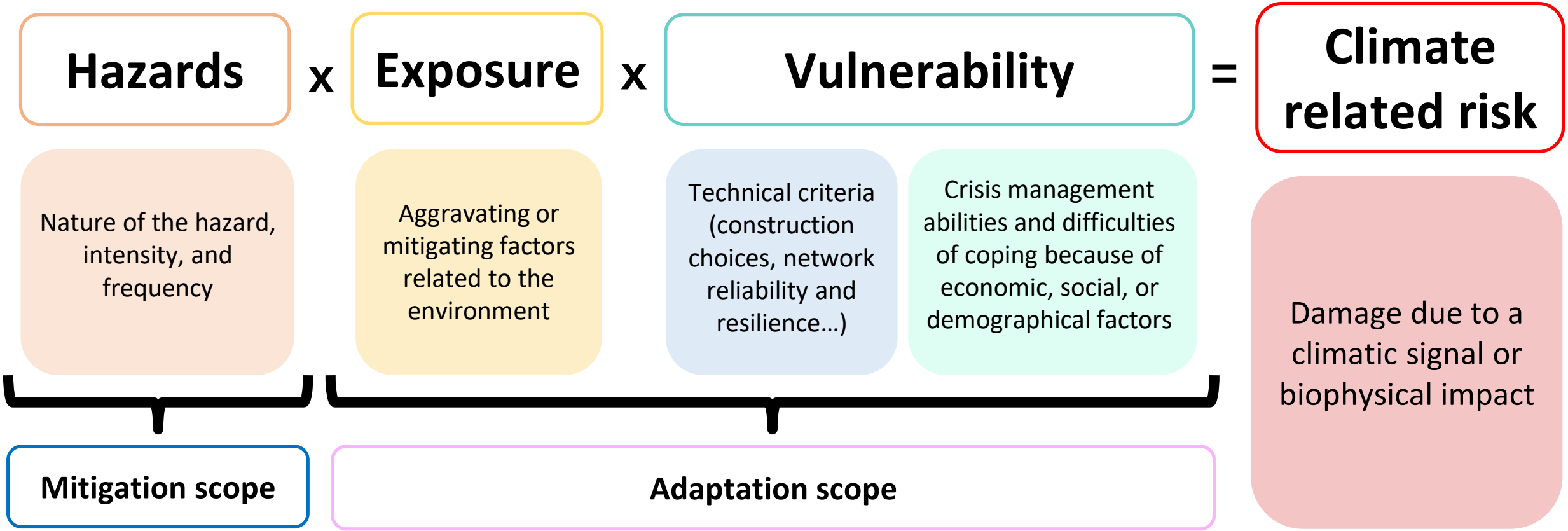
Weather

Happens on a **daily basis** in the atmosphere (air temperature, rain, snow, wind, etc.)

Climate

“Average” weather over a **long period of time** (decades, centuries, millennia)


Weather
Climate
Weather
The weather on a given day and place
Climate variability
Deviations from climate average, short-term variations (annual)
Climate change
Long-term climate variations (multi-decadal, secular)
Days
Months
Years
Decades
Centuries
Rain
Storms
Wet/ dry season
El Niño
Pacific Decadal Oscillation
Global warming
Sea level rise


Hazards
x
Exposure
x
Vulnerability
=
Climate related risk
Nature of the hazard, intensity, and frequency
Aggravating or mitigating factors related to the environment
Technical criteria (construction choices, network reliability and resilience…)
Crisis management abilities and difficulties of coping because of economic, social, or demographical factors
Damage due to a climatic signal or biophysical impact
Mitigation scope
Adaptation scope

Exposure

It’s the presence of people and resources in a place at risk

Vulnerability

It’s the predisposition to damage. It encompasses sensitivity and the inability to cope/adapt

Addressing climate change

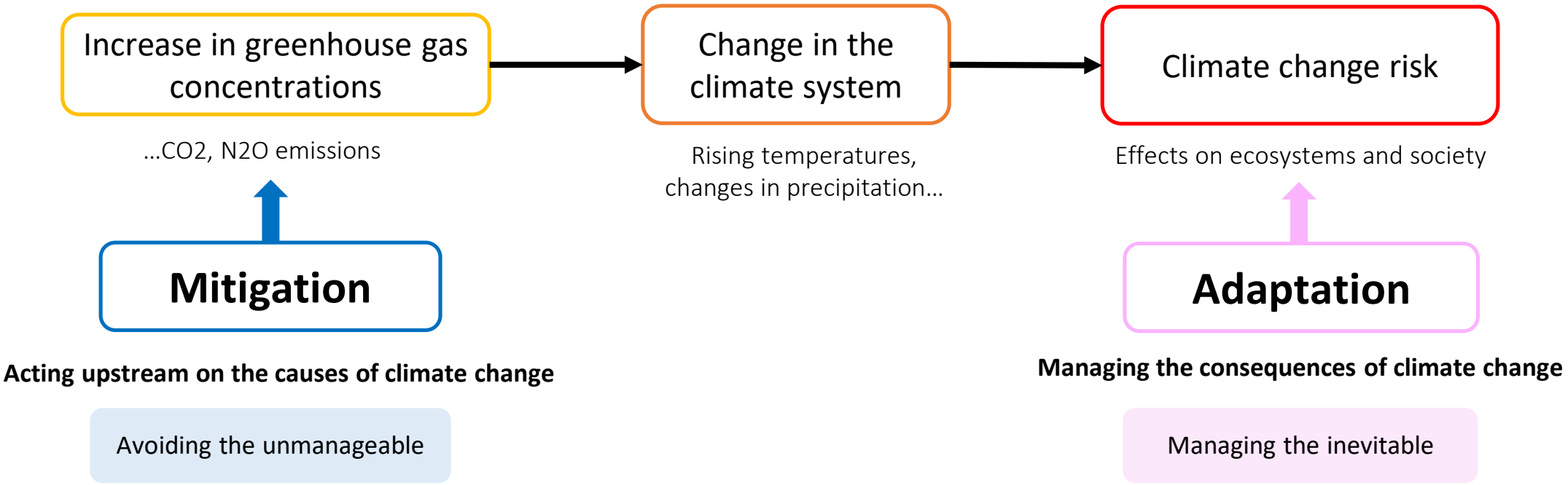
Mitigation

Reducing climate change.
It involves **reducing** the flow of heat-trapping **greenhouse gases** into the atmosphere

Adaptation

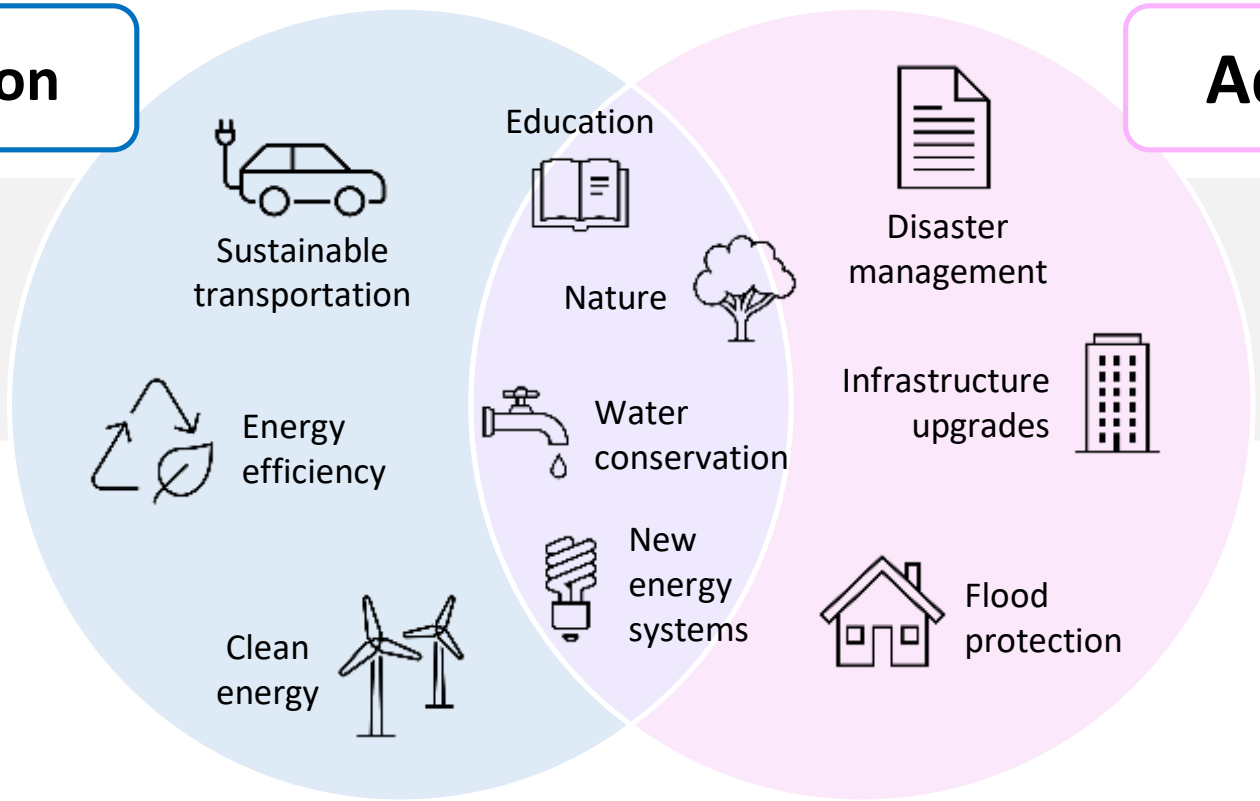
Adapting to life in a changing climate.
It involves **adjusting to actual or expected future climate**.

Distinct yet complementary strategies against climate change



Mitigation

Actions to reduce emissions that cause climate change



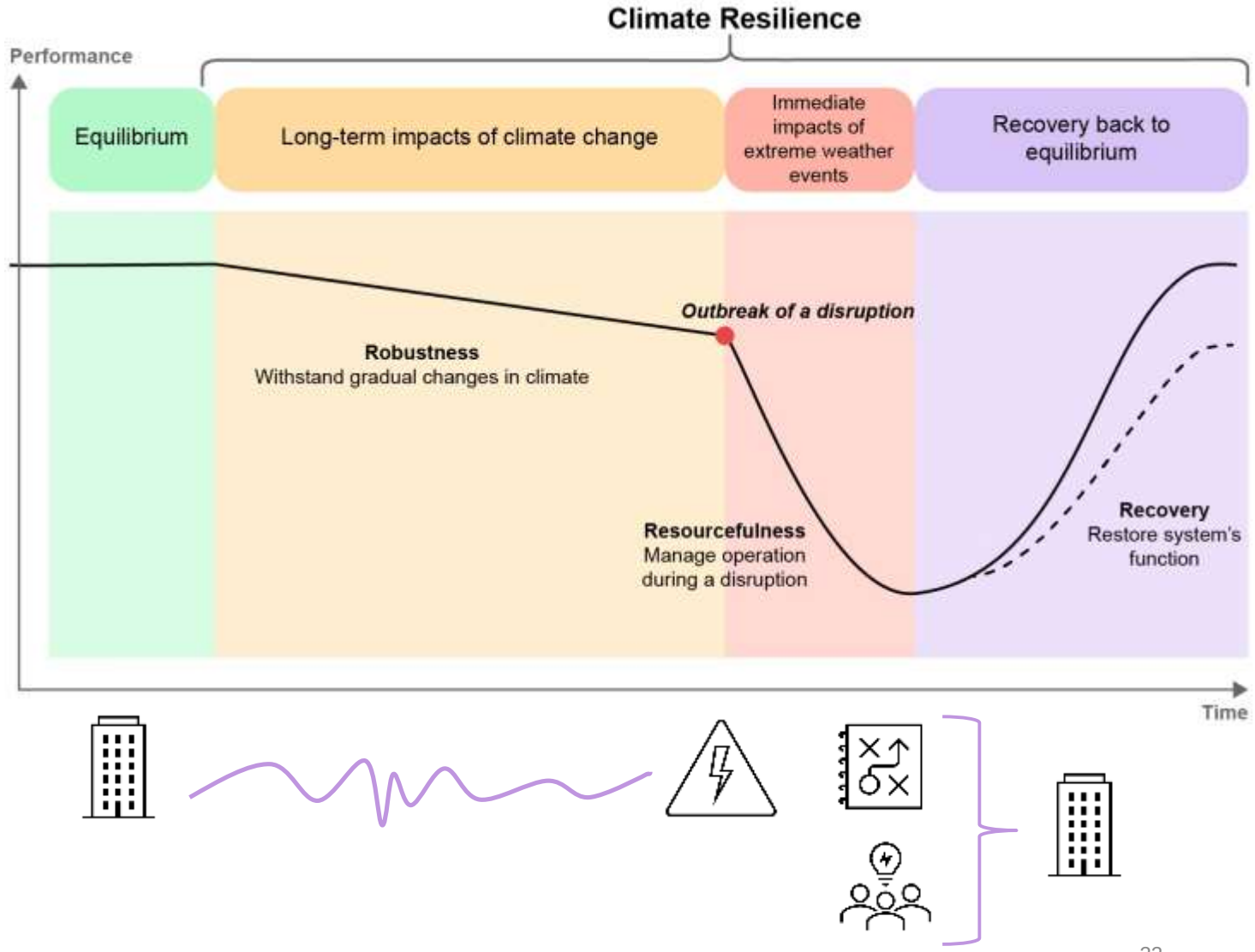
Adaptation

Actions to manage the risks of climate change impacts

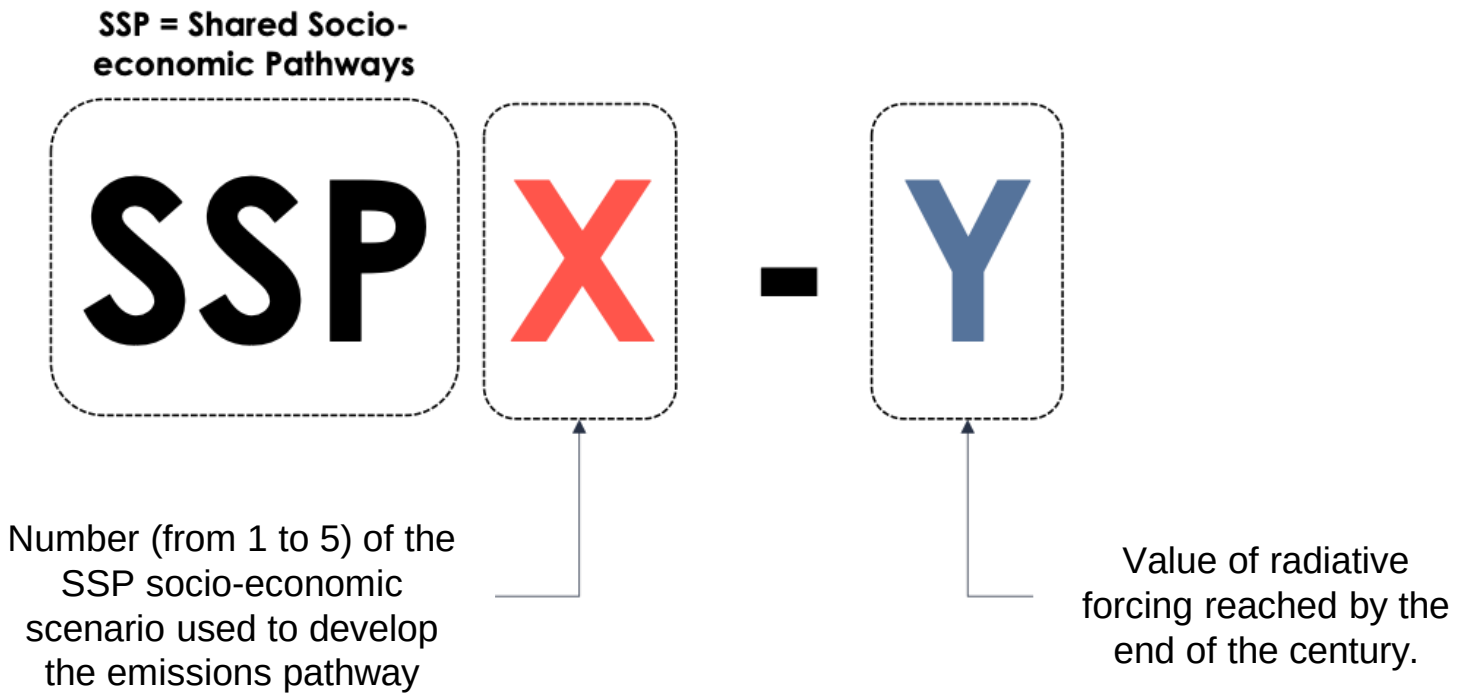
…Building Resilience

Resilience

It's the capacity to **prepare** for, **respond** to, **recover** from the impacts of hazardous climatic events while incurring minimal damage to societal wellbeing, the economy and the environment, and **adapt** to future distruptions.

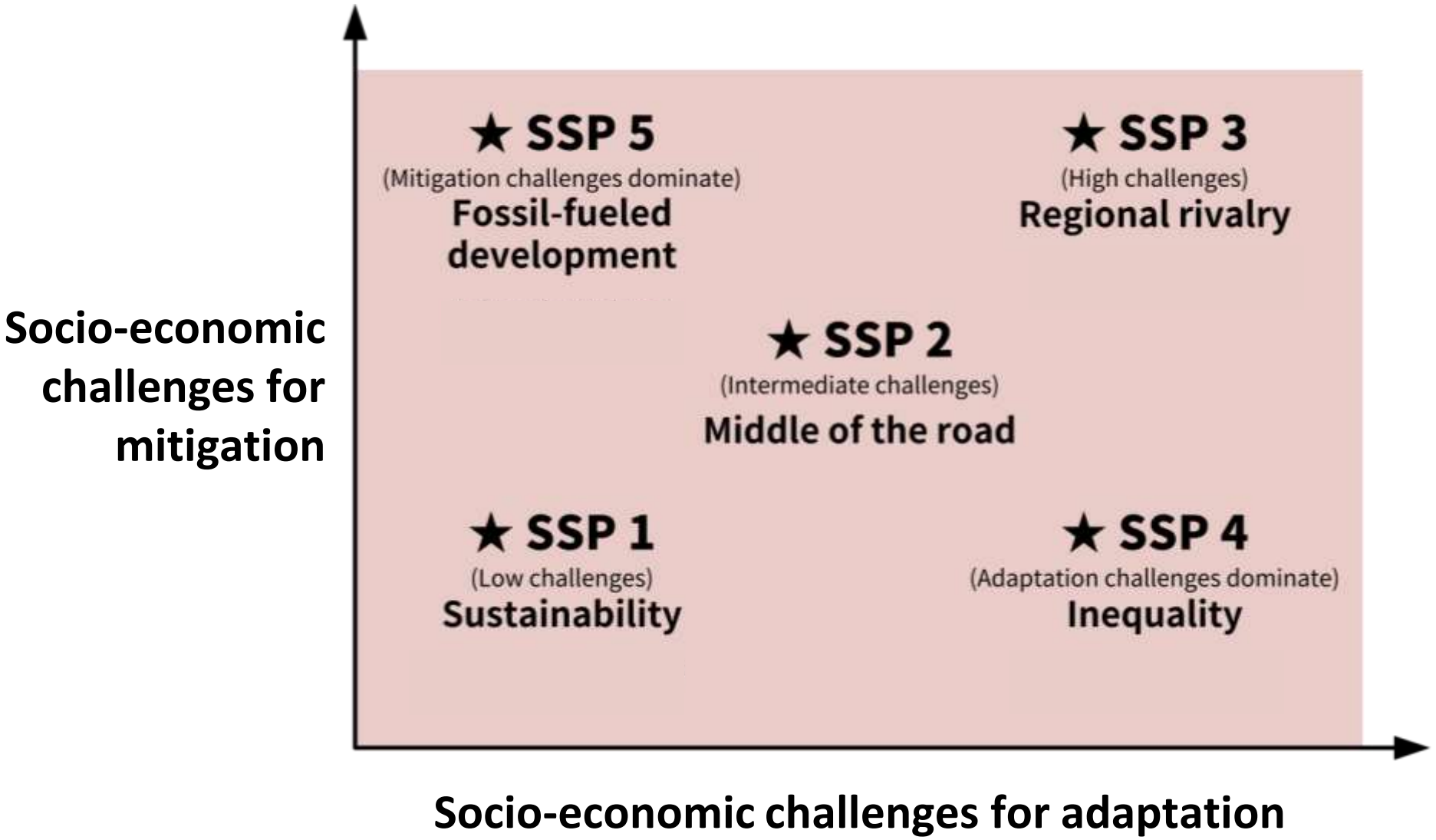


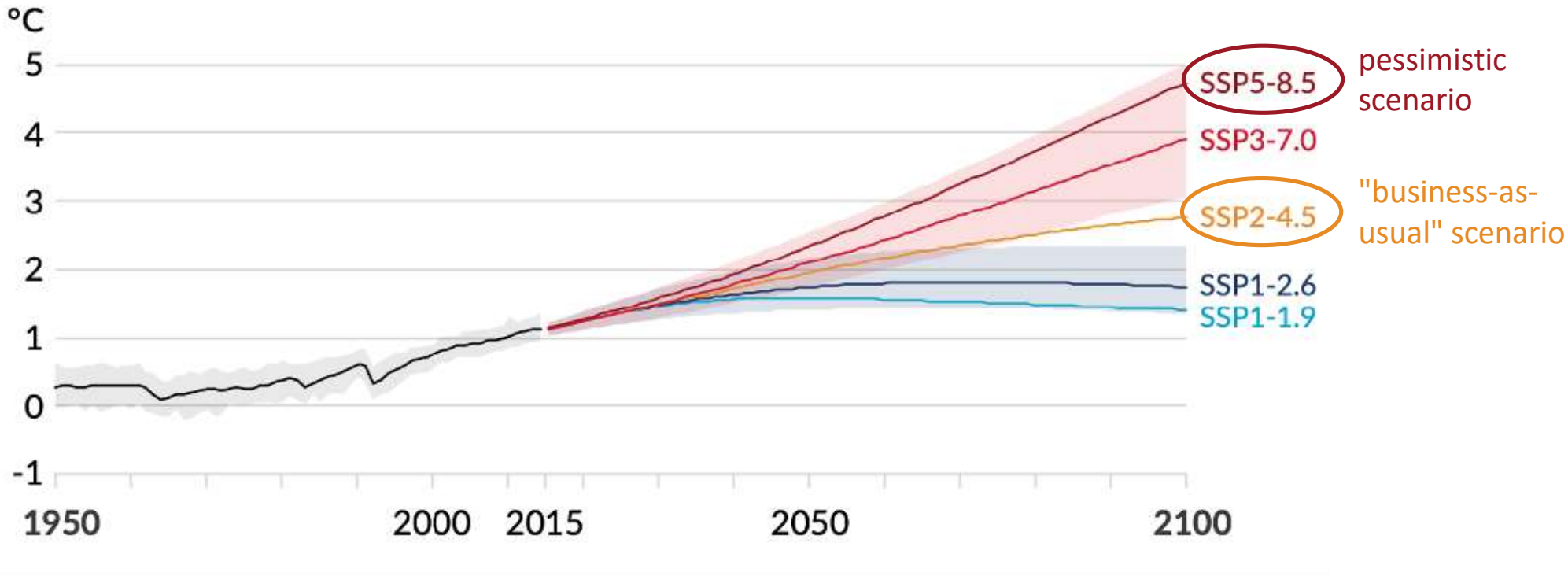
Climate scenarios



- **Assessing the potential physical risks associated with climate change**

The aim of climate projections is to estimate the probability of observing a given change over a given period, in a given prospective scenario and for a given region.


★ SSP 5
(Mitigation challenges dominate)
Fossil-fueled development
★ SSP 3
(High challenges)
Regional rivalry
★ SSP 2
(Intermediate challenges)
Middle of the road
★ SSP 1
(Low challenges)
Sustainability
★ SSP 4
(Adaptation challenges dominate)
Inequality
Socio-economic challenges for mitigation
Socio-economic challenges for adaptation



Global warming trajectories under the five SSPx-y scenarios used in the IPCC summary for decision-makers

Adapting healthcare facilities: Growing initiatives and emerging regulations

Raising awareness of the impact of climate change on healthcare facilities

"As observed during COVID-19 pandemic, ***health systems are the main line of defence*** *in protecting populations from emerging threats, including the impacts of a changing and more variable climate."*

(COP26, 2021)

COP26 Health Program

Commitments to build sustainable, climate-resilient health systems :

- Conducting climate change and health **vulnerability and adaptation assessments** at population level and/or health care facility
- **Developing a Health National Adaptation Plan (HNAP)** informed by the health V&A, which forms part of the National Adaptation Plan
- Using V&A and HNAP **to facilitate access to climate change funding for health** (e.g. project proposals submitted to the Global Environmental Facility (GEF), Green Climate Fund (GCF) or Adaptation Fund (AF) or EU LIFE program)

EU taxonomy for sustainable activities

“The EU taxonomy regulation creates a clear framework for the concept of sustainability, exactly defining when a company or enterprise is operating sustainably or environmentally friendly. Compared to their competitors, these companies stand out positively and thus should benefit from higher investments. Thereby, the legislation aims to reward and promote environmentally friendly business practices and technologies. ”

Objectives :

1. Climate change mitigation
2. Climate change adaptation
3. Transition to a circular economy
4. Pollution prevention and control
5. Sustainable use and protection of water and marine resources
6. Protection and restoration of biodiversity and ecosystems

TCFD Recommendations

The Task Force on Climate-related Financial Disclosures (TCFD) was created with the aim to push companies and organizations to disclose climate-related financial risks transparently, so that investors can factor them into their decisions.

In 2017, the TCFD published a set of recommendations to encourage consistent, reliable and clear financial reporting based on 4 pillars:

- Governance
- Strategy
- Measurement and targets
- Risk management

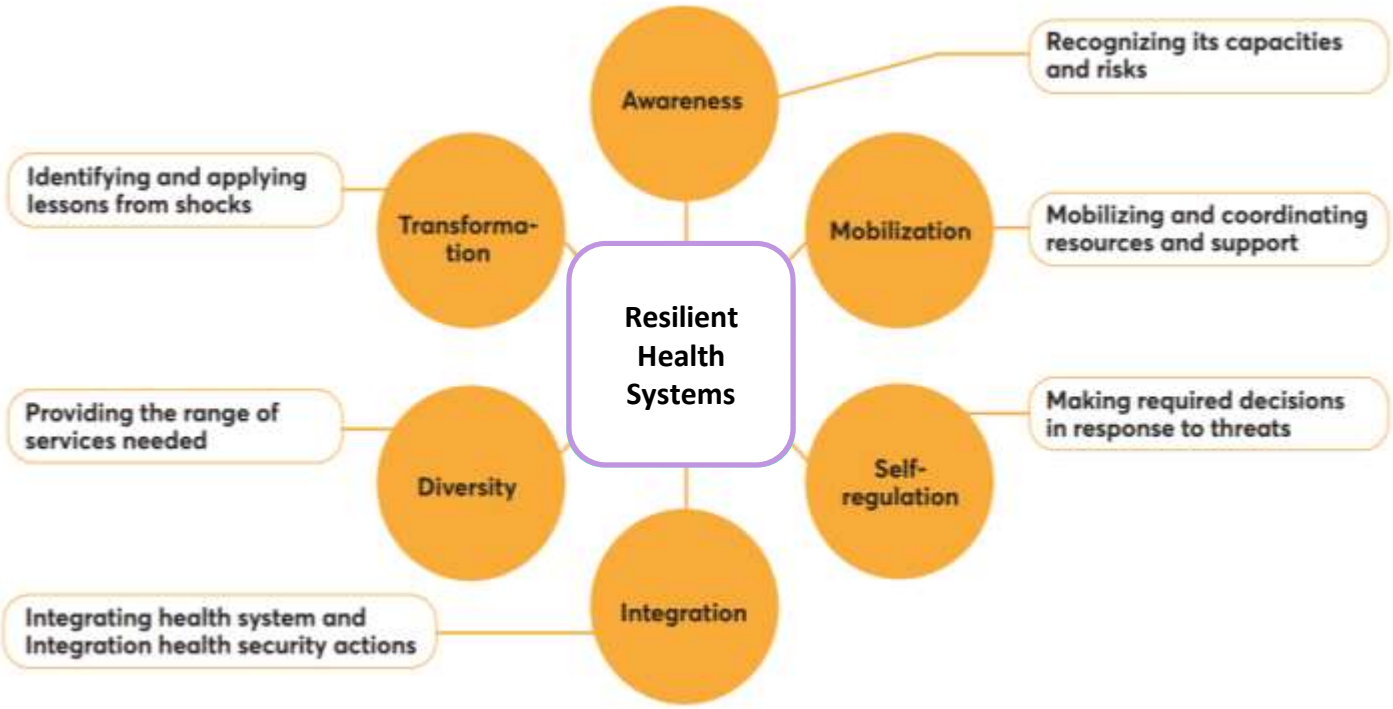
These recommendations are now widely recognized by governments, investors and finance executives. The TCFD now represents the latest best practice in corporate climate reporting.

ESG investing in the context of CC

Environmental, Social, and Governance (ESG) investing refers to a **set of standards for a company's behavior** used by socially conscious investors to screen potential investments.

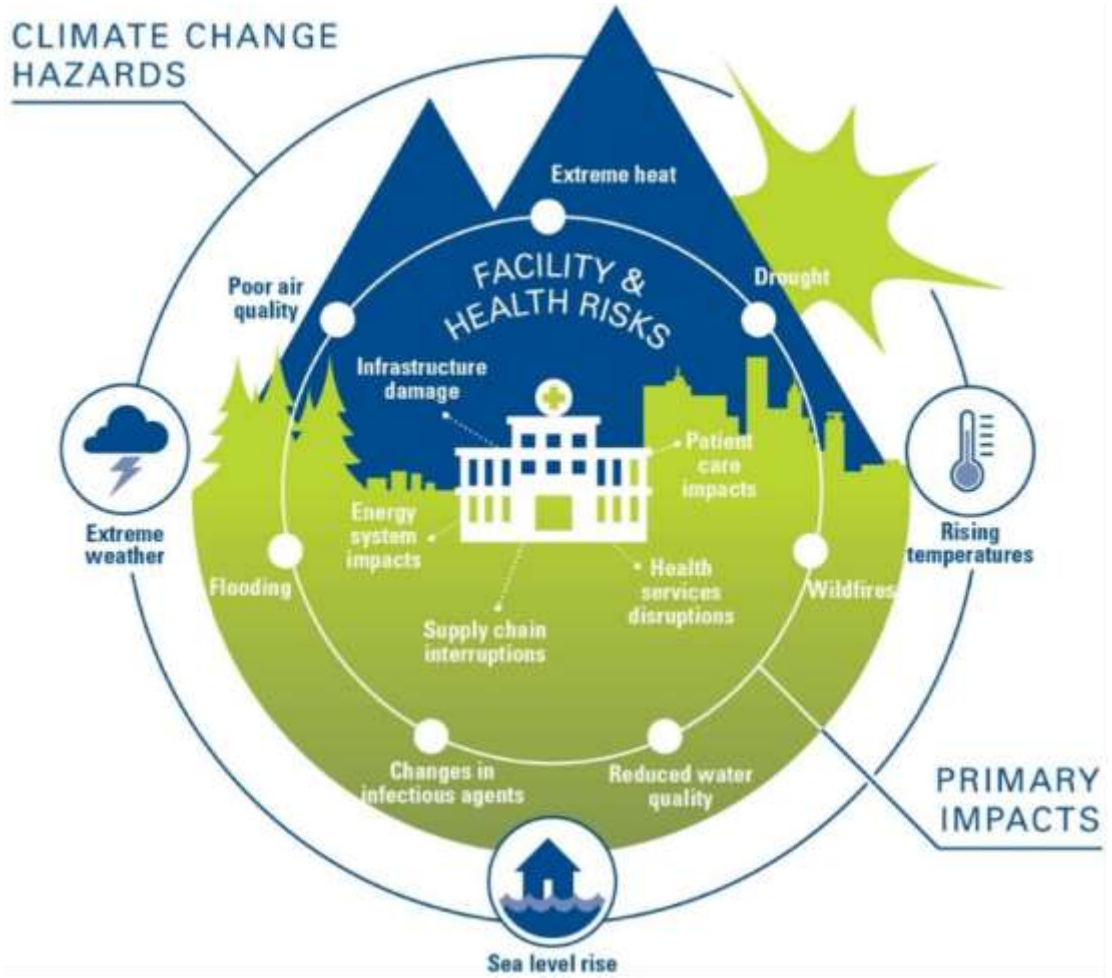
ESG in the context of climate change refers to **environmentally sustainable practices** undertaken by companies in order to mitigate their negative environmental impact while continuing to make a profit.

Resilient healthcare facilities are necessary



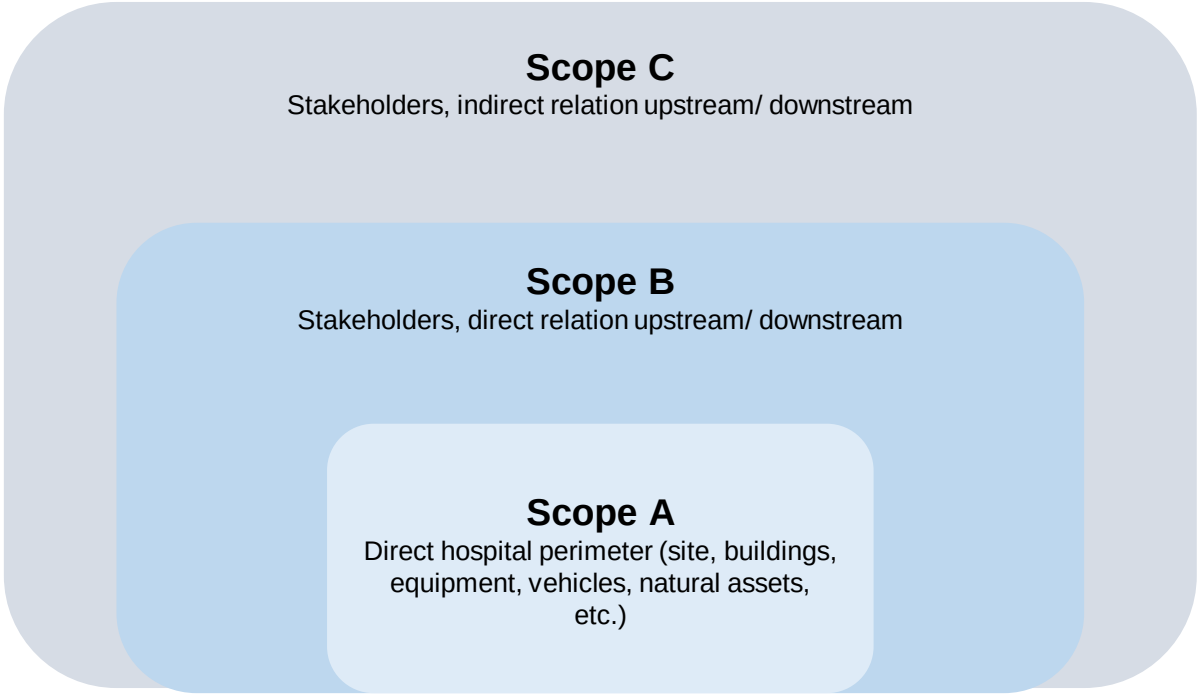
Source: WHO Health Services Resilience Team, WHO headquarters

Impacts of CC on healthcare facilities



Source: Aubie Vines G., Murdock T., Sobie S., Hohenschau D. Lower Mainland Facilities Management: Moving towards Climate Resilient Health Facilities for Vancouver Coastal Health. Report Prepared for Vancouver Coastal Health; Vancouver, BC, Canada: 2018

Analysis scopes



Analysis scopes

Scope A :

- Building and construction integrity (building, outdoor areas)
- Maintenance of storage conditions for food products (dry, fresh, frozen), pharmacy and waste (organic waste, recyclable waste, hazardous products).
- Integrity and operation of equipment - operating condition of biomedical equipment, power supply equipment, cold production equipment (refrigeration systems, air conditioners), water supply (pumps, pipes), IT.
- Maintaining working conditions (temperature, humidity)
- Other physical assets operated by the facility that are necessary for its operation (fleet of road vehicles: SMUR ambulances)

Scope B :

- Availability and quality of food, medicine and supplies (bedding, etc.)
- Mobility of people (healthcare staff, but also patients) - Availability of transport networks
- Availability and quality of power, heating or cooling, water, telecom and internet networks, waste disposal
- Stable political, regulatory and socio-economic environment

Scope C :

- Value chain for Tier 1 suppliers
- Value chain for Tier 1 customers
- Value chain for infrastructures and networks supplying the plant

Examples of impacts on hospitals

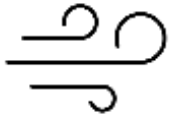
Climate hazards

They are events which, should they occur, would have an impact on the system in question

Heat waves

Storms

Wildfires



High winds

Floods

Submersion and coastal erosion

Heatwaves

Mean surface temperatures and extreme heat events have been observed to increase. These are anticipated to keep increasing in the future.

Increasing temperatures have dangerous effects on people's health, especially for the most vulnerable ones

High temperatures create an uncomfortable environment for the patients but also the hospital staff

High temperatures can cause the medical equipment and the AC systems to malfunction

Increasing temperatures can cause materials to expand, and whilst materials can reduce at the end of the summer period, over time, successive expansion and contraction of building materials can cause damage to manifest and make irreversible changes to the building's structure

Storms

If the Earth follows the anticipated warming pattern outlined by scientists, there will likely be a rise in occurrences of intense precipitation. Nevertheless, the forecasts are less definitive regarding a potential worldwide surge in severe thunderstorms.

Storms can damage to the roof, windows, and doors from winds and debris can lead to significant interior damage

Storms can cause breaching of the building envelope

The high wind pressure of a storm, combined with the heavy rainfall, leads to water intrusion

Debris being blown around can cause severe injuries to people

Electric supplies can be cut off due to power lines being damaged

Flooding

Climate change results in more intense rainfall, which increases the chances of flooding throughout the globe.

Floods can threaten lives

Floods can damage roads and infrastructure thus disrupting access to hospitals

Floods can cause losses in expensive medical equipment, hospital furniture, lifeline installations and medical supplies

Floods can damage utilities (water supply, sewerage, electricity grid, etc.)

Wildfires

Fueled by increasing temperatures, changing precipitation patterns and extended drought periods, extreme wildfires are projected to become more frequent and intense

Fire can destroy the building and lead to deaths

In case of a wildfire near the hospital :

Smoke exposure can cause damage to electronic equipment and the building in general

Particles from smoke and the burning of hazardous chemicals reduce air quality and bearing multiple respiratory and cardiovascular ailments for humans

Drought

Severity and geographic extent of droughts are anticipated to increase under climate change.

Drought causes reactive clay to shrink and causes subsidence which puts extreme stress on the building's structure and foundations

Drought directly impacts water supplies which have a substantial impact on hospitals as access to water is crucial for essential healthcare operations, including heating, cooling systems, restroom facilities, and medical equipment usage.

The capacity of hospitals to operate impacted by:

Impacts on the infrastructure

<u>Direct impact:</u> Damage to hospital facilities & infrastructure during extreme weather events (such as buildings and A/C systems)

<u>Undirect impact:</u> Damage to utilities (water, energy, waste, etc.) and **communication infrastructure** that the hospital needs to operate (for patients, hospital staff, supply chains for food and medicines)

Impacts on the health workforce and patients

A sudden influx of patients during extreme weather events (heatwaves, wildfires, floods, etc.)

An overall deterioration of human health, in particular the most vulnerable ones – children, pregnant women, and the elderly – due to reduced water & food quality, growing of pathogens (tiger mosquitoes)

Shutdown of the CH de Saint-Affrique due to a flood in 2014

Hospital	Location	Number of beds	Main hazards
CH Emile Borel	**Saint-Affrique, France**	**260**	**Flooding** 

Key figures on the impact of flooding on the hospital

Impact on users

123 patients evacuated between November 28 and 29

Estrangement and separation from families - more than 80 residents left their homes, some for as long as 8 months

Impact on professionals

Agents recovered 10,492 hours to compensate for time off

Some professionals had to practice their profession on another site (CH Albi - CH de Millau - site de St Come)

Impact on the activity of 2015

The kitchen service produced 27% fewer meals (approximately -40,000)

The facility recorded 11% fewer stays (around -500)

Laboratory activity has been reduced by 17.5%, and bacteriology has been discontinued and outsourced to the Millau hospital

1,391 stays in Medicine and Geriatric Short Stay, compared with 1,478 in 2013 (-6.25%)

Imaging activity down by -21,06 %

Impacts of flooding on the buildings of the hospitals

Building B – USLD – Caylus Nursing home

Technical installations and services

Pictures taken on the 28th November 2014. Source: Mme. Corine Barthe-Cadier

Laundry room – Kitchen – Bio-cleaning room




Technical installations and services




Pictures taken on the 28th November 2014. Source: Mme. Corine Barthe-Cadier

Impacts of flooding on the medical care

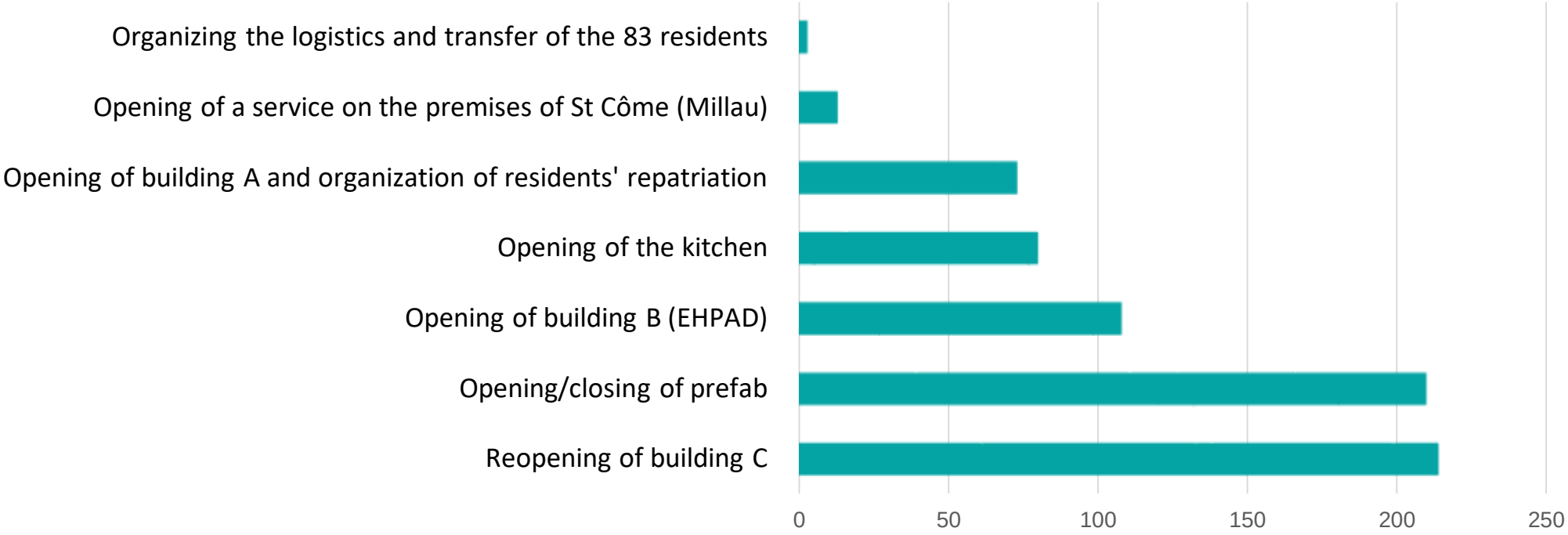
28/11/2014 (flood)

- Evacuation of patients and adaptation of logistical flows within the building
- Road access to the hospital closed (bridges closed) for ¾ hour
- Medical fluids cut off: 1 intubated patient had to be manually ventilated until transfer
- Power cut - network + generator + emergency power units (total blackout)
- Telecommunications outage: landline telephone, internet, computer network, etc.

Until 01/12/2014

- Organizing the evacuation of patients/residents to other facilities
- Organizing the logistics for the 83 residents (meals) at the nursing home La Sorgues
- Contacting insurance companies and suppliers to stop interventions and deliveries
- Organizing professional elections
- Securing and closing buildings (looting threat)

Number of days between closing (28/11/2014) and reopening



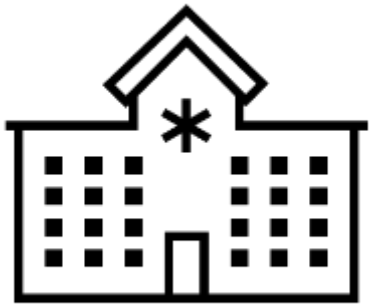
Until 07/12/2015

- Bacteriology outsourced to the Millau hospital, an outsourcing that has lasted
- At each stage: regulatory inspection bodies, safety commission
- Make staff available to other hospitals, e.g.: IADE to Albi Hospital
- Assessment of hours worked by staff
- By 2022, not all premises were refurbished (excluding care facilities)

The impact of the 2022 heatwave on the activity of the nursing home Caylus in Saint-Affrique

Hospital	Location	Number of beds	Main hazards
Nursing home CAYLUS	**Saint-Affrique, France**	**45**	**Heat wave** 

The residents of the Caylus nursing home



2 sites
125 residents

Caylus nursing home
45 residents
Average age : 89 years

Health risks of the heatwaves for the elderly

Increased risk of hyperthermia for the elderly due to:
- sweating disorders
- disruption of the thirst mechanism

Associated with the frailties of the Caylus public:
- polypathologies
- 84% neurodegenerative diseases
- palliative care

Health risks of the heatwaves for the elderly

The warmest room :

32°C

The coolest room :

26°C

In average during the heatwave :

26°C

Increased fragility

45 residents

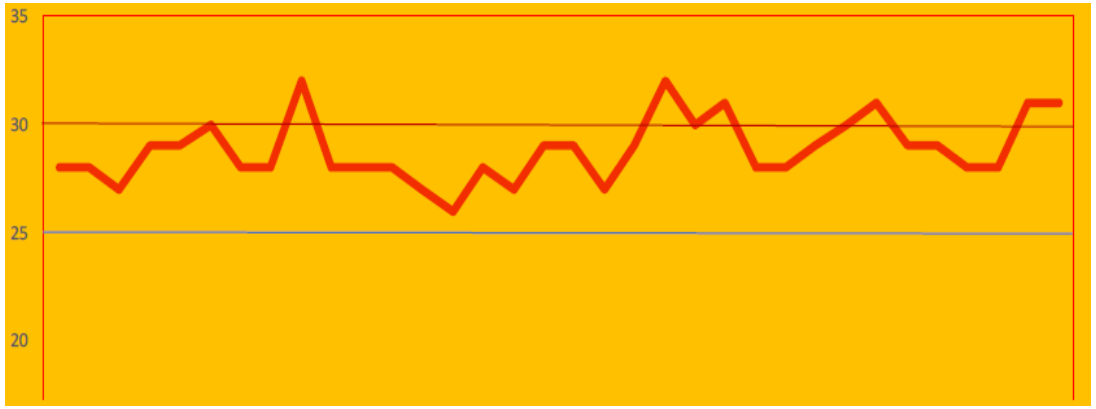
Risk of dehydration

The impact of the heatwave on interior temperatures

Exterior temperatures during the heatwave in Millau

	July 2022	August 2022
Extreme maximum temperature	38,6 (the 17th)	37,8 (the 13th)
Average maximum temperature	32,8	32,1
Average temperature	24,6	24,5
Average minimum temperature	16,4	16,8
Extreme minimum temperature	10,0 (the 2nd)	13,6 (the 16th)

Interior temperatures during the heatwave in the warmest room of the hospital

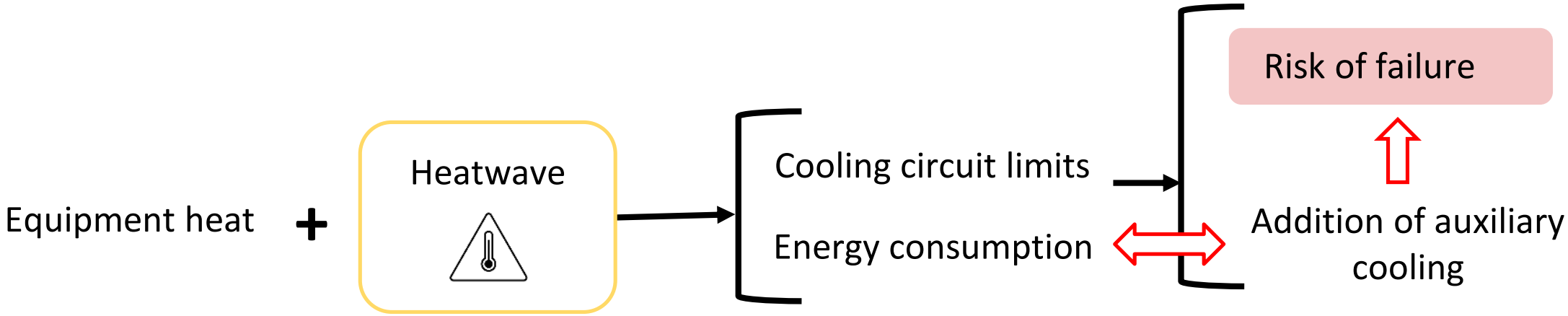


Temperature in the warmest room of the facility during the ALERT 3 of the heatwave plan
From the 16th of July 2022 to the 17th of August 2022

The impact of the 2022 heatwave on the biomedical equipment of the CH de Millau and CH de Saint-Affrique

Hospital	Location	Number of beds	Main hazards
CH de Millau **CH Emile Borel**	**Millau** **Saint-Affrique**	**495** **260**	**Heat waves** 

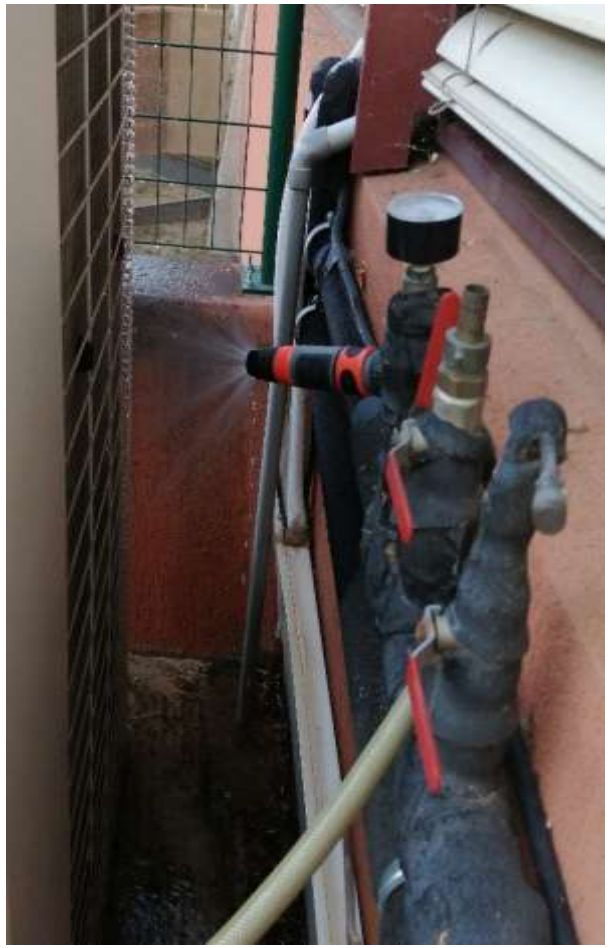
The impact of the heatwaves on the biomedical equipment



MRI

Prerequisites	Equipment	Risks
Helium must be kept in a liquid state (-269°C) to guarantee the magnet's superconductivity.	2 chillers (backup)	A high outside temperature can cause the chillers to malfunction, without having a viable backup solution with city water in summer
	1 City water supply for ultimate backup of the 2 chillers	An important increase in helium temperature causes a change in its physical state (from liquid to gas).
Examination room temperature and humidity must be maintained to guarantee constant image quality.	1 Air handling unit for temperature and humidity stability	Ice formation in the magnet : Damage cost : Shutdown + intervention of after-sales service + helium refill ≈ 80 000 €

Laboratory



Prerequisites

Temperature must be kept below 27°C in the laboratory.

Examination room temperature and humidity must be maintained to guarantee constant image quality.

Equipment

Air-conditioning unit

Risks

A high outside temperature can cause the air conditioning unit to malfunction

↓

A temperature above 27°C in the laboratory causes an automatic shutdown of the systems making it impossible to deliver results.

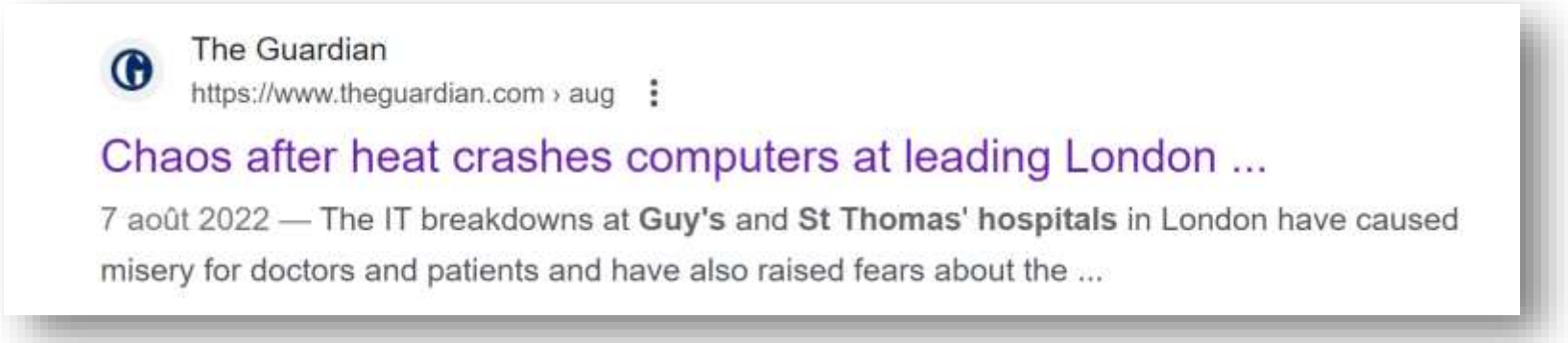
↓

A high temperature in the laboratory can lead to the destruction of certain reagents that have exceeded their upper limit of use.

Possible identified solutions

- Upgrading the equipment to **tropical standards**
- Improving **thermal insulation** of premises
- Changing the **technology** (MRI: Aerothermal)
- Integrating **air-conditioning systems** into the building to regulate energy consumption, ensure activity continuity (in the event of a breakdown) and recover heat

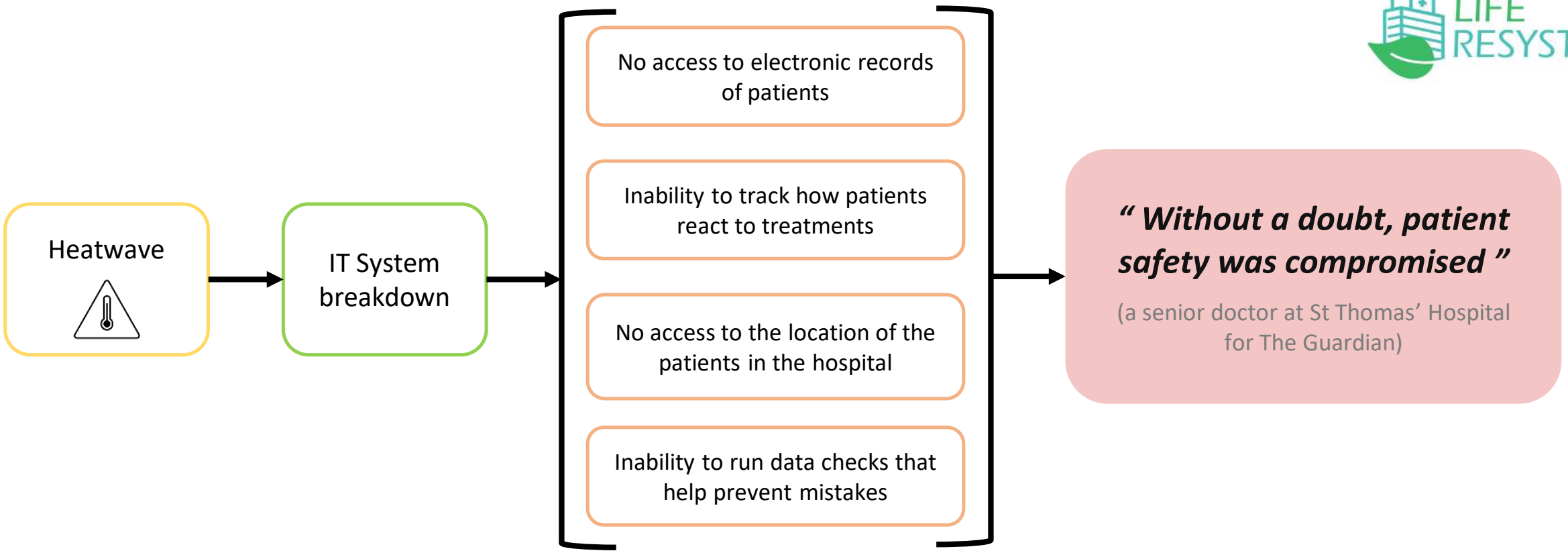
Disruptions in Guy's and St Thomas Hospitals in London due to a heatwave in 2022



Hospital	Location	Number of beds	Main hazards
Saint Thomas Guy's	**London, UK**	**840 400**	**Heat waves** 

Two of the UK’s leading hospitals, Saint Thomas and Guy’s, have had to **cancel operations, postpone appointments and divert seriously ill patients** to other centers after their computers crashed at the height of the **heatwave** that occurred in July 2022.

Saint Thomas Hospital, London, UK. Photograph: One-Image Photography/Alamy

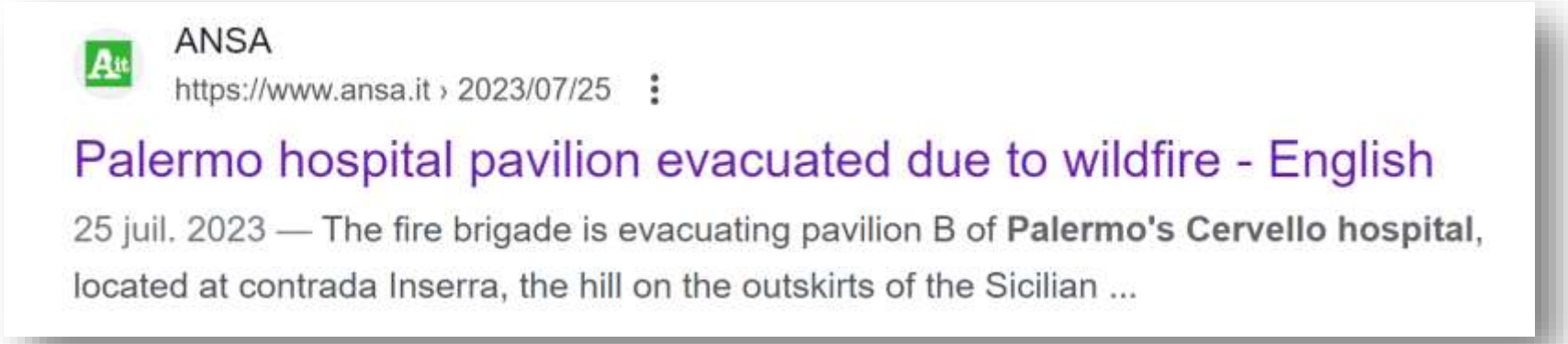


The **IT breakdowns** at Guy’s and St Thomas’ hospitals in London have caused misery for doctors and patients and have also raised **fears about the impact of climate change on data centers that store medical, financial and public sector information.**

“***Computers are now vital to healthcare**, with artificial intelligence being explored or used to support various tasks like prognosis. For example, AI can use medical imaging scans to diagnose cancer. That means **that the appetite for computing, communicating, storing and retrieving data is going up all the time**… At the same time, global temperatures are going up, and that means that **power and cooling systems have to be a lot more effective and resilient**.*”

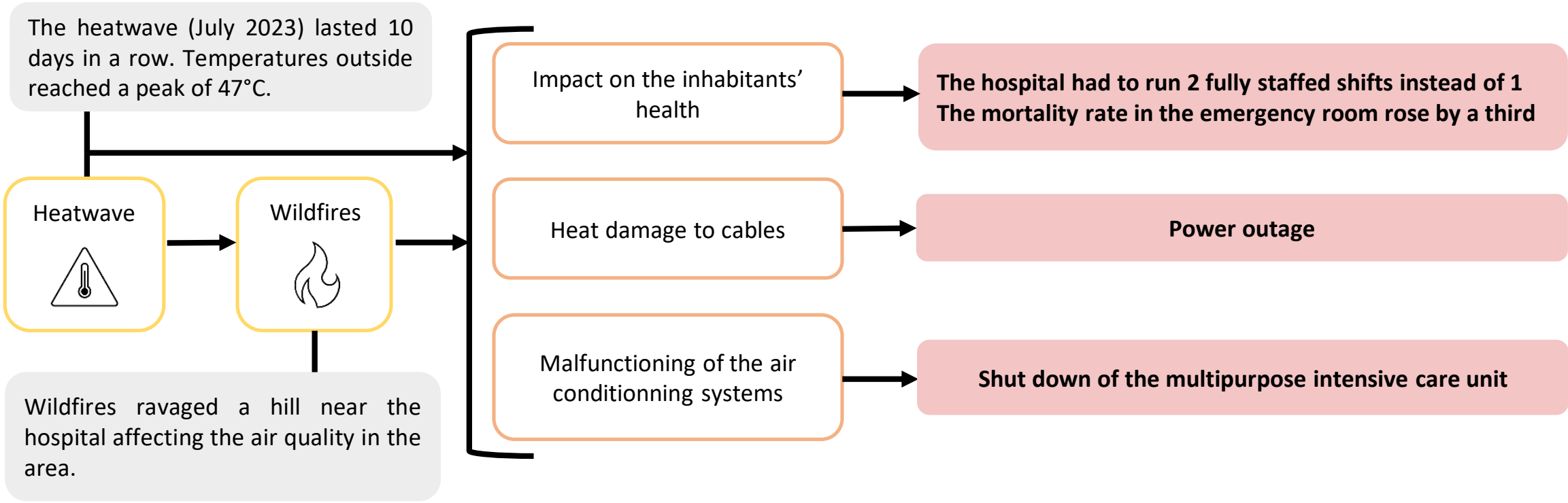
(Professor George Zervas, of University College London’s department of electronic and electrical engineering)

Disruptions at Cervello Hospital in Palermo due to wildfires in 2023



Hospital	Location	Number of beds	Main hazards
Cervello Hospital	**Palermo, Italy**	**N/A**	**Wildfires** 

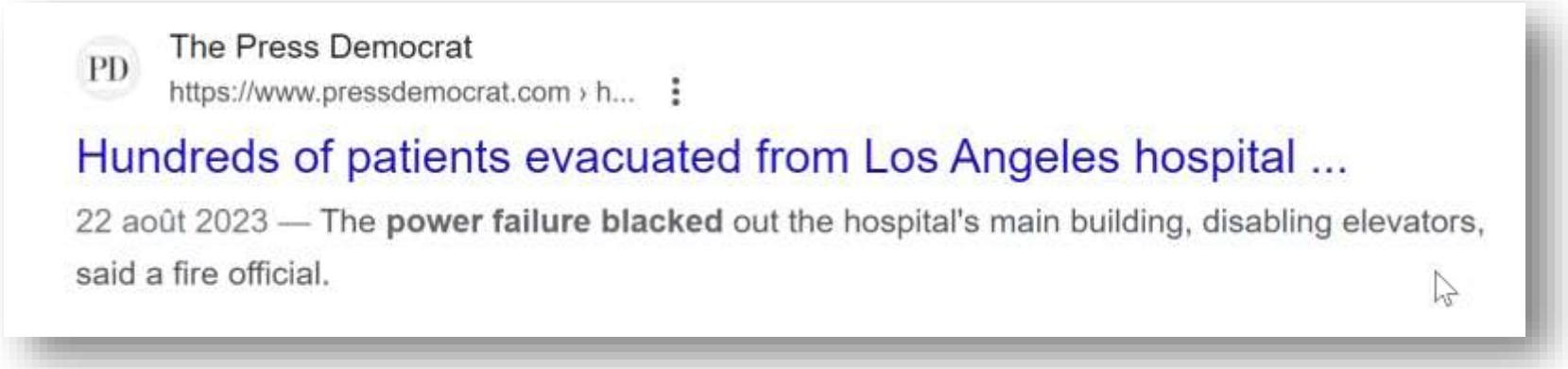
The firefighters evacuated a pavilion of the Cervello hospital in Palermo which is located under the Inserra district, the hill on the outskirts of the capital that was burning for hours amidst a heatwave, making the air in the area unbreathable and causing system breakdowns in the hospital.



*"During the 30 years I've worked as a doctor, I saw 4 or 5 cases of hyperthermia. During those 10 days, I saw 5 or **6 cases a day** […]. On a normal day, we have a code red 30 times per day, when a patient's life is really at stake, but during those days, we had **50 per day** – so, a major increase"*

(Tiziana, a doctor of Cervello Hospital)

Evacuation of White Memorial Medical Center in Los Angeles due to a storm in 2023



A succession of power outages at the White Memorial Medical Center of Los Angeles prompted the evacuation of 28 patients in critical condition to other hospitals while 213 other patients were moved to another building in the medical center. More than 100 firefighters and numerous ambulances were dispatched to the facility.

Los Angeles Fire Department evacuating patients for the White Memorial Medical Center.
AP Photo/Richard Vogel

Storm Hilary hit southern California. It was the first tropical storm to hit Los Angeles in 84 years.

Emergency power failure, even if they were regularly checked.

Storm

Power outage

Activation of the backup generators

Most probable cause :
Water short-circuited an electrical panel or system, severing it from the city's power supply.

Disabled elevators

The building counts 6 stories which made the evacuation harder using stairwells.
"One of the issues that we ran into because the fact that there's a complete power outage here is zero lights. So, zero visibility. We had no elevators working, so firefighter paramedics had to assist patients that were in critical condition to non-life-threatening critical or non-life-threatening condition down stairwells and they get them to a receiving ambulances" (Weiretar)

Disabled medical equipment

"Many years ago, I worked at White Memorial in the Neonatal Intensive Care Unit. A power outage risks the lives of all of those babies — and also the rest of the patients in critical care whose lives depend on respirators, ventilators and other critical life-sustaining equipment. Angelenos deserve a thorough examination of this incident." (Karen Bass, Mayor)

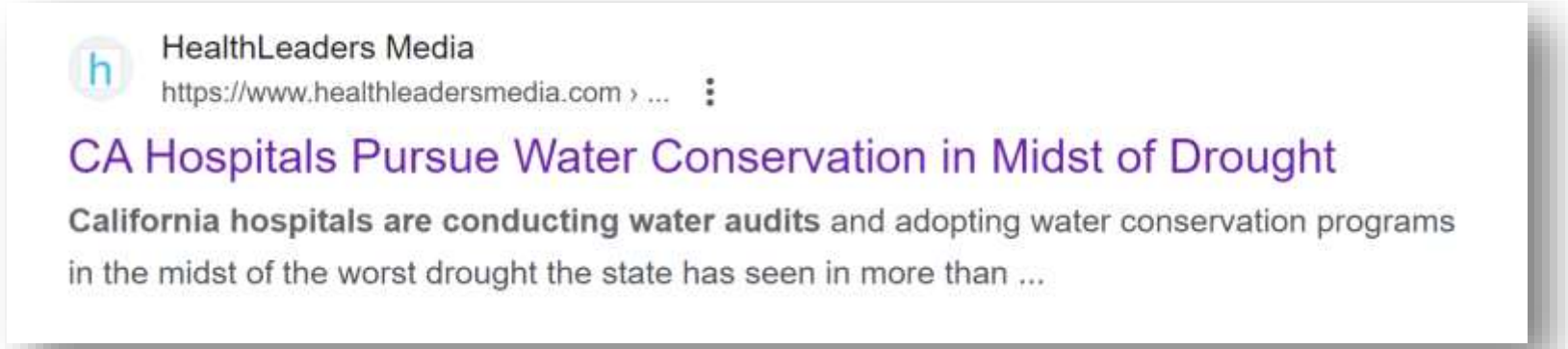
A woman gave birth to a baby girl during the complete blackout, and battery-powered flashlights were used to make the delivery happen.

"Our supervising nurses were there, physicians were attending, and what they ended up doing was putting together a whole bunch of flashlights and shining them up at the ceiling and illuminating the room so there was plenty of light."

(Grace Hauser, hospital spokesperson)

Photograph (Myung J. Chun / Los Angeles Times)

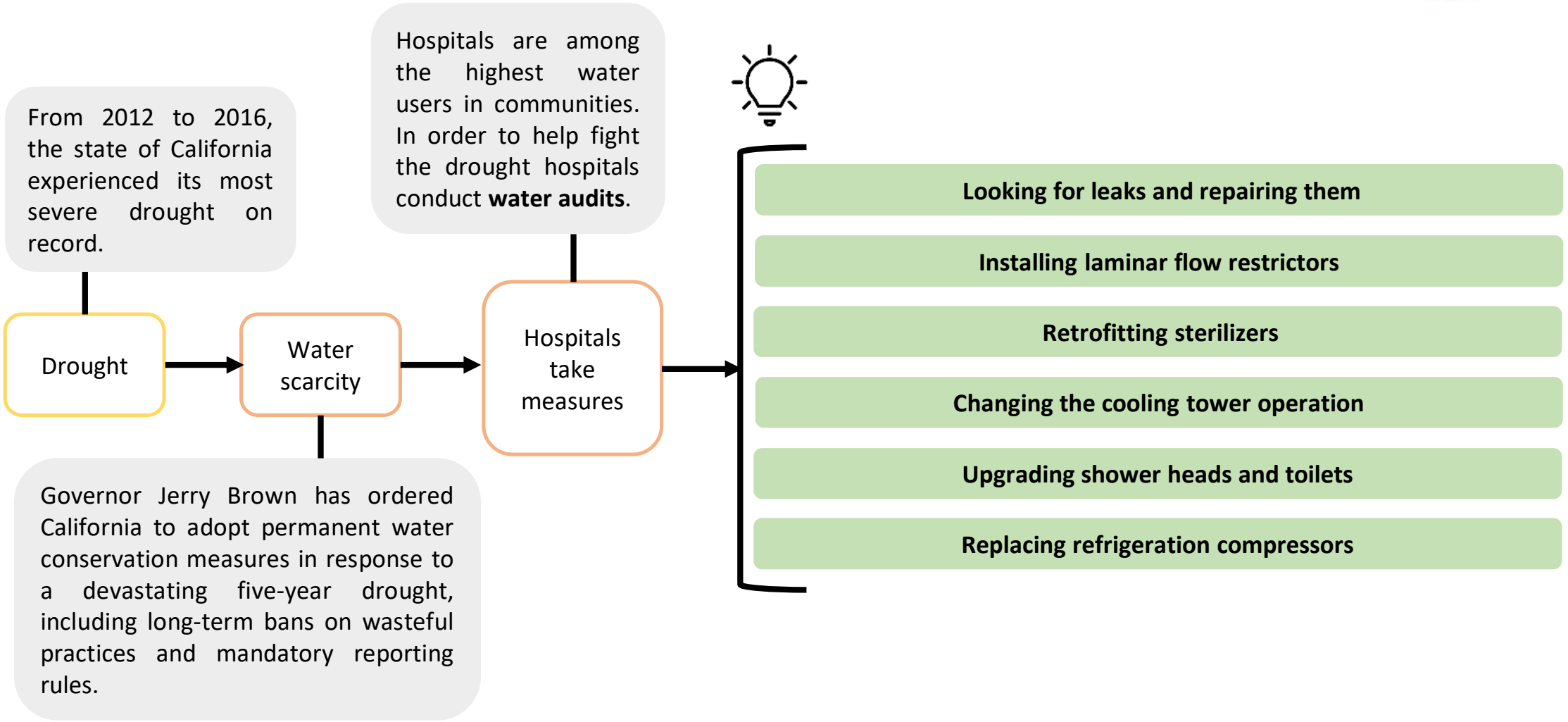
Tri-City Medical Center Oceanside overhauls its water management system due to drought in 2015



Hospital	Location	Number of beds	Main hazards
Tri-City Medical Center	**Oceanside, California, USA**	**388**	**Drought** 

California hospitals are doing their part to conserve water in the midst of a three-year drought, the worst in more than a century.
Many are conducting water audits and adopting programs that conserve water and help hospitals and health systems save money.

A concrete block that was used to moor a boat sits in dry cracked earth that used to be the bottom of Lake McClure in La Grange, California. Photograph: Justin Sullivan/Getty Images 2015

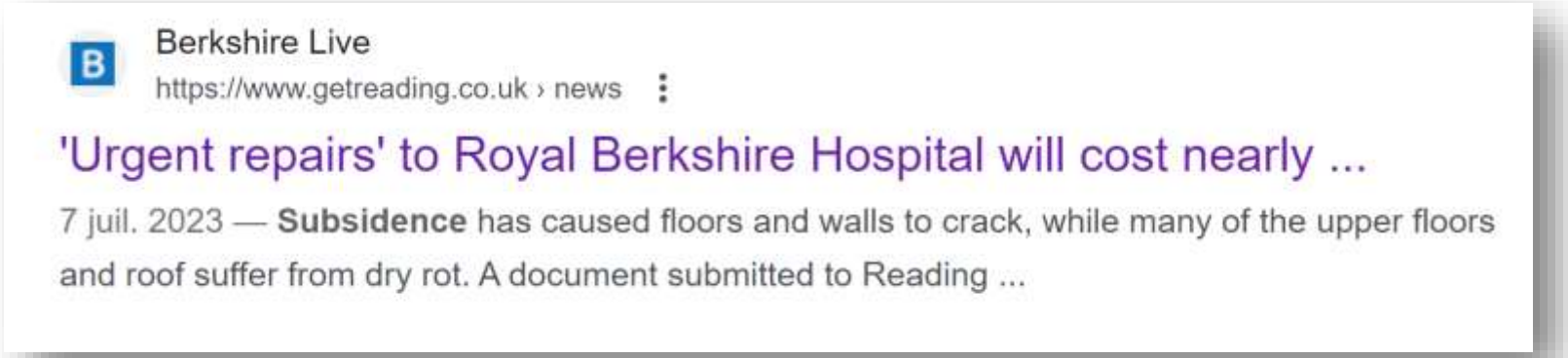

From 2012 to 2016, the state of California experienced its most severe drought on record.
Hospitals are among the highest water users in communities. In order to help fight the drought hospitals conduct **water audits**.
Drought
Water scarcity
Hospitals take measures
Looking for leaks and repairing them
Installing laminar flow restrictors
Retrofitting sterilizers
Changing the cooling tower operation
Upgrading shower heads and toilets
Replacing refrigeration compressors
Governor Jerry Brown has ordered California to adopt permanent water conservation measures in response to a devastating five-year drought, including long-term bans on wasteful practices and mandatory reporting rules.

The water audit concluded that Tri-City could reduce its water use by about 15% and saved about 5 million gallons a year by implementing relatively minor changes.

"With saving that much water, we're looking at a payback on investment in less than one year."

(Chris Miechowski, director of facilities for Tri-City Medical Center)

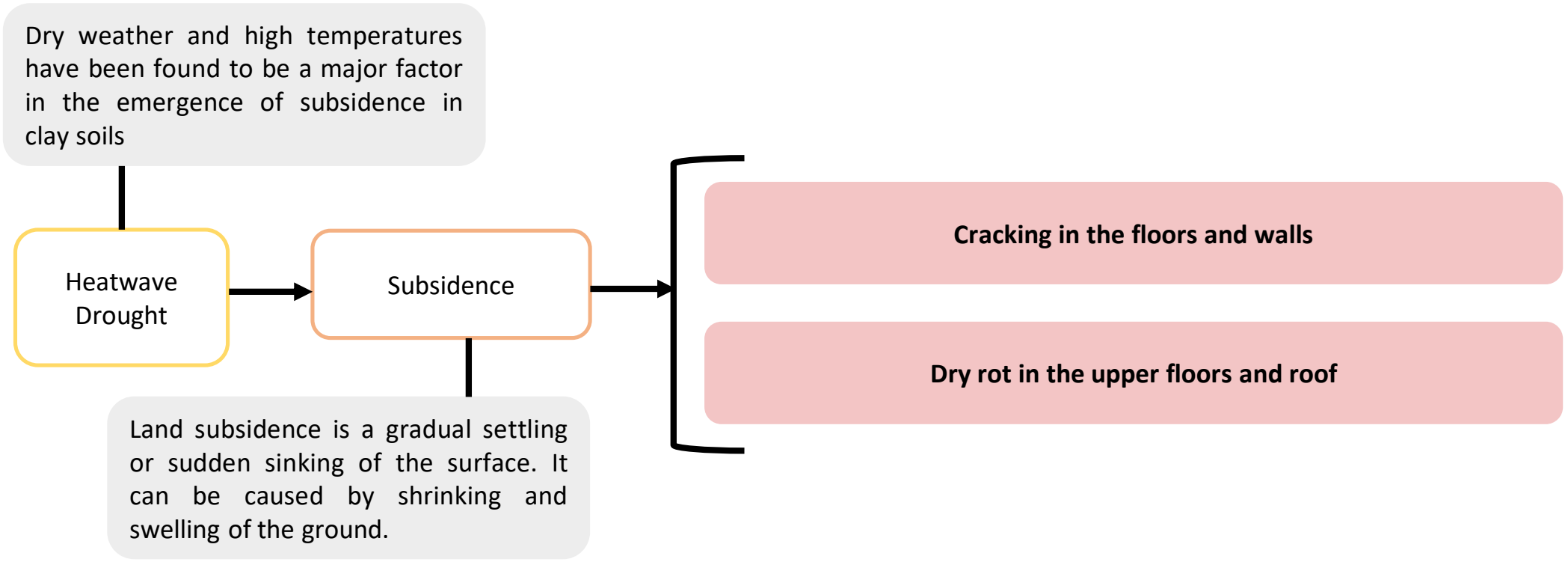
Royal Berkshire hospital facing subsidence in 2023



Hospital	Location	Number of beds	Main hazards
Royal Berkshire Hospital	**Reading, UK**	**813**	**Subsidence**

Royal Berkshire Health Trust is spending nearly £2 million on urgent repairs to its hospital in Reading - and is investigating whether subsidence issues could affect the whole site.

Source : Image: BerkshireLive - Grahame Larter


Dry weather and high temperatures have been found to be a major factor in the emergence of subsidence in clay soils
Heatwave
Drought
Subsidence
Land subsidence is a gradual settling or sudden sinking of the surface. It can be caused by shrinking and swelling of the ground.
Cracking in the floors and walls
Dry rot in the upper floors and roof

“The work will involve injecting cementitious grouting to replace sub-strata layers which have been eroded over the years by the water table and flow of groundwater. As part of the work, which is costing £1.9m and will be completed next month, we will also be replacing some drains.”

(Spokesperson of the hospital)

Some of the areas needing repair at Royal Berkshire Hospital (Image: GBS Health)

“ The cost of inaction is far greater than the cost of action [towards adaptation]. ”

Simon Stiell, Executive Secretary of the UNFCCC (2021)

In 2019, the **Global Commission on Adaptation** released a report indicating that investing **US$1,8 trillion from 2020 to 2030 could generate US$7,1 trillion** in total net benefits in 5 areas:

- **Climate-resilient infrastructure**
- Early warning systems
- Improved dryland agriculture crop production
- Global mangrove protection
- Investments in making water resources more resilient.

CLIMATE CHANGE RESILIENCE FRAMEWORK FOR HEALTH SYSTEMS AND HOSPITALS

3. General presentation of the methodology and tools of the project

Dr. Stelios Karozis

Collaborating Research / Project Manager

National Centre for Scientific Research "Demokritos"

Reminder

Overarching goal: Increase the climate resilience capacities of the European health infrastructure and the critical infrastructures that depend on it.

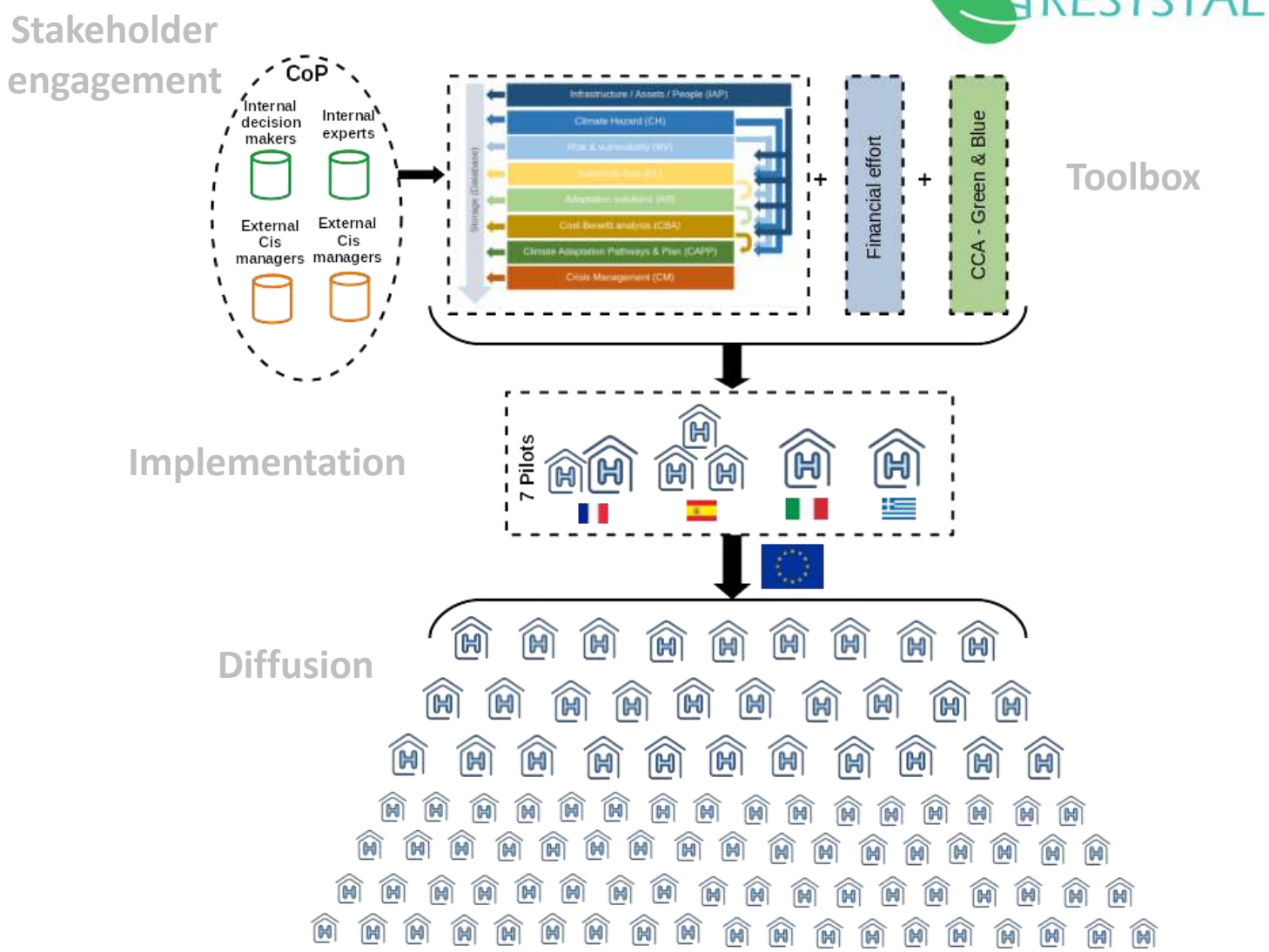
Specific objectives:

➔ Produce a decision support system that will be tested in seven pilot hospitals in Spain, France, Italy and Greece.

➔ Mobilize and engage stakeholders, decision makers and hospital staff through communities of practice.

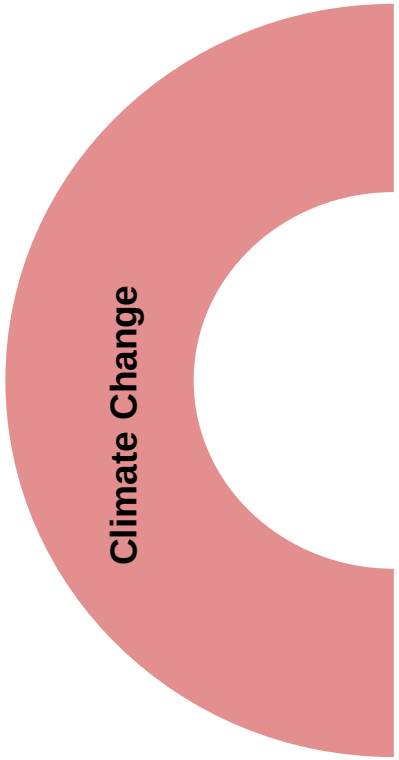
Components of LIFE Resystal

- Set the basis of a European Network for the climate adaptation creation of large Scaling Network
- Open Access exploitable result, the Upscaling Adaptation Starting Package (UASP)
- Guidance for system-level adaptation

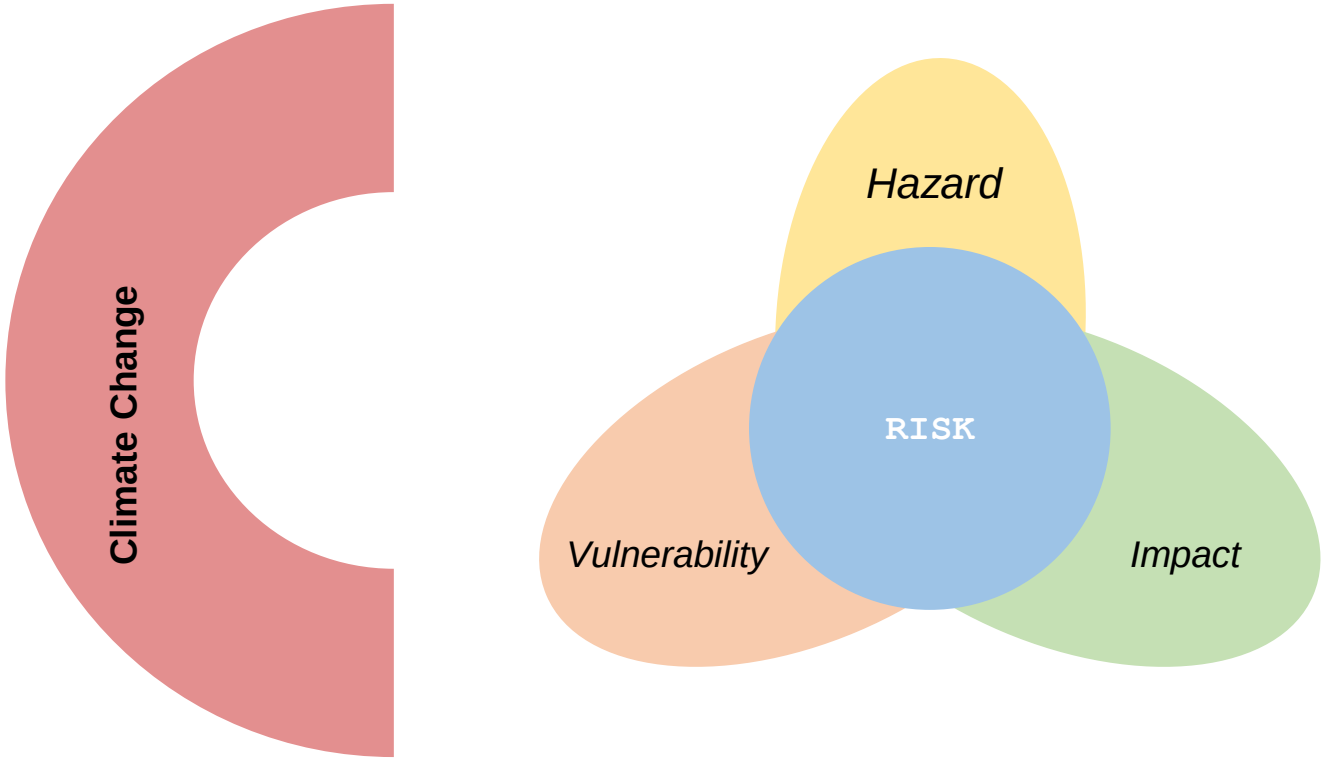


https://life-resystal.eu/

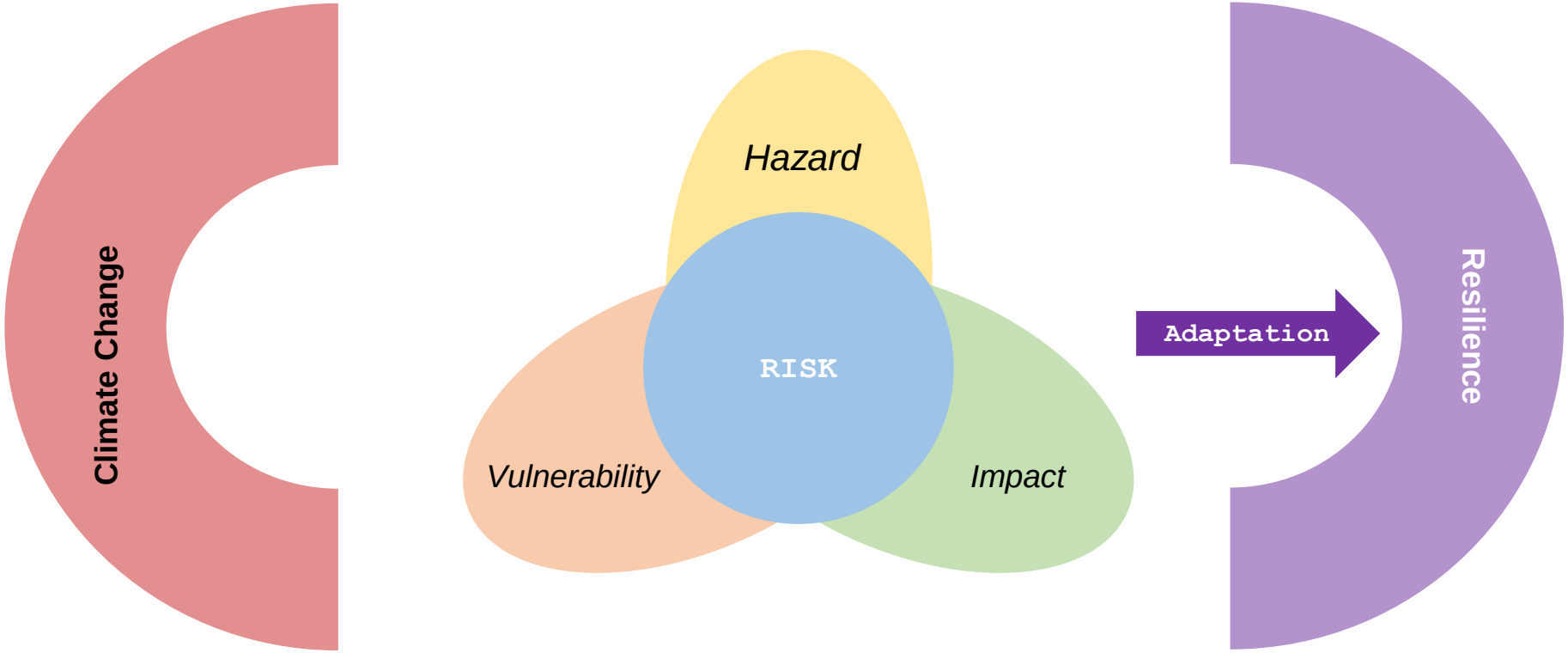
Climate resilience in health systems



Climate resilience in health systems



Climate resilience in health systems



Overview of the LIFE Resystal toolbox

LIFE RESYSTAL

LIFE RESYSTAL

Dashboard CM skarozis

The key components of the overall design of the Local Toolbox consist of the modules and the interconnections of the modules in order to function as a unified tool and provide assessment and solutions to climate change for the health sector.

Modules:

0 Infrastructure / Assets / People (IAP)

1 Climate Hazard (CH)

2 Risk & Vulnerability (RV)

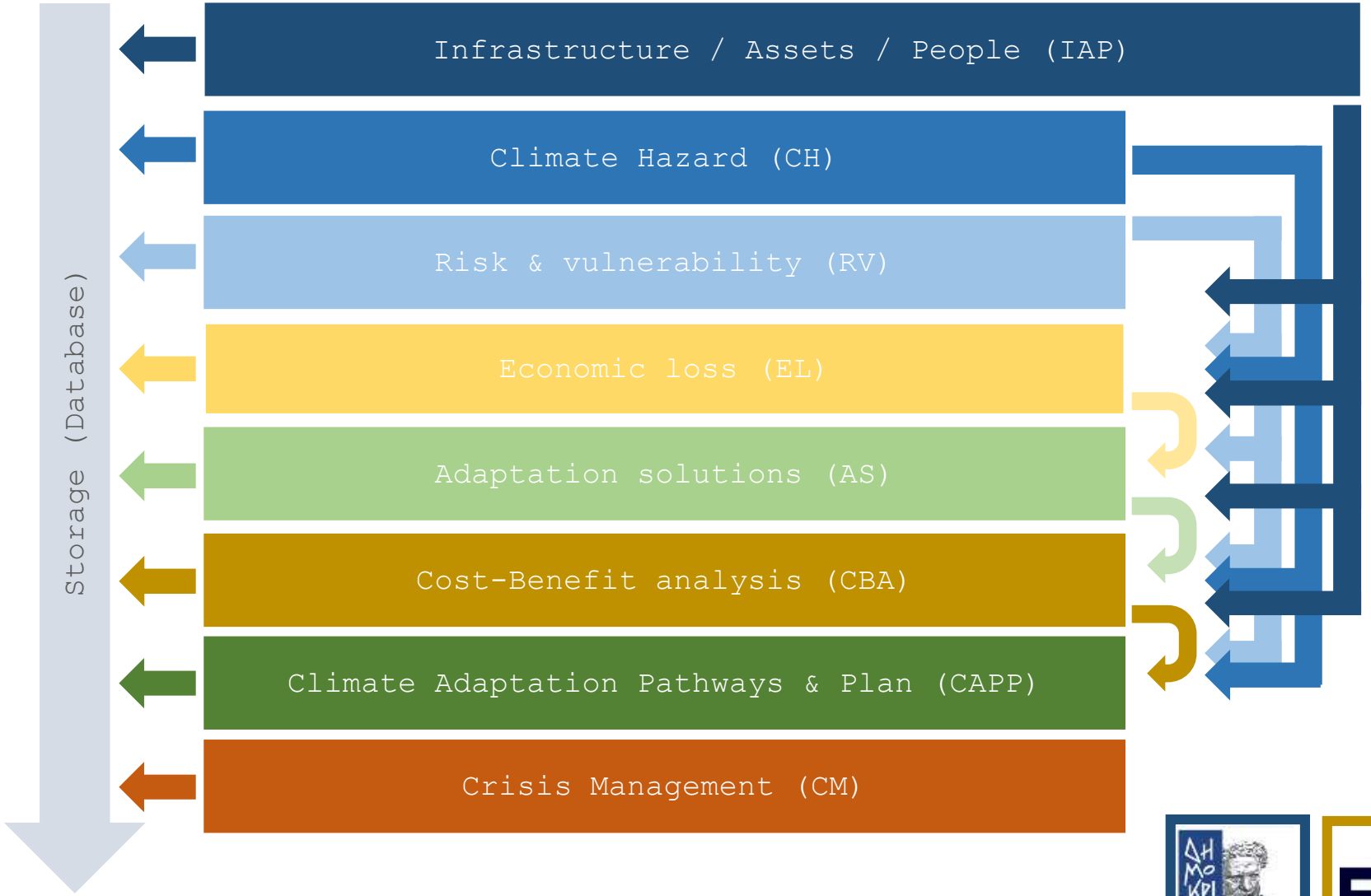
3 Economic Loss (EL)

4 Adaptation Solutions (AS)

5 Cost-Benefit Analysis (CBA)

6 Climate Adaptation Pathways & Plan (CAPP)

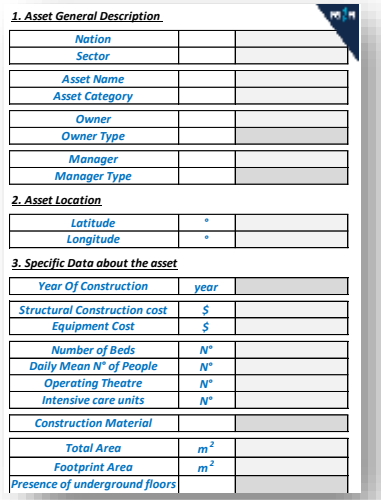
7 Crisis Management (CM)



A decision support system for adaptation planning, covering short, medium and long-term climate change risk management

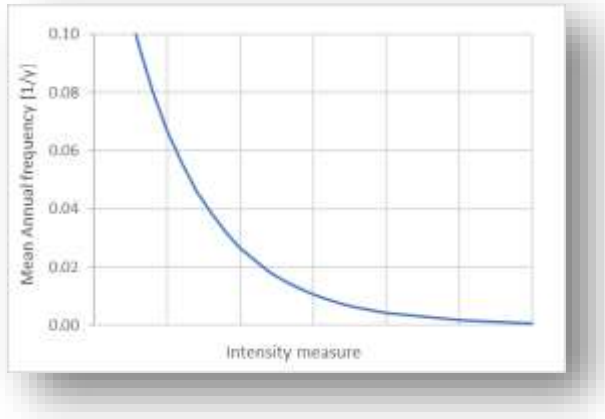
Characteristics of the

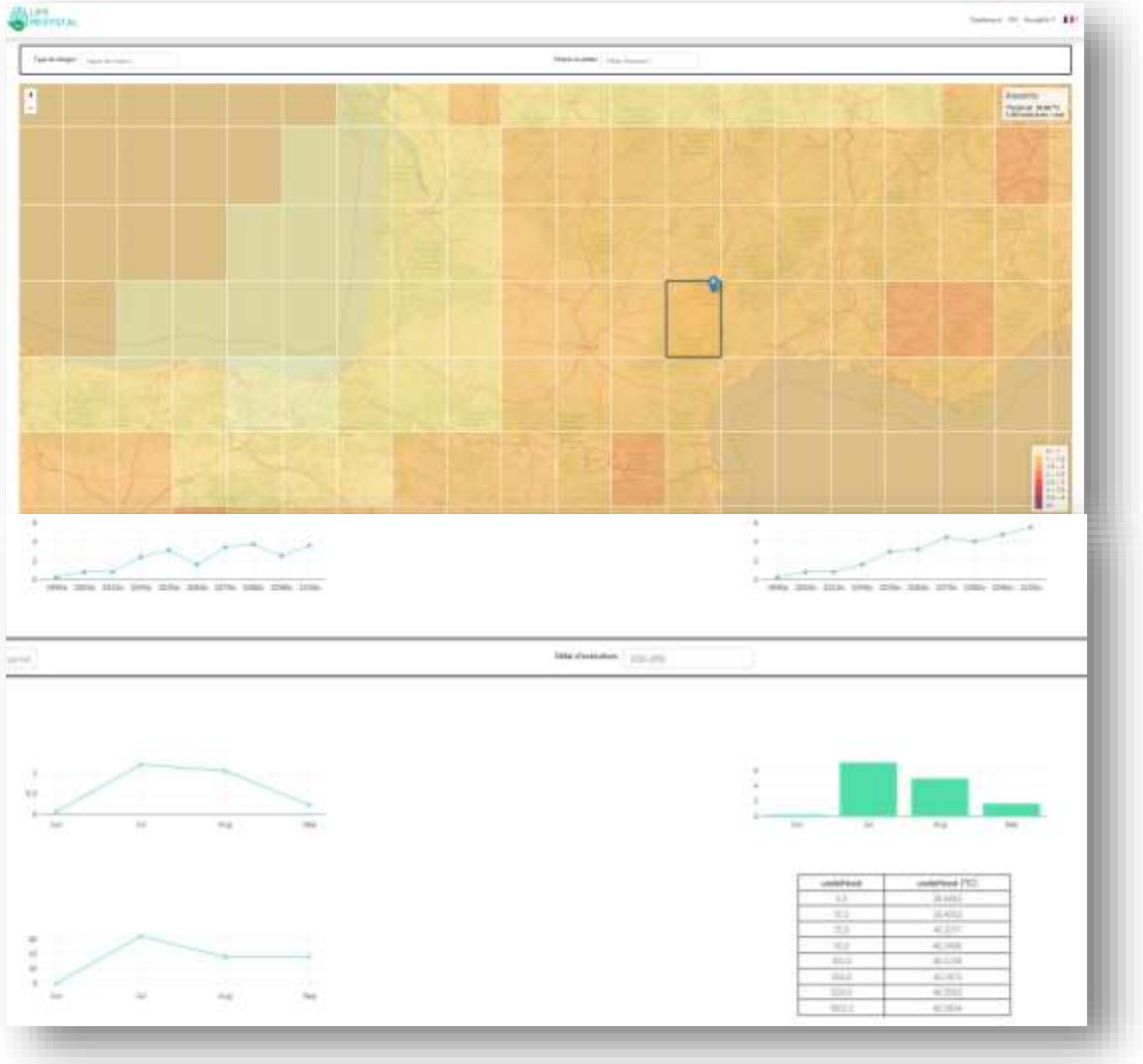
Position, height, year of completion, year of retrofit, capacity, catchment area, number of operating theaters …



1. Asset General Description		
Nation		
Sector		
Asset Name		
Asset Category		
Owner		
Owner Type		
Manager		
Manager Type		
2. Asset Location		
Latitude	°	
Longitude	°	
3. Specific Data about the asset		
Year Of Construction	year	
Structural Construction cost	$	
Equipment Cost	$	
Number of Beds	N°	
Daily Mean N° of People	N°	
Operating Theatre	N°	
Intensive care units	N°	
Construction Material		
Total Area	m^2	
Footprint Area	m^2	
Presence of underground floors		

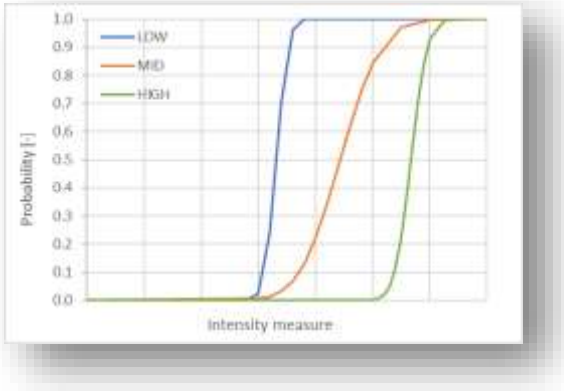
Hazard characteristics

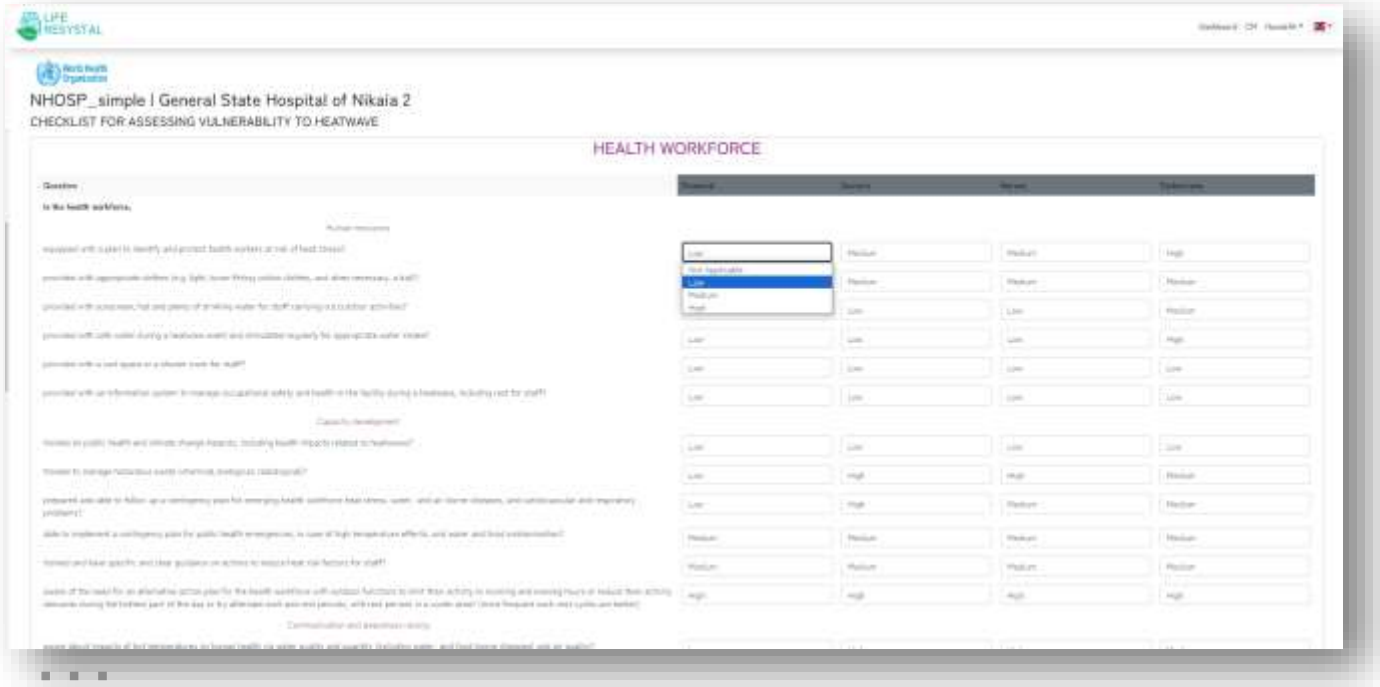




Risk assessment

Through a questionnaire to be completed by the hospital to assess its vulnerability to the studied hazard in 4 main categories (health workforce, WASH and health care waste, Energy, Infrastructure, technologies, products and processes)



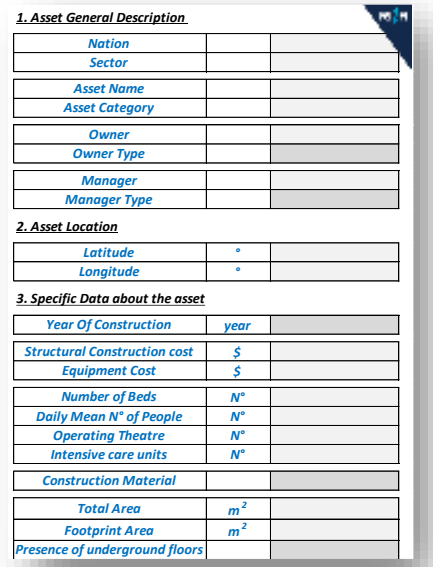


Economic loss (EL)

Estimation of the economic losses related to the occurrence of a certain hazard on a specific asset.

The aim of M3 is to assess the actual situation of the assets. The actual losses are defined through the evaluation of the Expected Annual Loss (EAL) by the combination of the three main aspect of the risk assessment, such as hazard, vulnerability, and impact.

Infrastructure / Assests / People (0)



1. Asset General Description

Nation		
Sector		
Asset Name		
Asset Category		
Owner		
Owner Type		
Manager		
Manager Type		

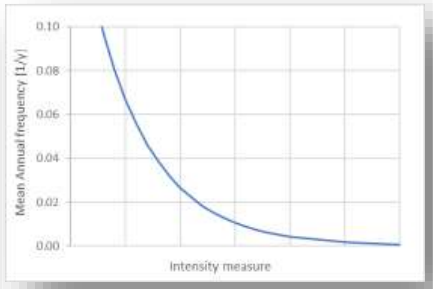
2. Asset Location

Latitude	°	
Longitude	°	

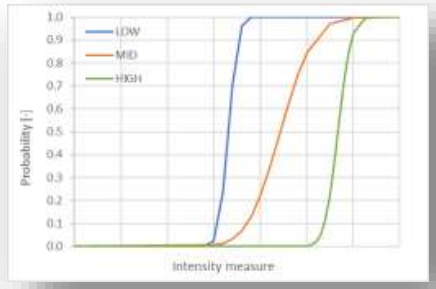
3. Specific Data about the asset

Year Of Construction	year	
Structural Construction cost	$	
Equipment Cost	$	
Number of Beds	N°	
Daily Mean N° of People	N°	
Operating Theatre	N°	
Intensive care units	N°	
Construction Material		
Total Area	m^2	
Footprint Area	m^2	
Presence of underground floors		

Climate hazard (1)



Risk & vulnerability (2)

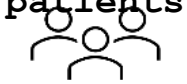


The **IMPACT** is the scale of the consequences of an event

Impact on **infrastructure**

Damage on the stuctures

Impact on **health workforce and patients**



Impact on **service continuity**

Full or partial interruption of the functionalities

$$I_{TOT,DSi} = I_{P,DSi} + I_{D,DSi} + I_{R,DSi}$$

$$I_{TOT,DSi} = f(Char, Contex, Res)$$

Infrastructure / Assets / People (0)

1. Asset General Description

Nation		
Sector		
Asset Name		
Asset Category		
Owner		
Owner Type		
Manager		
Manager Type		

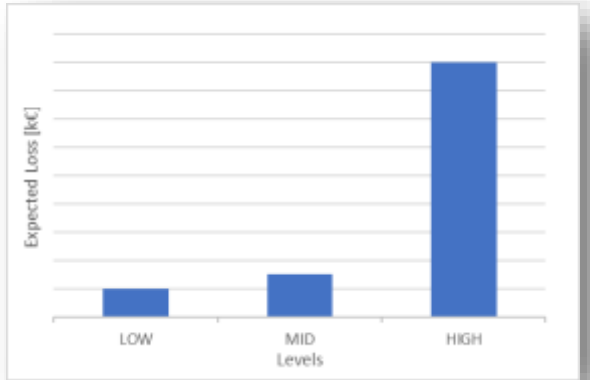
2. Asset Location

Latitude	°	
Longitude	°	

3. Specific Data about the asset

Year Of Construction	*year*	
Structural Construction cost	*$*	
Equipment Cost	*$*	
Number of Beds	*N°*	
Daily Mean N° of People	*N°*	
Operating Theatre	*N°*	
Intensive care units	*N°*	
Construction Material		
Total Area	m^2	
Footprint Area	m^2	
Presence of underground floors		

Total impact



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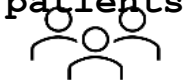
Impact on **infrastructure**

Damage on the stuctures

Impact on **health workforce and patients**



Impact on **service continuity**

Full or partial interruption of the functionalities

Infrastructure / Assets / People (0)

1. Asset General Description

Nation		
Sector		
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Year Of Construction	*year*	
Structural Construction cost	*$*	
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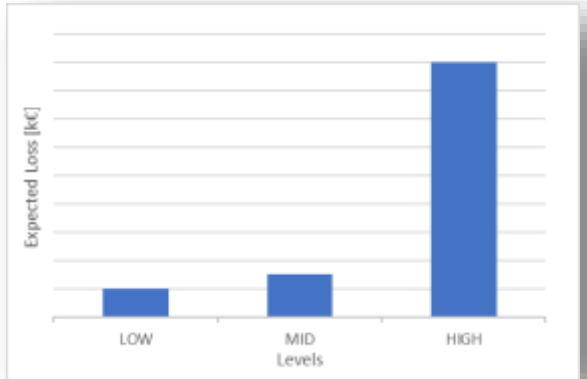
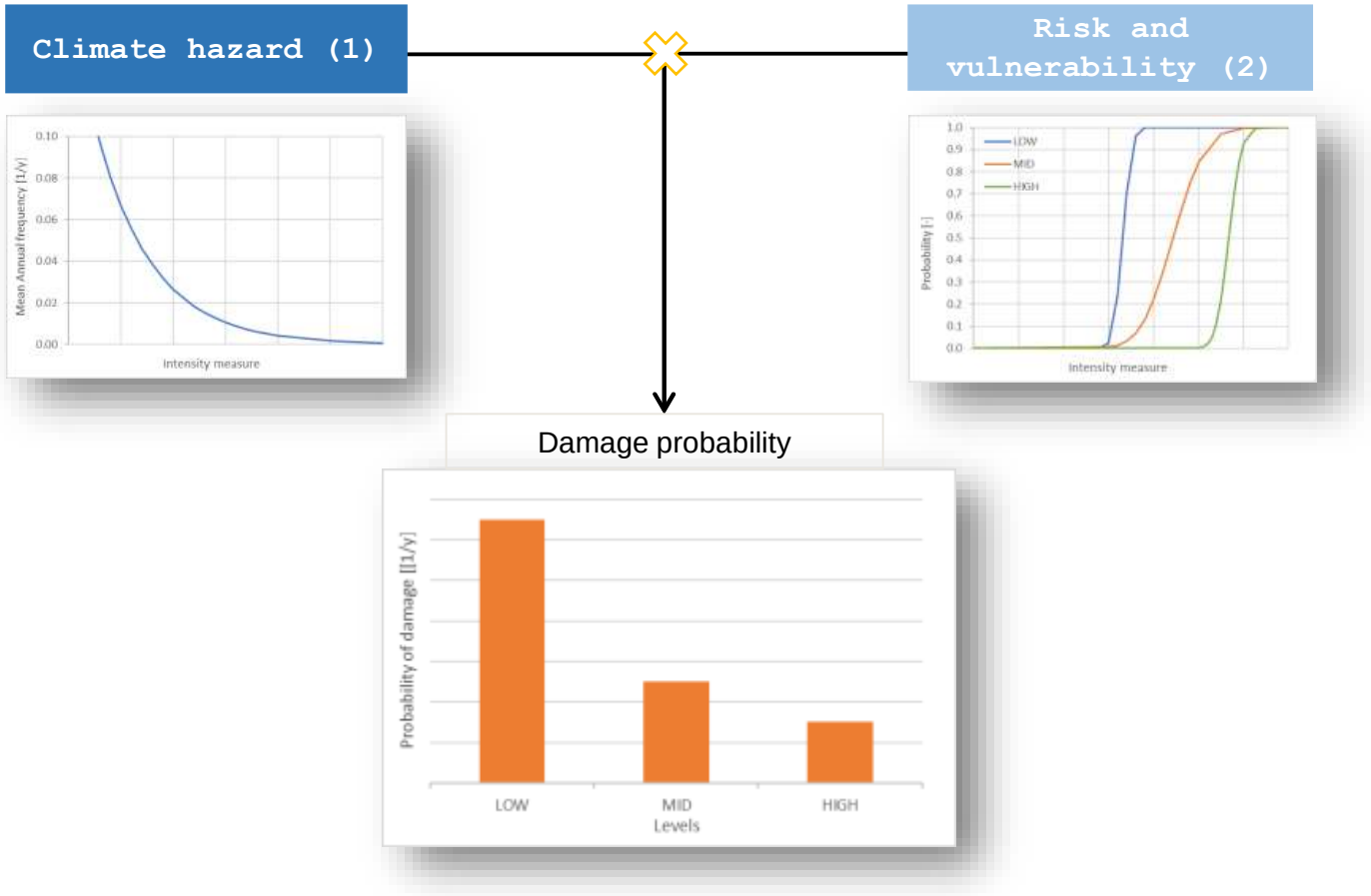
Operating Theatre	*N°*	
Intensive care units	*N°*	
Construction Material		
Total Area	m^2	
Footprint Area	m^2	
Presence of underground floors		

Total impact

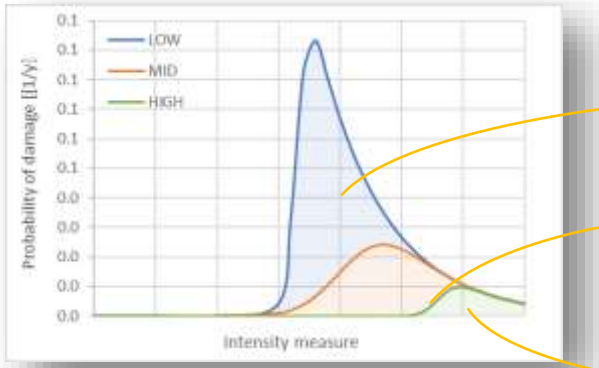


The probability of damage represents the probability that a certain impact level can occur

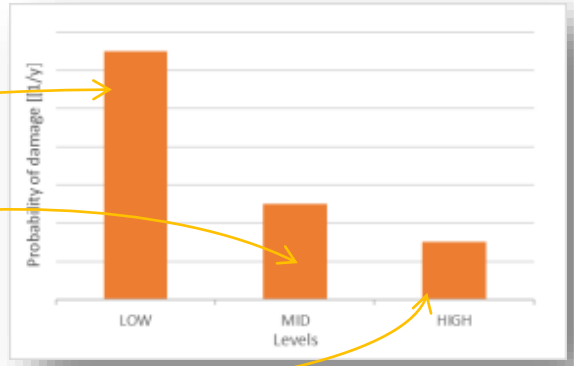


Economic Loss (EL)

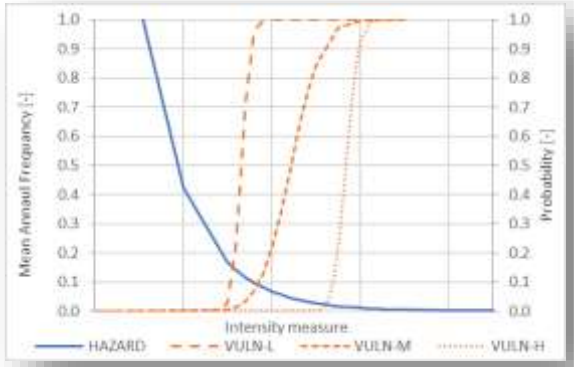
Curve of the probability of damage



Value of the probability of damage

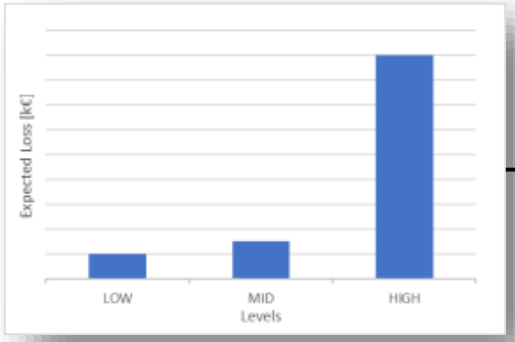


Multiplying the frequency with the probability

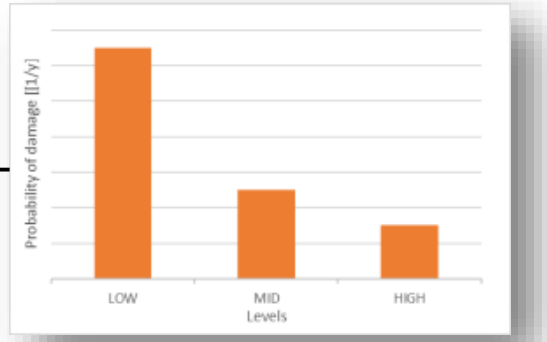


Economic Loss (EL)

Total impact

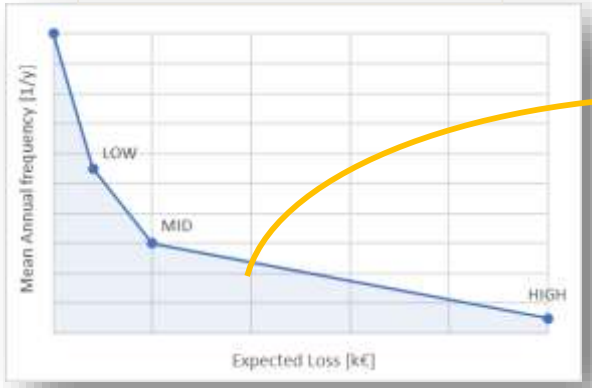


Probability of damage



$$\sum_{i=1}^{n} \frac{(I_{TOT,DS(i+1)} - I_{TOT,DSi})(P_{D\,i+1} - P_{D\,i})}{2}$$

Expected annual loss



Expected annual loss [k€/y]

A database of adaptation solutions will be proposed, classified by hazard and several other categories.

Category	Element	Adaptation measure	Description	Effect on adapt	Climatic Hazard Addres	Secondary Haza	Classification	Unit Cost
Infrastructure	Walls	Updating walls with improved external insulation	External wall insulation refers to a layer of insulation fixed to the outside face of an existing wall. The insulation can be finished with render or cladding.	Direct	Heatwaves	N/A	Grey	11l/m³
Infrastructure	Space considerations/ organization	Assessing opportunities to reorganize the layout of interior spaces to optimize solar gain all year round	Optimizing the distribution of spaces according their functions and therefore their solar needs	Direct	Heatwaves	N/A	Soft Grey	10000l/building
Infrastructure	Windows	Updating windows by replacing glazing with low solar gain, vacuum or smart glass alternatives or fritting existing glazing	Low solar gain glass has a thin coating that reflects heat,vacuum glazing has a smart glass fritting	Direct	Heatwaves	N/A	Grey	11l/m³
Infrastructure	Space considerations/ organization	Reinstating passive cooling solutions	Using design choices to reduce heat gain and increase heat loss	Direct	Heatwaves	N/A	Grey	1500l/building
Infrastructure	Services/ Utilities	Installing a CMV system with a double flow	A CMV or controlled mechanical ventilation is an aeraulic system installed within a building. Its main function is to renew the air in a building. The ventilation network of the CMV is equipped with inlets and outlets to manage the incoming and outgoing airflow.	Direct	Heatwaves	N/A	Grey	5000l/unit
Infrastructure	Roof, Vegetation	Setting-up a green roof (intensive or extensive)	A green roof system is an extension of the existing roof which involves, at a minimum, high quality waterproofing, root repellent system, drainage system, filter cloth, a lightweight growing medium, and plants. An intensive green roof has more soil depth	Direct	Heatwaves	Flooding	Green	Intensive: 250l/m³ Extensive: 140l/m³
Infrastructure	Walls, Vegetation	Setting-up green facades	A green façade is a wall completely or partially covered with greenery. A greenfaçade with climbing plants uses a trellis system to hold the vines of plants thatare rooted in the ground or containers.	Direct	Heatwaves	N/A	Green	800l/m³
Infrastructure	Roof	Painting or choosing light-coloured and reflective materials for a strong albedo in roofs or other	A coating of light or white colours reflect more of the sunlight and reduce the heat gained by building materials. Special surface coatings or materials using nano-technologies to create minuscule mirrors can be used to reflect incoming sunlight and thereby avoid heating the building.	Direct	Heatwaves	N/A	Grey	800l/m³
		Installing a solar protection system, exterior shading for windows, shutters set into						

Estimation of the economic losses related to the occurrence of a certain hazard on a specific asset, considering the implementation of different adaptation pathways.

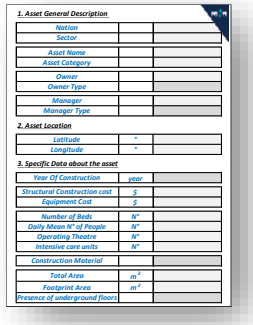
This module is closely linked to the Economic Losses module.

If module 3 is able able to the actual situation of the assets in terms of Expected Annual Loss (EAL) the aim of M6 is to consider the implementation of

Inputs :

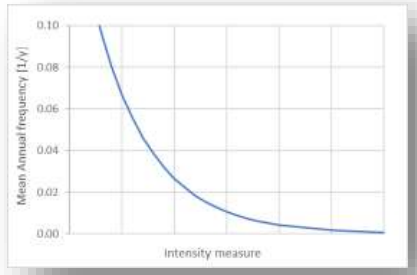
Infrastructure / Assets / People (0)

Characteristics and context



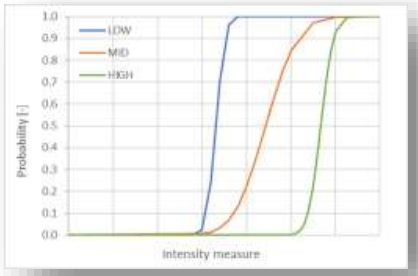
Climate hazard (1)

Hazard



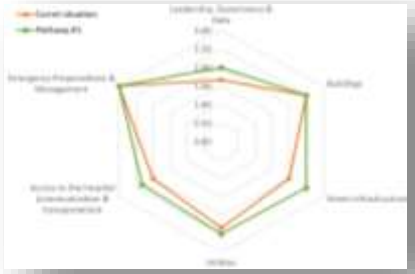
Risk and vulnerability (2)

Vulnerability



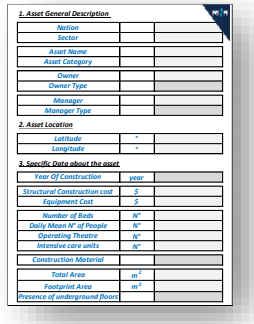
Adaptation solutions (4)

Adaptation pathways



Infrastructure / Assets / People (0)

CHARACTERISTIC & CONTEXT

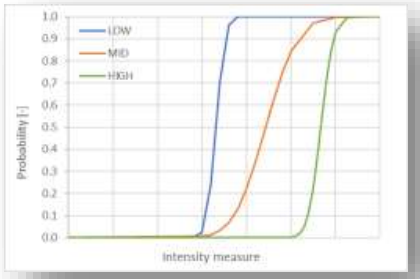


Climate Hazard (1)

HAZARD

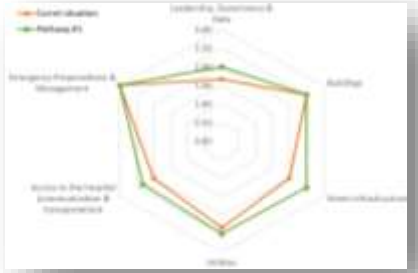
Risks and vulnerability (2)

Vulnerability



Adaptation solutions (4)

Adaptation pathway

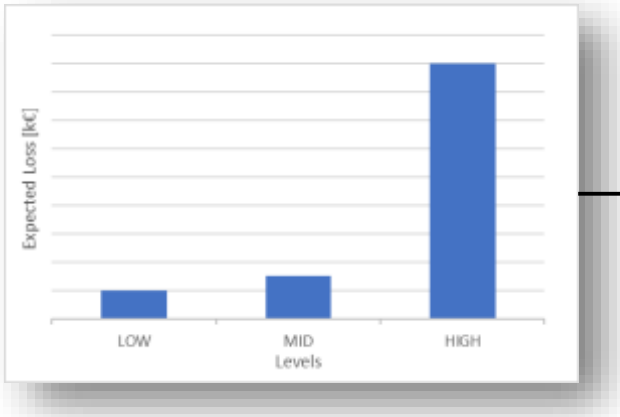


Risks and vulnerability (2)

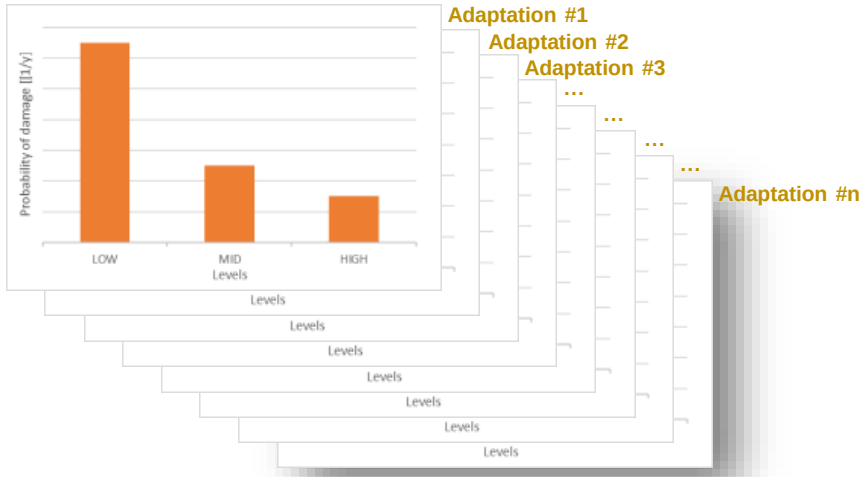
VULNERABILITY

Risks and vulnerability recalculated after implementation of adaptation measures.

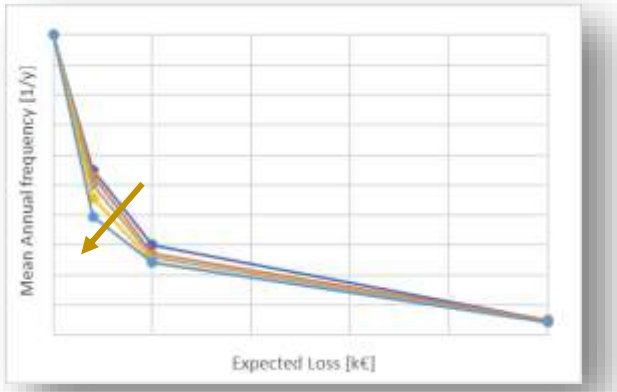
Total impact

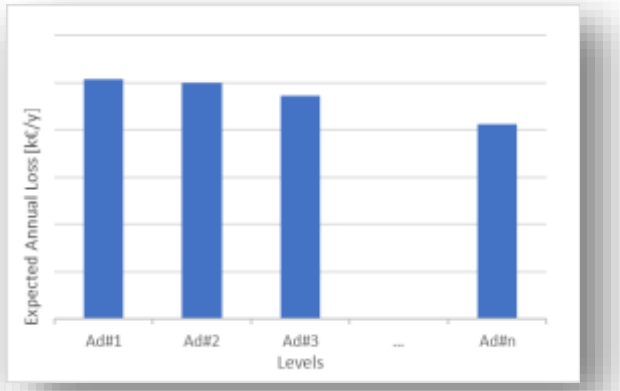


Set of probability damage

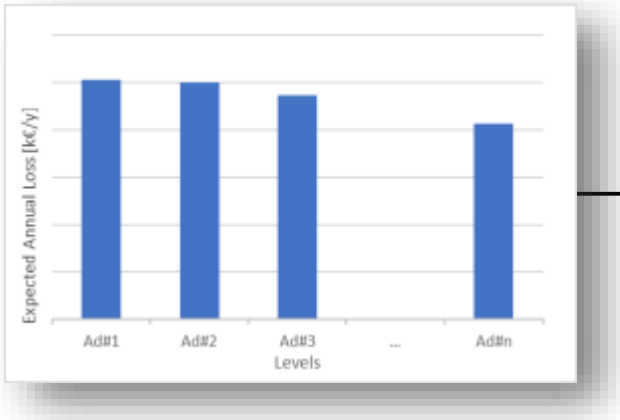


Expected annual loss

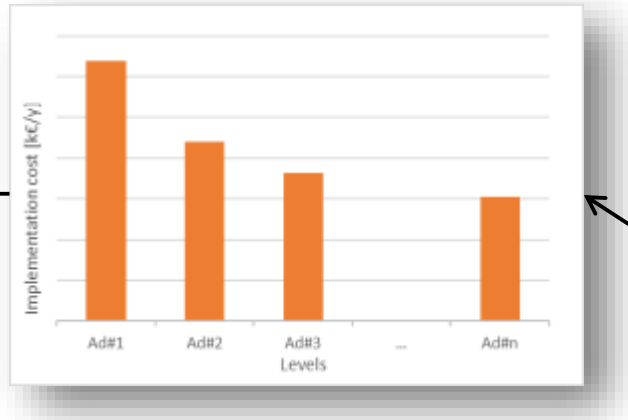




Expected annual losses

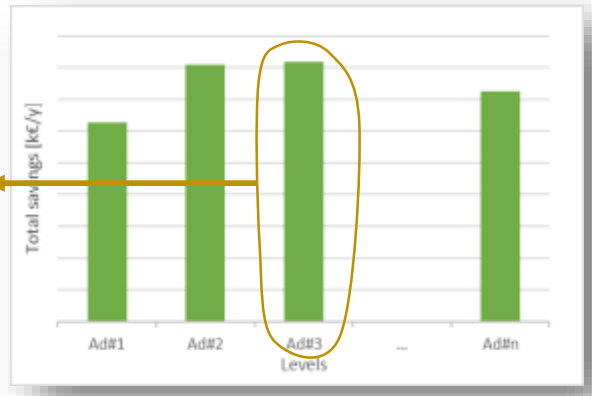


Implementation costs



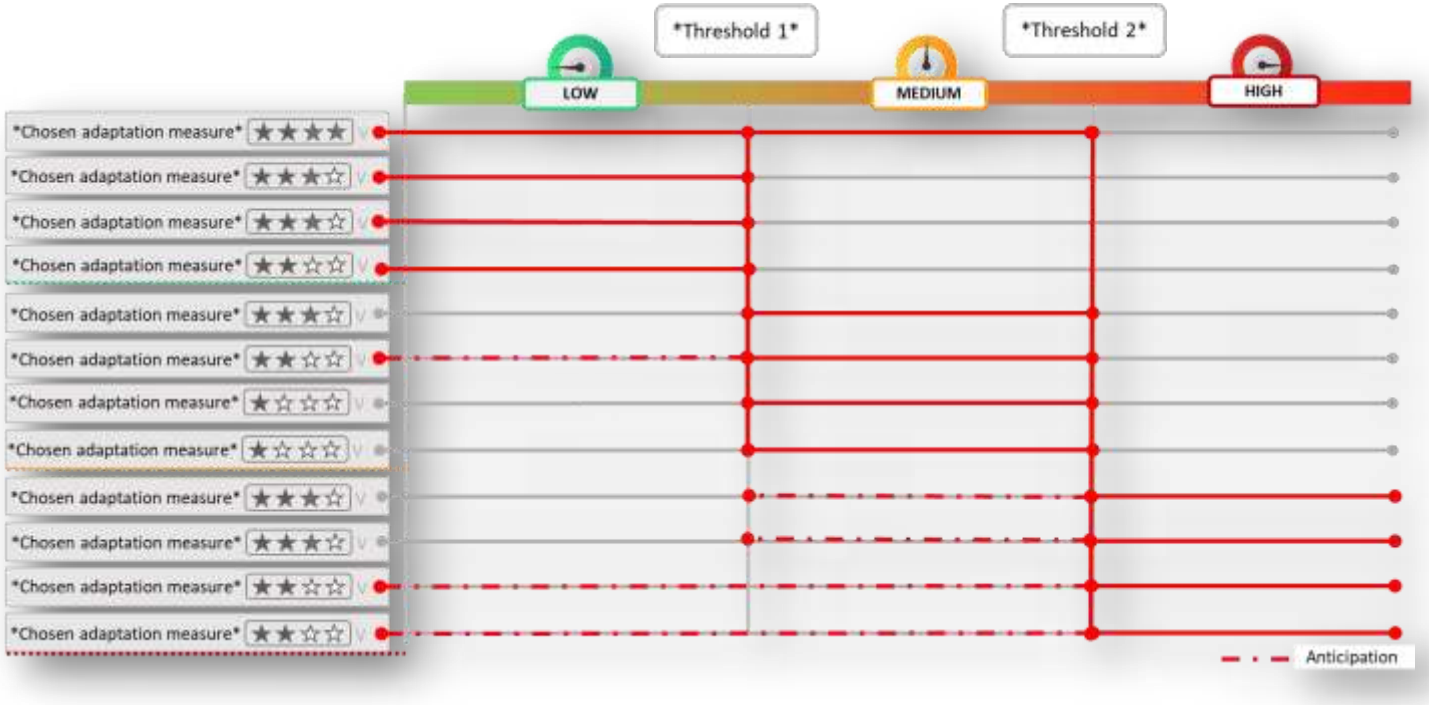
Input on adaptation solutions (4)

Total savings



COST vs BENEFIT optimum [k€/y]

Prioritization of adaptation measures based on the results of a multi-criteria analysis (cost, effectiveness, feasibility, cost-benefit ratio, environmental co-benefits, etc.) and construction of adaptation pathways



Overview

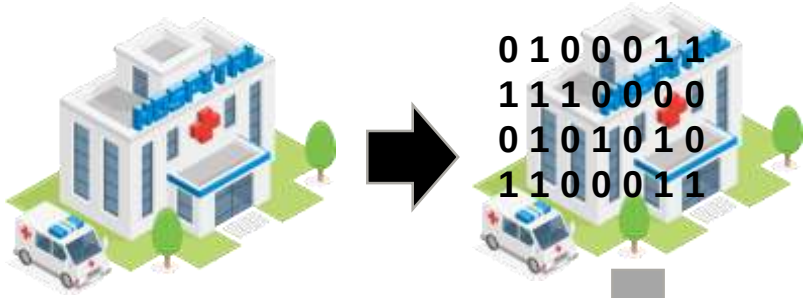
Data sources

Hospital properties

Experts

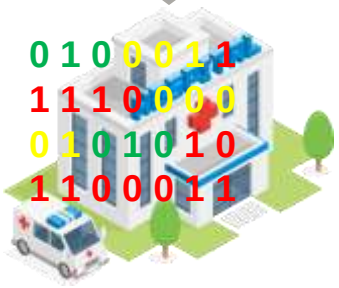
Climate data

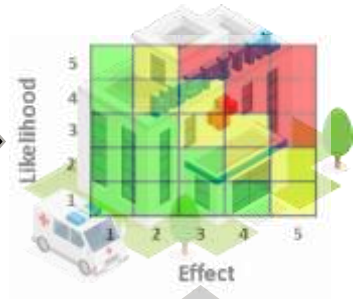
Data sources **Vulnerability & Risk**



Hospital properties

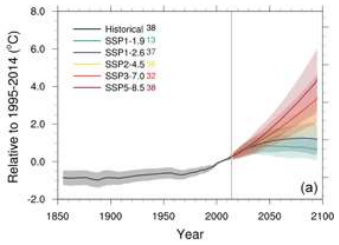
Experts



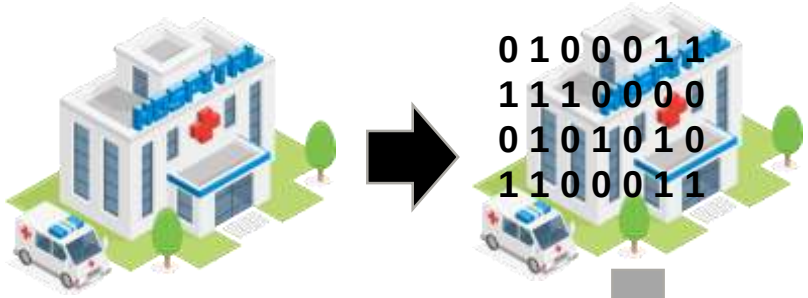


TAS, global

Climate data

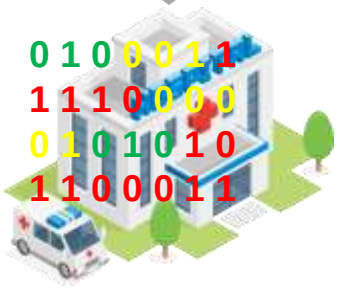


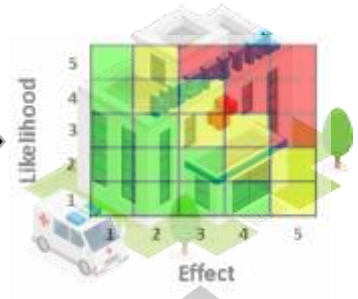
Data sources **Vulnerability & Risk**



Hospital properties

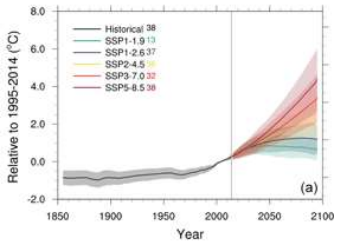
Experts





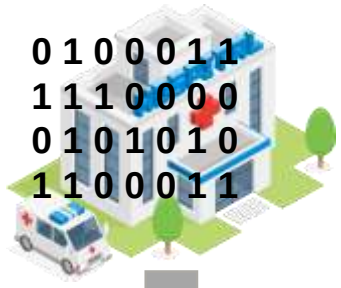
TAS, global

Climate data

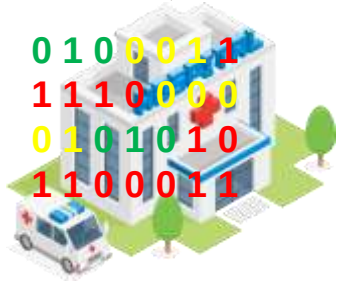


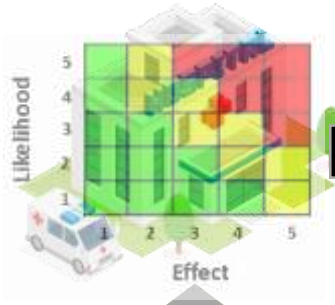
Data sources **Vulnerability & Risk** **Cost & Adaptation**

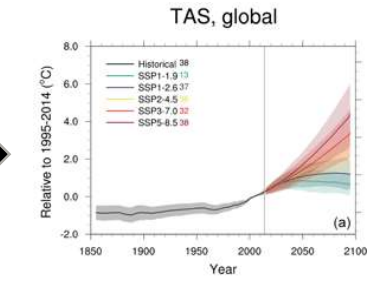
Hospital properties



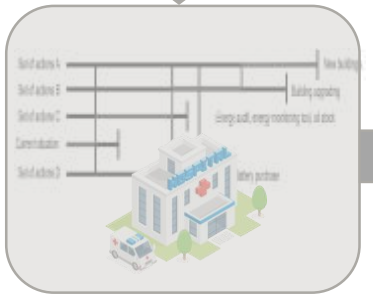
Experts

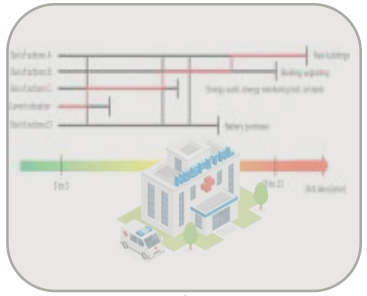


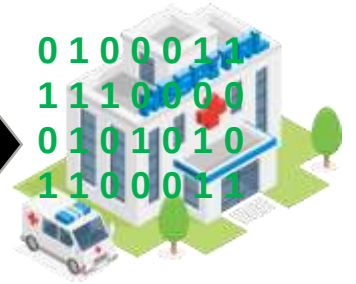




Climate data







Goal

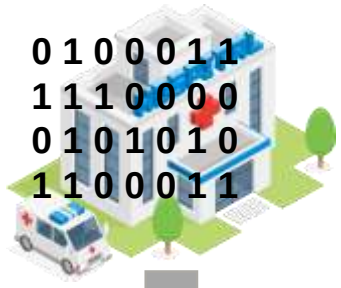
Data sources

Vulnerability & Risk

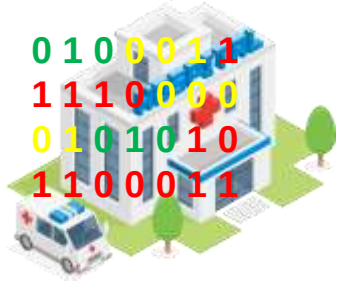
Cost & Adaptation

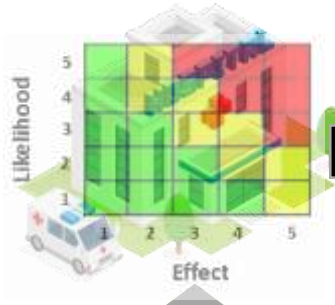
Tools for tactical information and strategic decision-making

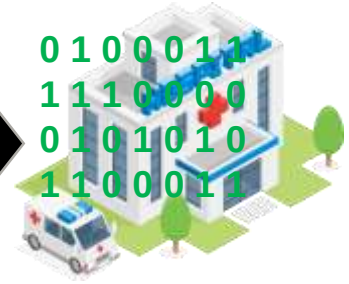
Hospital properties



Experts

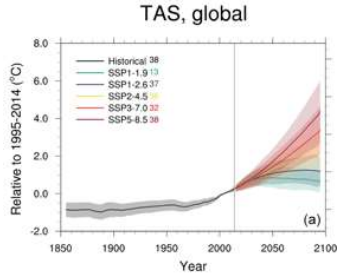


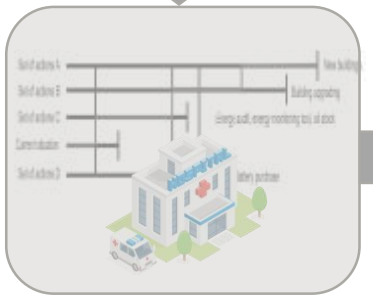




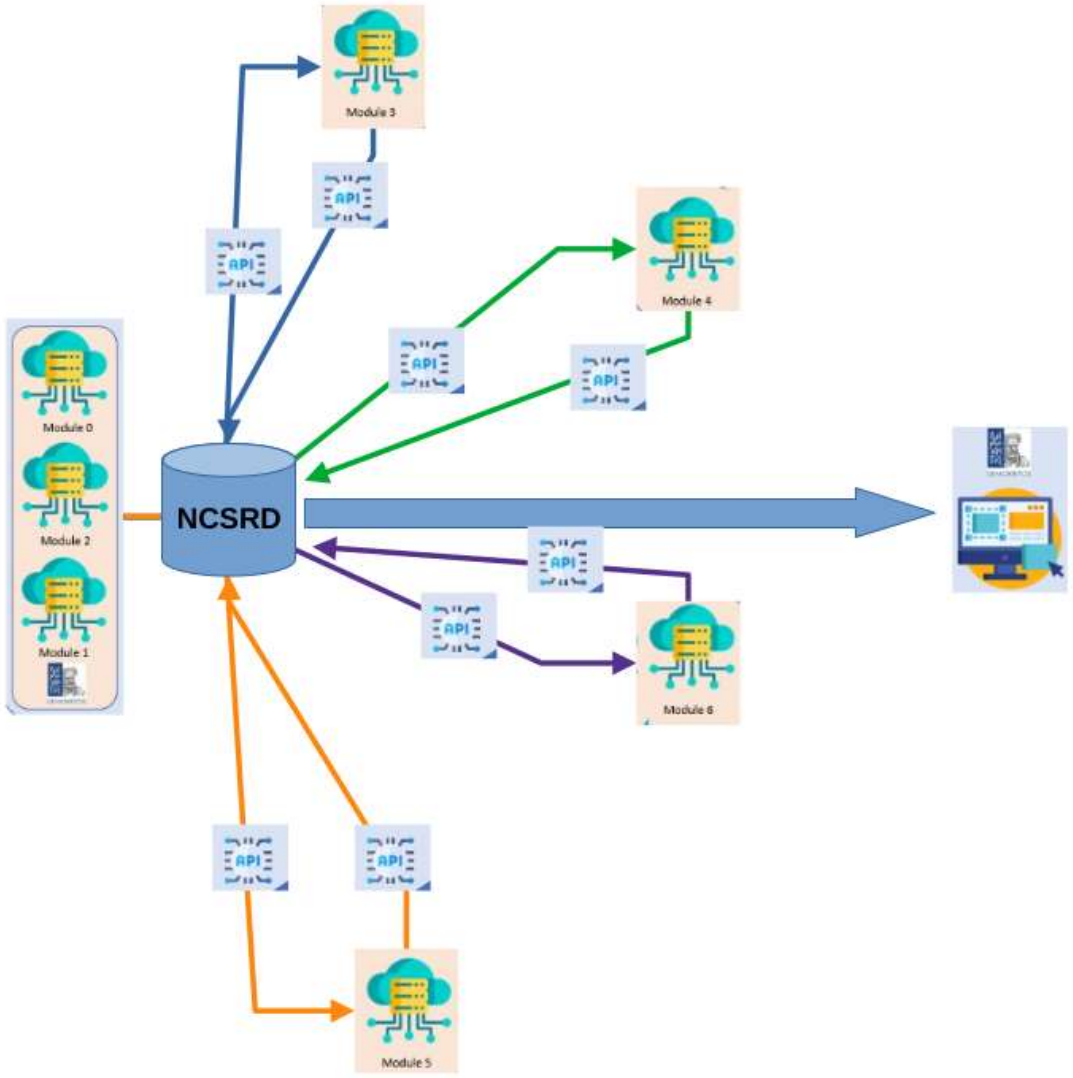
Goal

Climate data





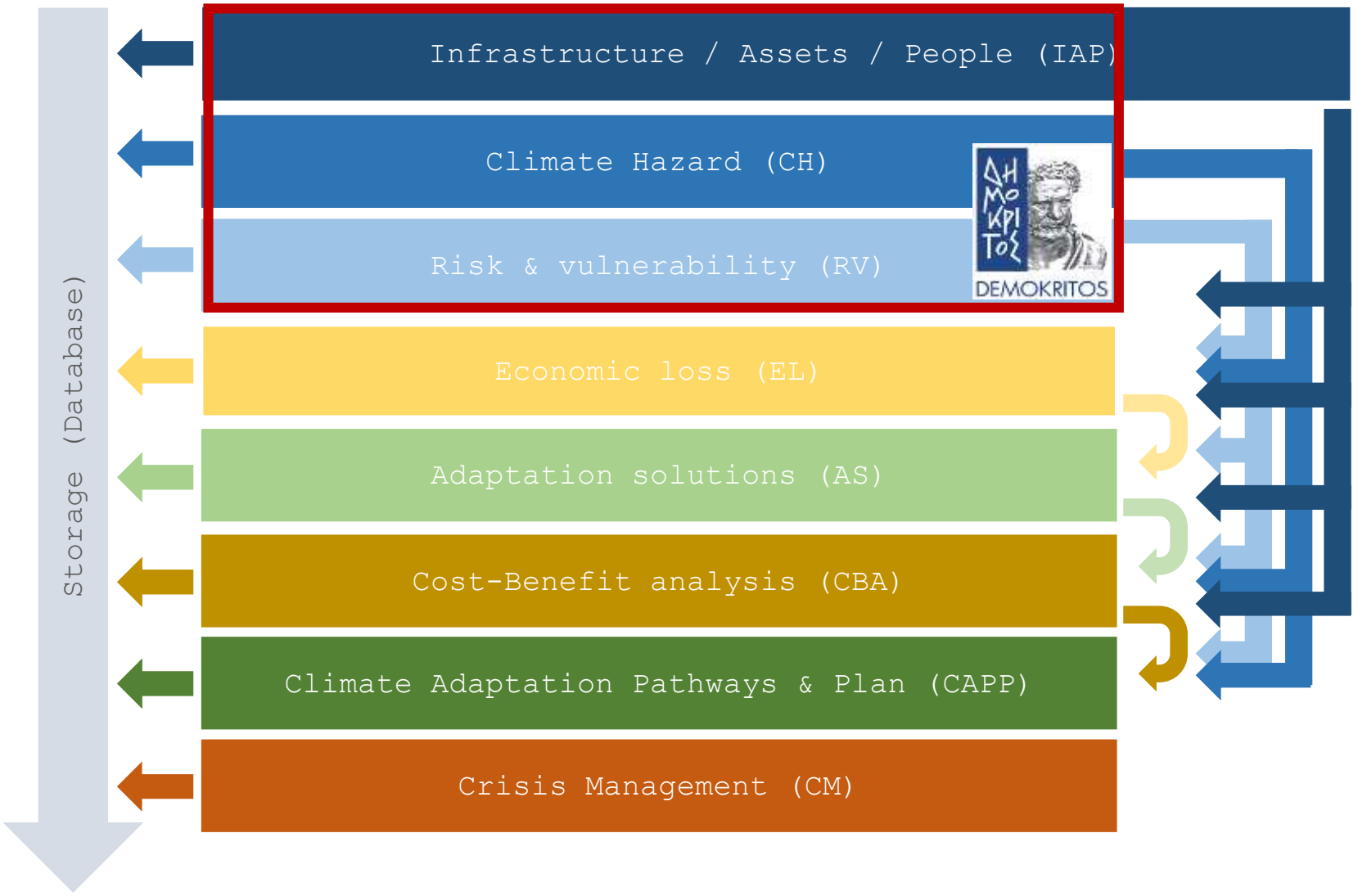
An API to connect the various modules



CLIMATE CHANGE RESILIENCE FRAMEWORK FOR HEALTH SYSTEMS AND HOSPITALS

4. Workshop 1 : Testing the climate risk assessment tool

DEMOKRITOS


Infrastructure / Assets / People (IAP)
Climate Hazard (CH)
Risk & vulnerability (RV)
DEMOKRITOS
Economic loss (EL)
Adaptation solutions (AS)
Cost-Benefit analysis (CBA)
Climate Adaptation Pathways & Plan (CAPP)
Crisis Management (CM)
Storage (Database)

Check the link :

https://mssg.ipta.demokritos.gr/life-resystal-tm/?page_id=39

Or

https://7of9.ipta.demokritos.gr:8000/en/dashboard

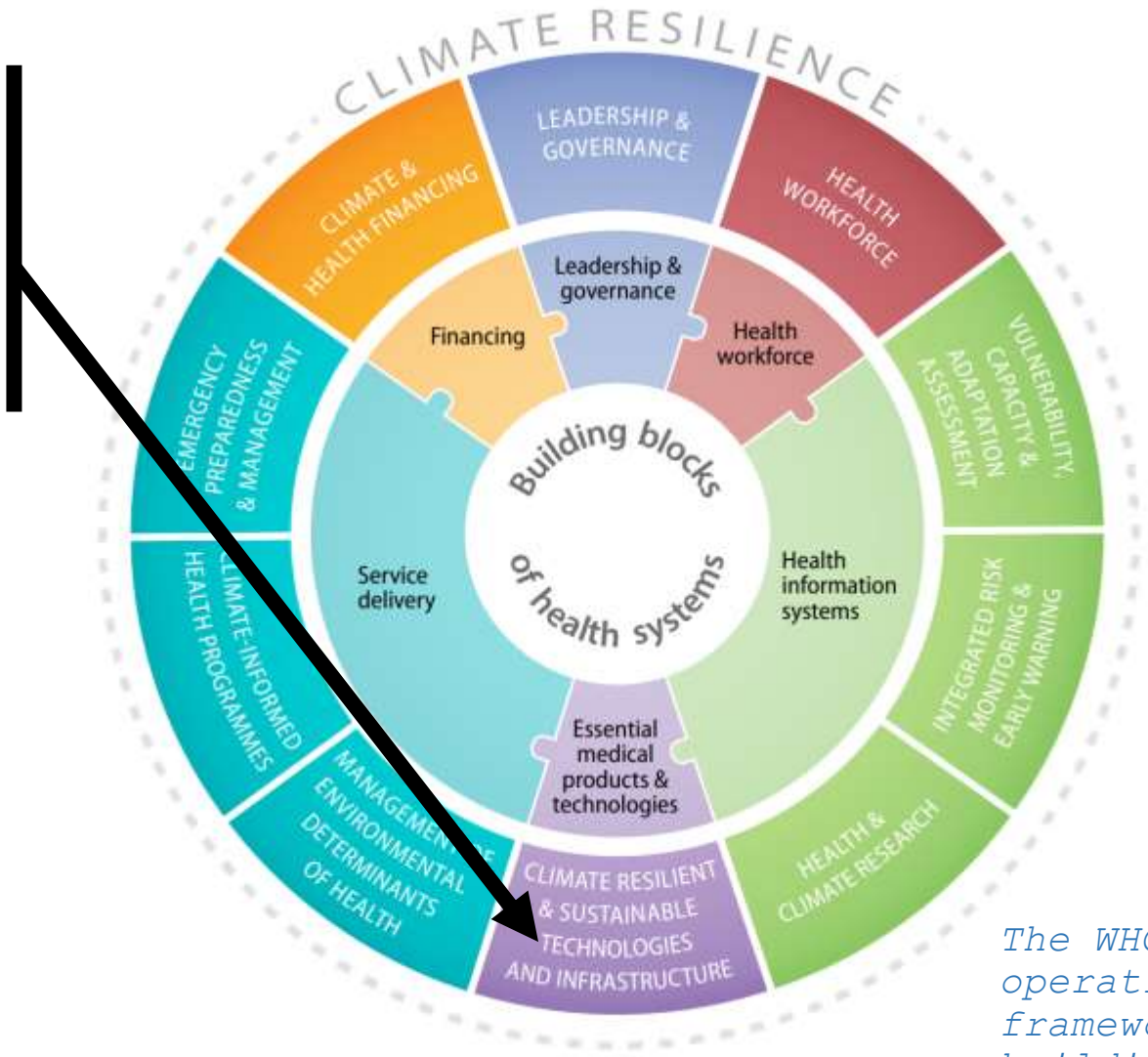
CLIMATE CHANGE RESILIENCE FRAMEWORK FOR HEALTH SYSTEMS AND HOSPITALS

5. Climate resilient investments

A review of current practices and introduction to the hospital structural adaptation inventory

ORIENTATION

- **Structural adaptation:** building and utility retrofitting, material selection, layout design and configuration, and management of energy and water resources.
- **Workforce capacity building:** developing and strengthening skills, processes and resources amongst the workforce to increase preparedness and accelerate recovery periods.



The WHO operational framework for building climate resilient health

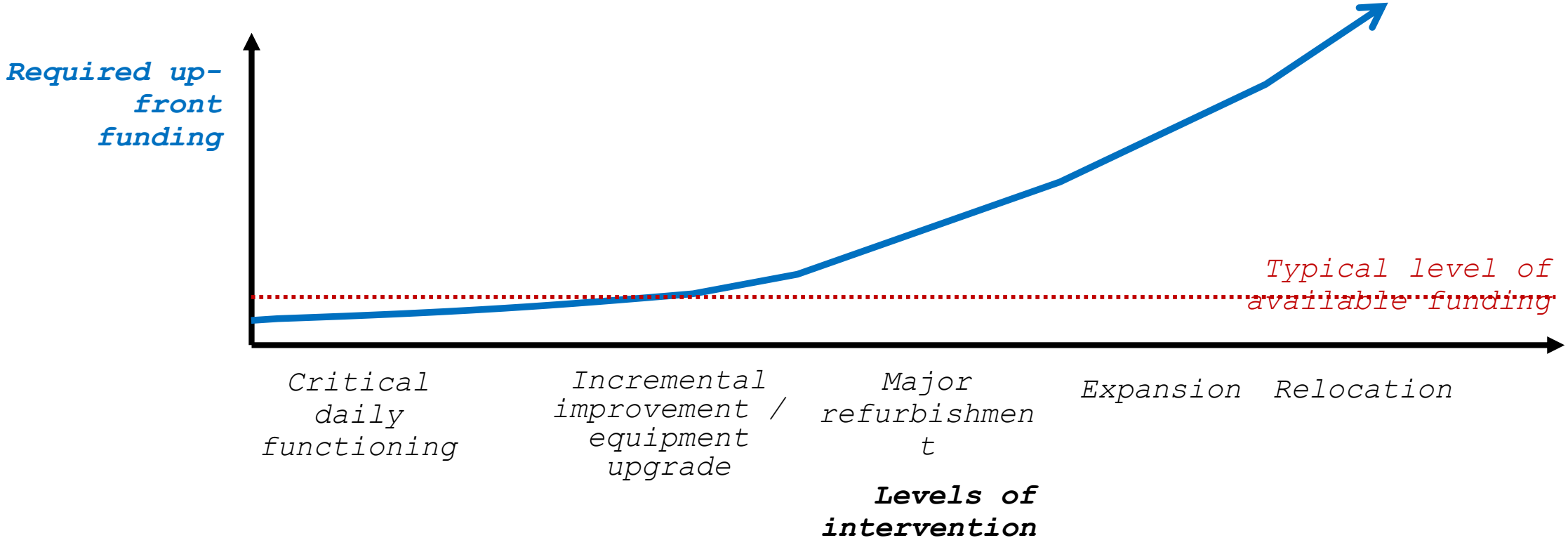
OUTCOMES OF TODAY'S SESSION

1. Understand what constitutes a structural adaptation
2. Familiarity with cases of climate adaptation of hospitals and the motivating factors behind them
3. Enhanced ability to create a case for investment*

*This outcome will not be achieved from this session alone but in combination with the other LIFE RESYSTAL training sessions.

ASSET MANAGEMENT & CLIMATE RISK MANAGEMENT

Asset management: ""the coordinated series of activities that monitor and maintain things of value – in our case, physical assets. This involves balancing risk, cost, opportunities and performance to fully and effectively realize the value of an asset ***over its entire lifespan***".



SOURCES OF GUIDANCE: CLIMATE CHANGE & ASSET MANAGEMENT

Publisher	Report Title	Purpose	Relevance for health sector/hospital estates
United Nations (UN)	Managing Infrastructure Assets for Sustainable Development: A Handbook for Local and National Governments	To provide practical guidance to local and national governments at operational and planning levels on how to manage the infrastructure assets for sustainable development.	Recognizes the need for better asset management in the health sector, specifically to deal with health emergencies and climate change pressures.
UN Principles for Responsible Investment	Climate Change for Asset Owners	To introduce the topic of climate change to asset owners. It aims to explain the importance of climate change in the context of the investment process and how to incorporate it into responsible investment policies.	Aimed at public infrastructure asset owners and managers.
International Monetary Fund	Strengthening Infrastructure Governance for Climate-Responsive Public Investment	To help governments identify potential improvements in public investment institutions and processes to build low-carbon and climate-resilient infrastructure.	
International Organization for Standardization	ISO 14090:2019	To provide guidelines to all sizes and types of organizations where their activities, products and services might be threatened by climate change. It focuses on climate change adaptation.	
UK Environment Agency	Impact of climate change on asset deterioration Report - SC120005/R1	To develop information and methods that will help to support future decision making in the context of climate change, specifically for flood and coastal erosion risks to critical infrastructure.	
Asset Management British Columbia, Canada	Climate Change and Asset Management: A Sustainable Service Delivery Primer	To integrate climate risks into British Columbia's asset management and climate change frameworks to influence management practices.	
The Coalition for Climate Resilient Investment	The Physical Climate Risk Assessment Methodology, Guidelines for Integrating Physical Climate Risks in Infrastructure Investment Appraisal	To integrate physical climate risks in infrastructure appraisal.	
The Institutional Investors Group on	Addressing physical climate risks: key steps for asset owners and asset managers	To advance a dynamic impact assessment of physical climate risks that can be incorporated in investment decision making through climate science, infrastructure asset management and engineering, and infrastructure finance.	

SOURCES OF GUIDANCE: SPECIFIC TO THE HEALTH SECTOR

Publisher	Report Title	Purpose	Relevance for the health sector/hospital estates
UK Department of Health	Health Building Note 00-07 Planning for a resilient healthcare estate	To help NHS-funded providers to determine appropriate levels of resilience for sites, buildings and installations against a wide range of emergencies, hazards and threats and their impacts and consequences including resilience to the impacts of climate change.	Highly specific for hospital estates and asset managers of this type of infrastructure.
US Department of Health and Human Services' Sustainable and Climate Resilient Health Care Facilities Initiative	A Toolkit for Sustainable and Climate-Resilient Facilities	To help assess vulnerability through a web-based toolkit and document medical facilities and suggestions for building resilience that has climate risks, infrastructure protection and resilience planning as some of its pillars. A recent addition is a high-level document on “Developing a Climate Resilience Plan for healthcare organisations: Key Considerations” has been released.	
World Health Organisation	Safe Hospitals in Emergencies and Disasters: Structural, Non-Structural and Functional Indicators	To serve as a guide for better structural and non-structural assessment and functional vulnerabilities. Also, to promote resilient hospital construction retrofitting of existing ones.	
Healthcare Without Harm	Addressing Climate Change in the Health Care Setting Opportunities for Action	To propose a multi-pronged approach for facilities operation: transportation, energy/operations, energy/built environment, waste and food service and promote climate change mitigation and adaptation.	

CLIMATE ADAPTATION VERSUS MITIGATION

Adaptation* (to climate change):

Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.

Mitigation*:

An anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases

Net Zero:**

"Reduction of emissions to as close to zero as possible."

Structural adaptation: interventions directly related to the physical infrastructure and associated land. E.g. building and utility retrofitting, material selection, layout design and configuration, and management of energy and water resources.

*Definitions from IPCC 2001 AR

** Definition from UK Department for Business, Energy & Industrial Strategy, 2021

HOW MIGHT STRUCTURAL ADAPTATIONS APPLY TO A HOSPITAL ESTATE*?

Buildings	**Utilities/services**	**Land**	**Communications/IT & transport**
Main structure	Heating	Green infrastructure (trees/planting)	IT mainframe
Fixtures	Cooling	Blue infrastructure (water features	Comms systems
Fittings/furnishings	Electricity	Grey: Paved areas (roads, parking areas)	Ambulances
	Water		Other vehicles
	Waste		
	Medical equipment		

*alternative terms for hospital estate include hospital/healthcare facilities, hospital complex, healthcare infrastructure

HOW MIGHT STRUCTURAL ADAPTATIONS APPLY TO A HOSPITAL ESTATE*?

Buildings	Utilities/services	Land	Communications/IT & transport
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	Waste		
	Medical equipment		

WHAT IS A STRUCTURAL ADAPTATION ?

Green roof

Wall/roof fabric

Glazing

Ventilation/air conditioning

Reinforced structures

Water supply/management

Mechanical plant

Heating

Location/relocation of a critical function

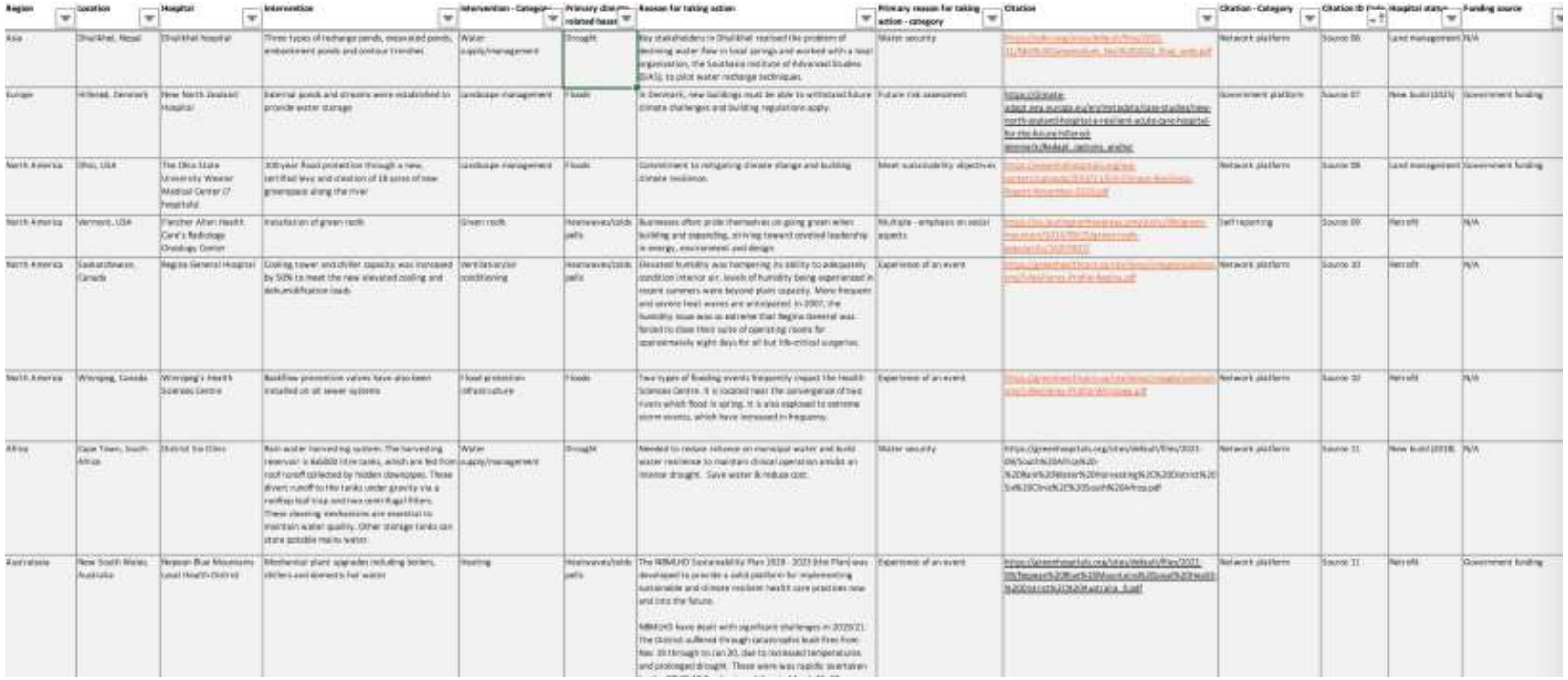
Landscape management

Flood protection infrastructure

Image generated using Canva from the prompt: A group of very old basic hospital buildings, one building with a green roof, surrounded by a large area of landscaped grounds. Show areas with trees and dry open areas without trees. Situate with a river on one side. City backdrop. Created 31/10/2023

AN INVENTORY OF PHYSICAL ADAPTATION MEASURES

- Structural measure
- Type of intervention (12 categories of measures)
- Location details
- Climate hazard
- Motivation/trigger for investment
- Source of



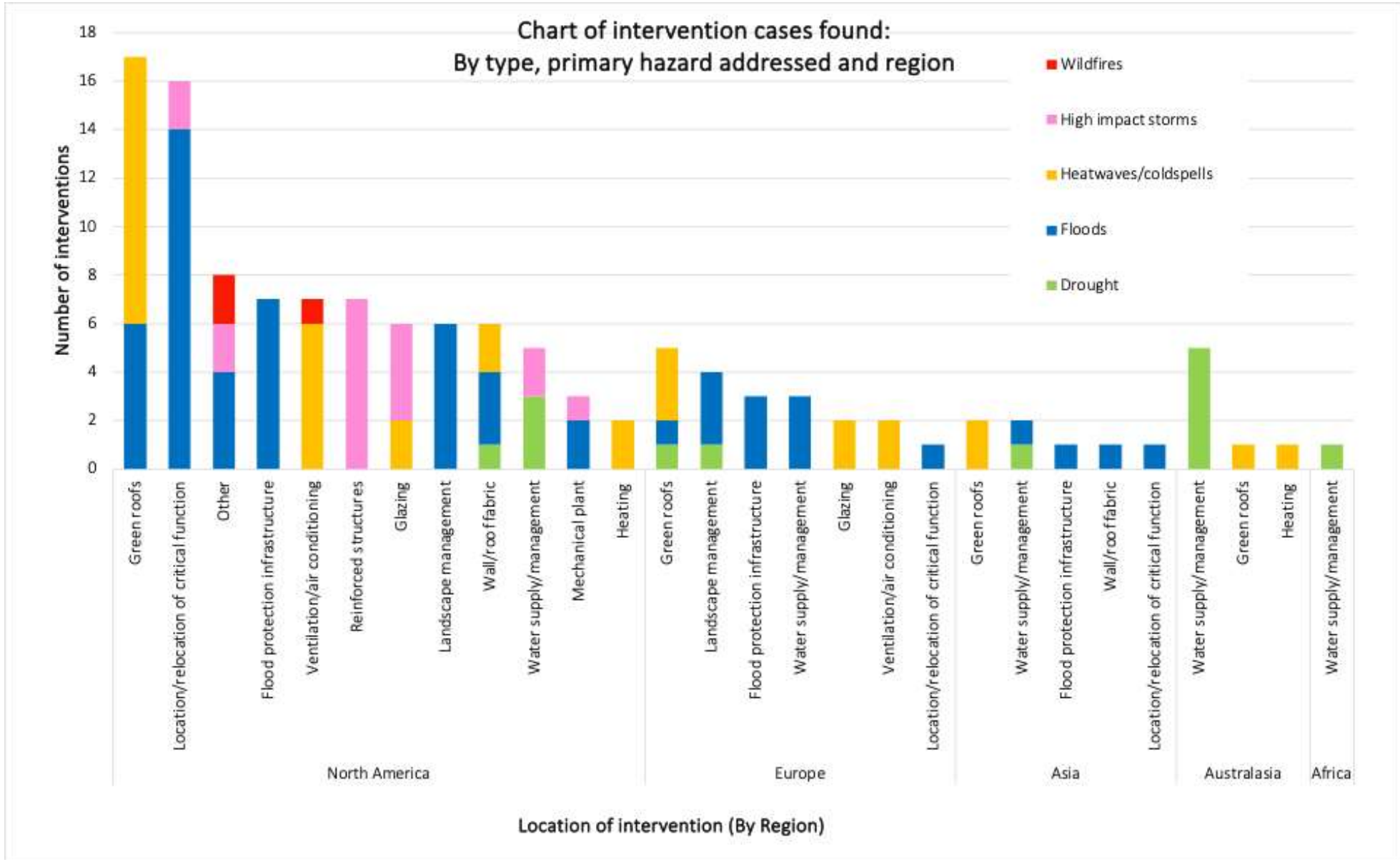
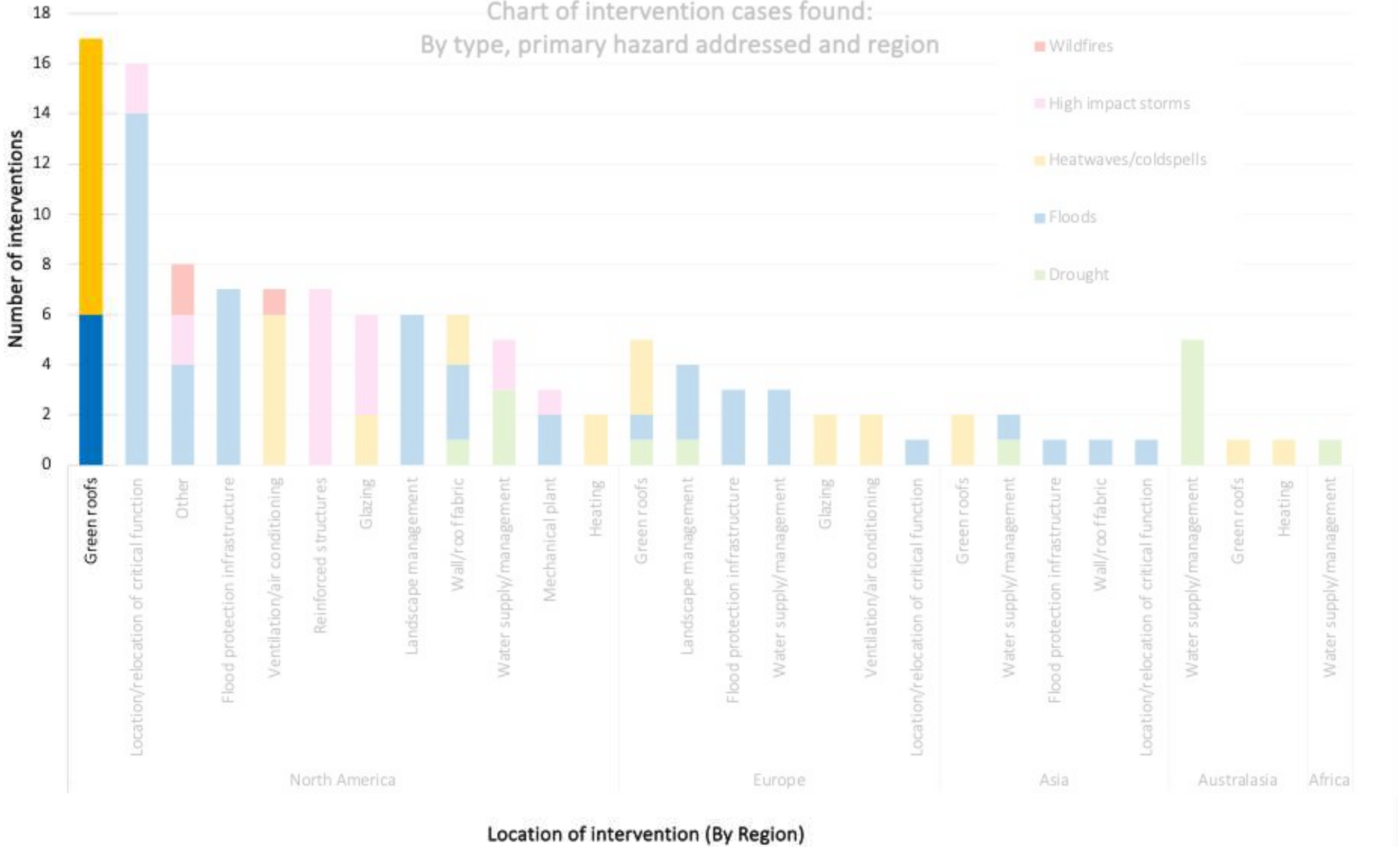


Chart of intervention cases found:
By type, primary hazard addressed and region
Number of interventions
18
16
14
12
10
8
6
4
2
0
Wildfires
High impact storms
Heatwaves/coldspells
Floods
Drought
Green roofs
Location/relocation of critical function
Other
Flood protection infrastructure
Ventilation/air conditioning
Reinforced structures
Glazing
Landscape management
Wall/roof fabric
Water supply/management
Mechanical plant
Heating
Green roofs
Landscape management
Flood protection infrastructure
Water supply/management
Glazing
Ventilation/air conditioning
Location/relocation of critical function
Green roofs
Water supply/management
Flood protection infrastructure
Wall/roof fabric
Location/relocation of critical function
Water supply/management
Green roofs
Heating
Water supply/management
North America
Europe
Asia
Australasia
Africa
Location of intervention (By Region)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6
4
2
0
Wildfires
High impact storms
Heatwaves/coldspells
Floods
Drought
Green roofs
Location/relocation of critical function
Other
Flood protection infrastructure
Ventilation/air conditioning
Reinforced structures
Glazing
Landscape management
Wall/roof fabric
Water supply/management
Mechanical plant
Heating
Green roofs
Landscape management
Flood protection infrastructure
Water supply/management
Glazing
Ventilation/air conditioning
Location/relocation of critical function
Green roofs
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Wall/roof fabric
Location/relocation of critical function
Water supply/management
Green roofs
Heating
Water supply/management
North America
Europe
Asia
Australasia
Africa
Location of intervention (By Region)

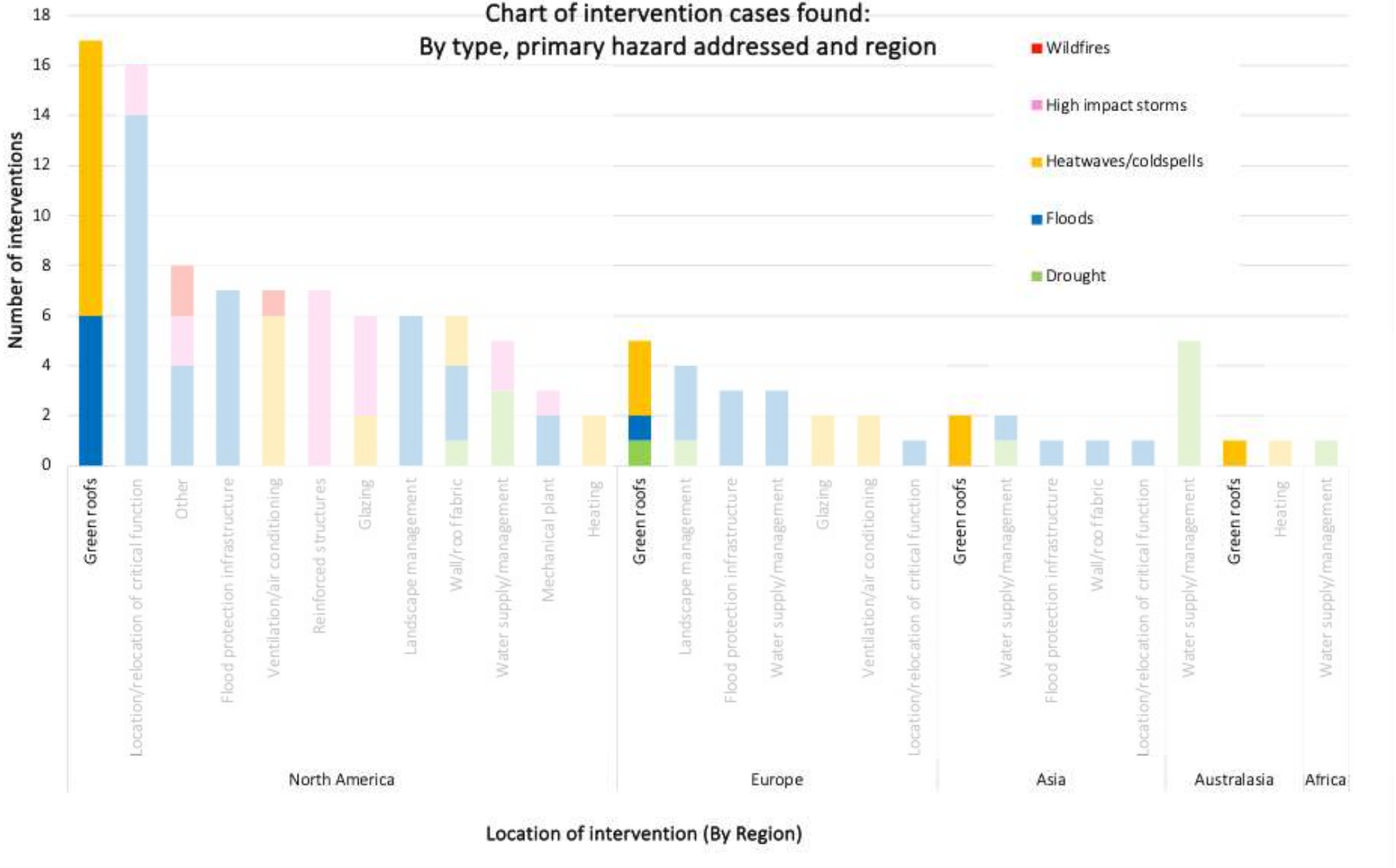
Chart of intervention cases found:
By type, primary hazard addressed and region
Number of interventions
0
2
4
6
8
10
12
14
16
18
Wildfires
High impact storms
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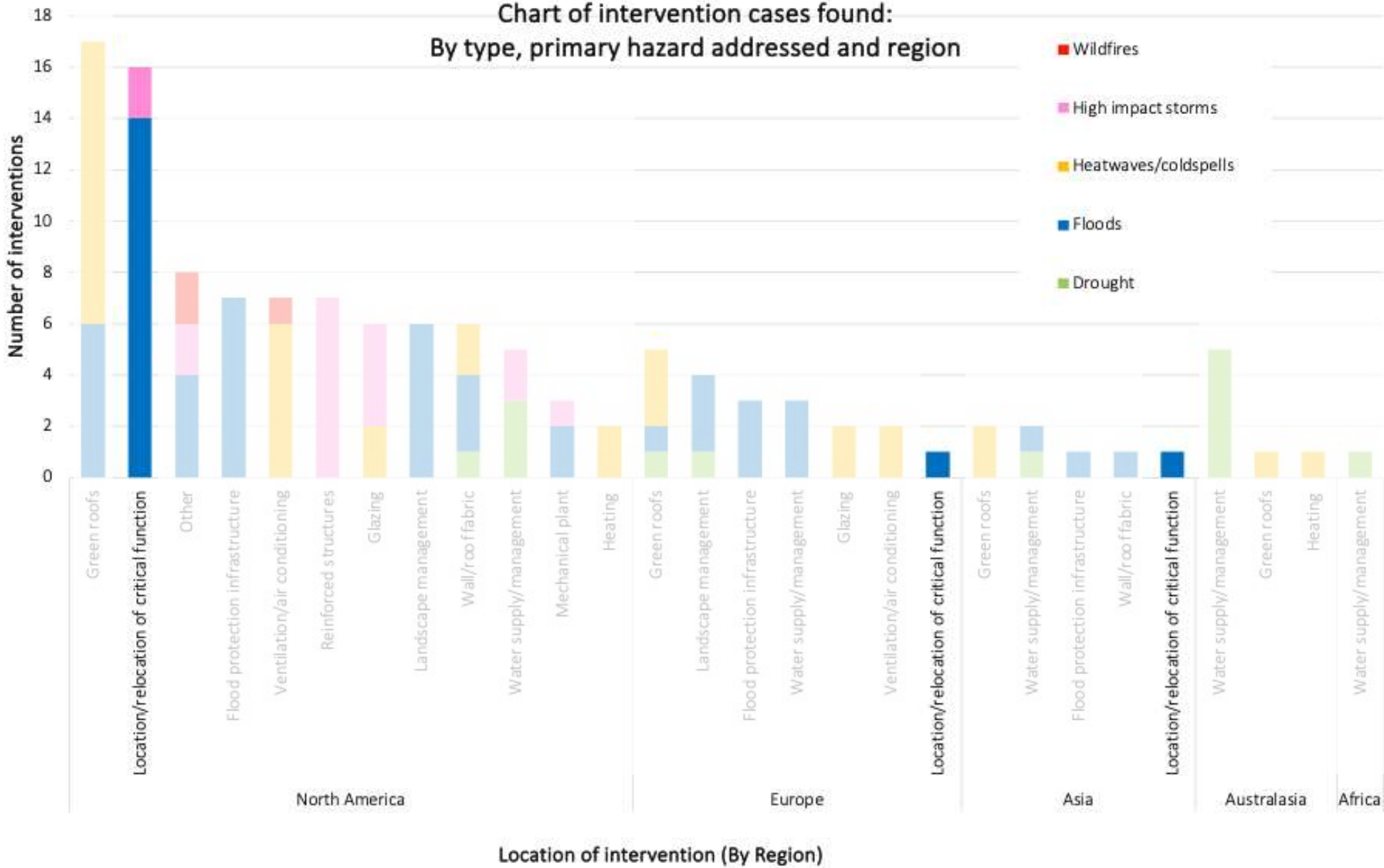
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North America
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Location of intervention (By Region)

WHY WERE THESE MEASURES IMPLEMENTED?

Primary motivating factor	No. of examples
Experience of an event	39
Future risk assessment	32
Meet sustainability objectives	15
Multiple – Emphasis on social aspects	17
Water security	11
Sustainability certification	6
Insurance premiums	4

The inventory records one main factor. In reality, there can be several motivating reasons

CASE 1: BOULDER COMMUNITY FOOTHILLS HOSPITAL IN BOULDER, COLORADO

Boulder Creek

Imagery ©2023 Google, Imagery ©2023 Airbus, CNES / Airbus, Maxar Technologies, U.S. Geological Survey, USDA/FPAC/GEO, Map data ©2023

Image capture: Apr 2023 © 2023 Google

CASE 2: NYU* LANGONE, UNITED STATES

*NEW YORK UNIVERSITY

- Installed a flood wall system and 12-foot-high steel storm barriers

- Elevated critical infrastructure & IT

- Also focused on wider sustainability efforts

- Redundancy and back-up systems

Photo: Peninsula, Hunter's Point South Park, Hunters Point, Queens, 2019. Tdorante10 CC-BY-SA-4.0 Sourced from Wikimedia Commons

Example 2: Cool Roofing on the Adamant Hospital in Paris, France

Climate hazard :

Heat

Resilient Strategy “ Passive cooling ”

- ➔ Application of a white coating with thermo-reflective and anti-UV properties on the roofs of the barge (can be applied to much larger surfaces)

Results :

- ➔ Indoor temperature felt reduced by **6 to 15 °C**
- ➔ Better thermal comfort for nursing staff and patients
- ➔ Significant drop in air conditioning costs during the summer

Example 3: Dealing with flooding at Spaulding Rehabilitation Center (Boston, USA)

Climate hazard :

Flooding

Resilient strategy: cohabiting with water

- ➔ Objective: keeping the site close to water (rehabilitation programs) while reducing the risk of damage in the event of flooding
- ➔ Building level raised above to protect against possible flooding

Results :

- ➔ The ground floor of the building can be flooded without causing major damage, allowing services on upper floors to remain operational
- ➔ Patient comfort is maintained (sea view)

Example 4: Greening the roof terrace at the Hospital Military Percy, Clamart , France

Climate hazard :

Heatwaves

Resilient strategy: green roof

➔ Objective: the mental and physical well-being of patients and biodiversity

Results :

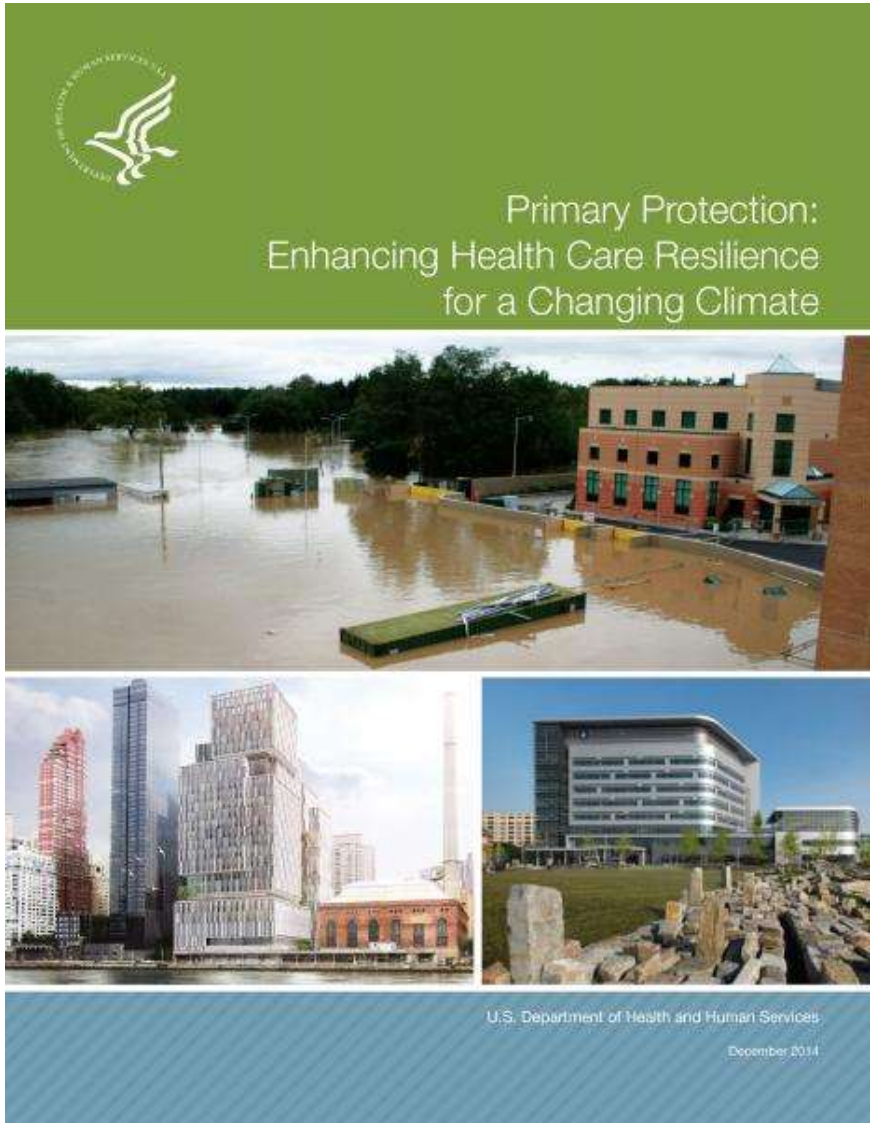
- Reduced temperatures
- Relaxation area for patients and nursing staff

LIMITATIONS

- Covers sources in selected academic databases, as well as a general search of the internet (subject to what is accessible via Google and how the search engine’s algorithms decides to prioritise)
- Covers sources in English language only

TO CONCLUDE

- Data is sparce – limited sharing of practice.
- Action is often driven by a reactive approach rather than anticipatory
- Motivations for adaptation are varied. Often it takes the experience of a major event to spur more significant action. But there are other incentives
- Earlier efforts in the



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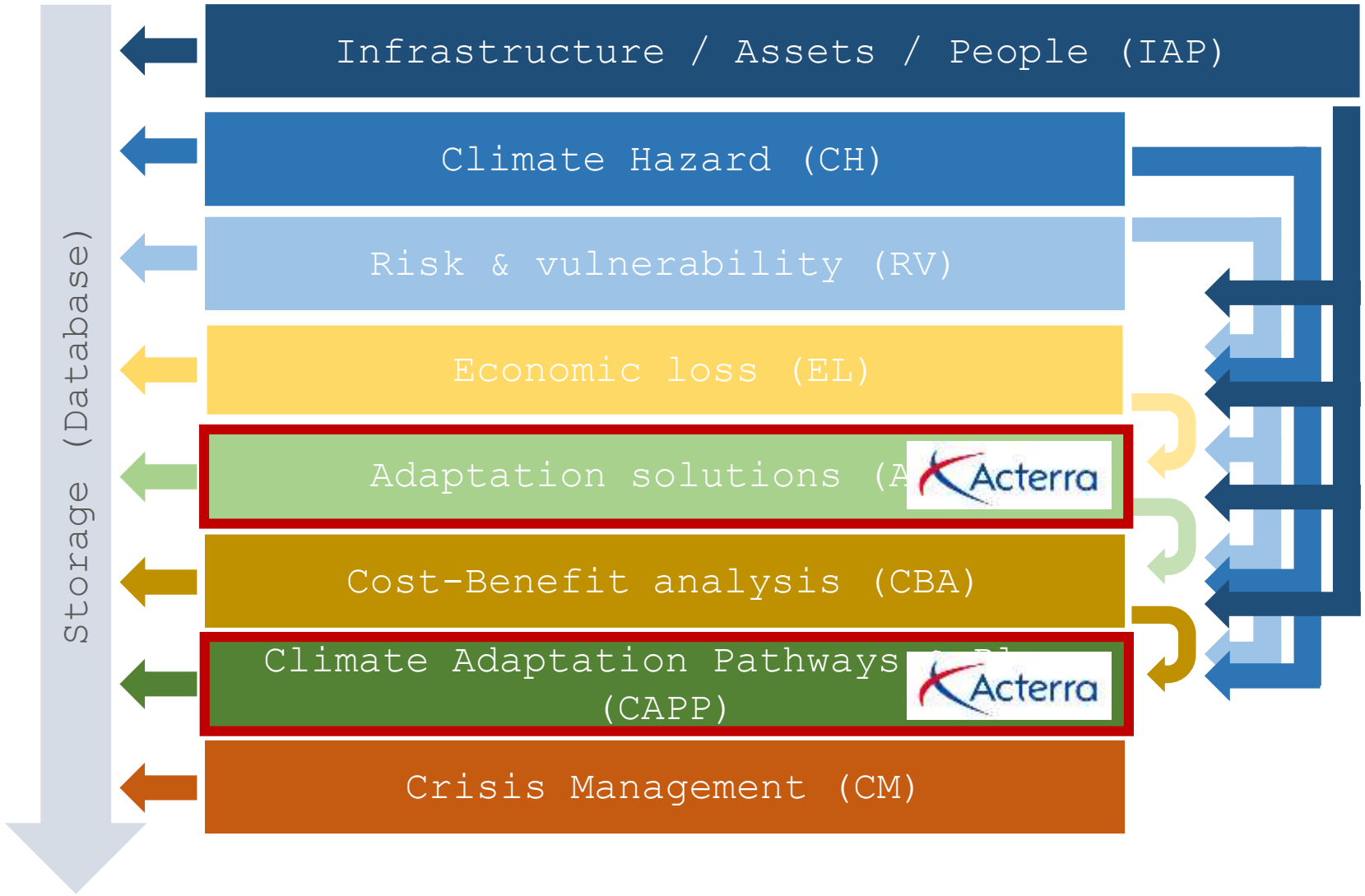
CLIMATE CHANGE RESILIENCE FRAMEWORK FOR HEALTH SYSTEMS AND HOSPITALS

6. Workshop 2 : Priorization of adaptation measures and pathways


Infrastructure / Assets / People (IAP)
Climate Hazard (CH)
Risk & vulnerability (RV)
Economic loss (EL)
Adaptation solutions (A
Acterra
Cost-Benefit analysis (CBA)
Climate Adaptation Pathways
(CAPP)
Acterra
Crisis Management (CM)
Storage (Database)

Adaptation pathways

"Sequences of actions, which can be implemented progressively ***depending on future dynamics****."*
(Werners, et al., 2021)

Adaptation pathways is an emerging research concept.
It addresses one of the major issues faced by decision-makers : **climate change <u>uncertainty</u>.**

There is no common approach to the development of climate adaptation pathways.
→ It's a context and stakeholder driven process.

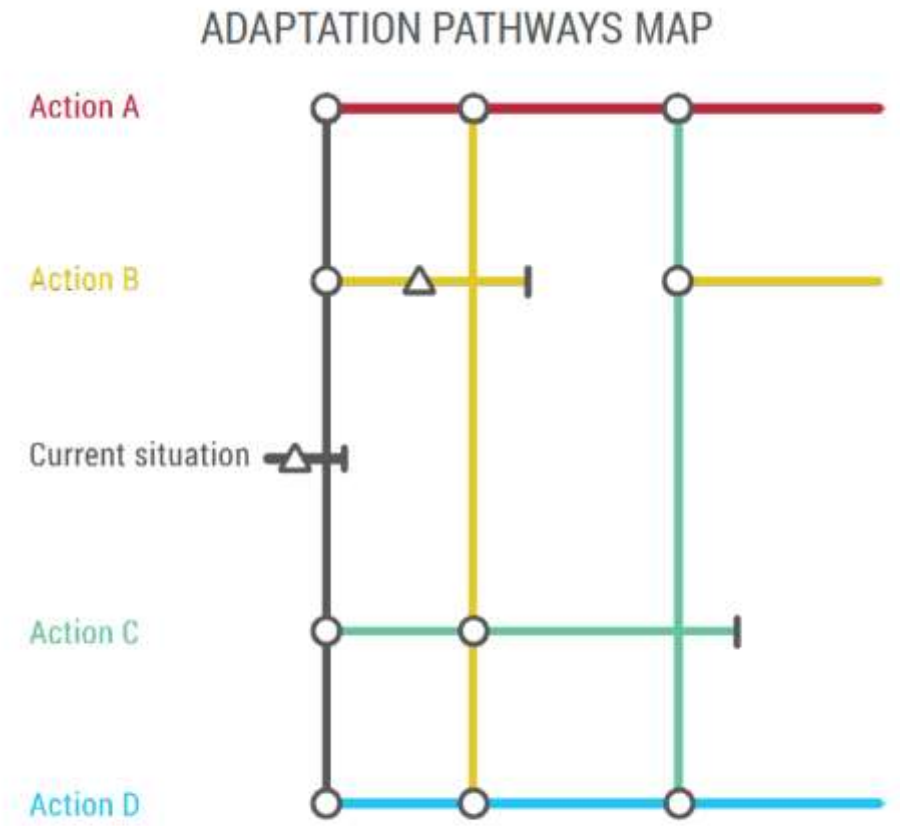


Figure 2 - Adaptation Pathways Map

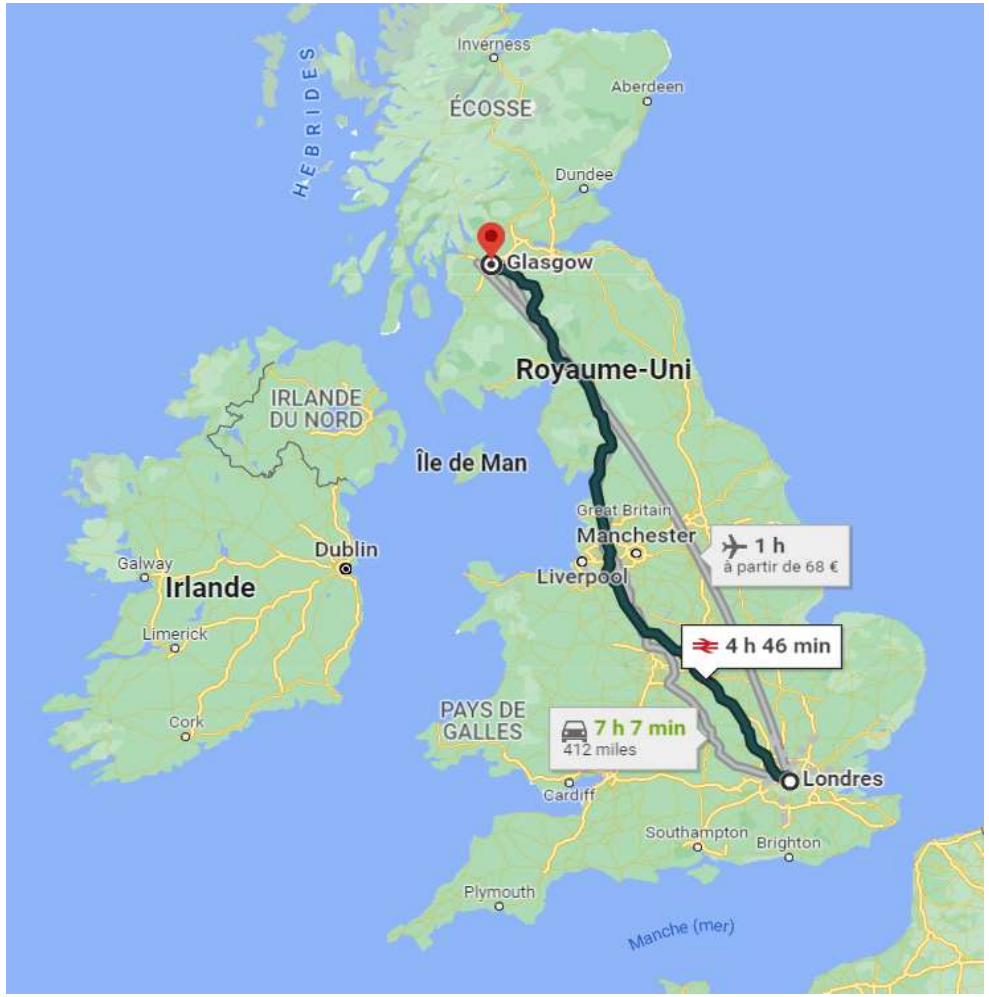
Ref. Adapted from Zandvoort et al. (2017). Adaptation pathways in planning for uncertain climate change: Applications in Portugal, the Czech Republic and the Netherlands. Environmental Science and Policy 78 (2017) 18–26.

Conceptual example

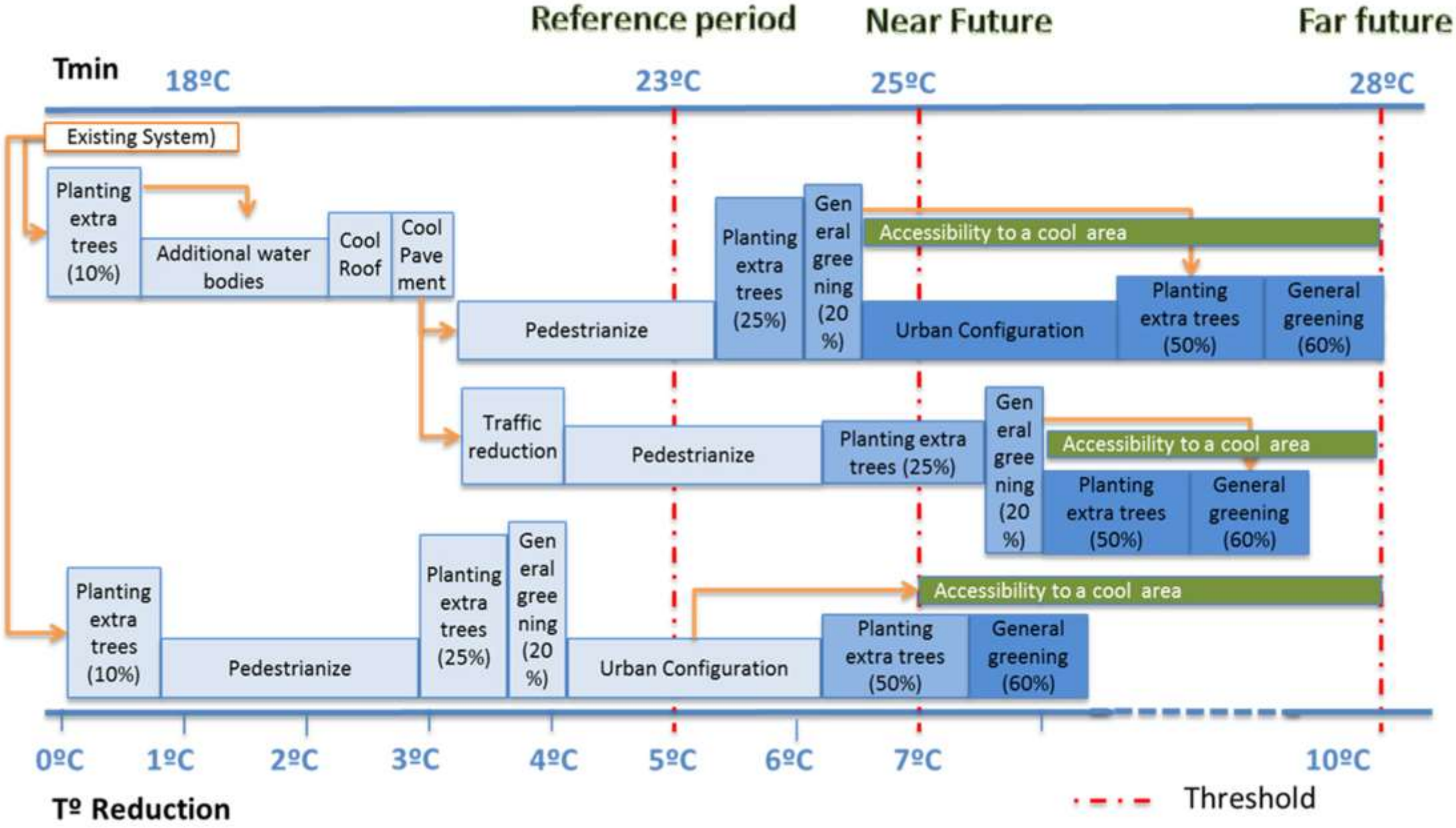
- **Planning ahead** (assessment of options based on feasibility, availability of resources and impact)

- **Decision points**
  E.g., car breaks down in the middle of the road
  → continue by train to reach the destination.

- **Reaching a destination**



Examples



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Source: Mendizabal et al., 2021

Climate Hazard(s) :

Climate-related risk : disruption of biomedical equipment (MRI) at millau hospital during to heatwaves

Overarching objective of the adaptation process: make acceptable the level of risk and ensure that the operation of the hospital is not impacted

Preliminary adaptation pathway elaboration

Indicator

Outside temperature during heatwaves

Thresholds

Outside temperature > particular threshold

Outside temperature > particular threshold

Risk levels →

The MRI functions normally: examination room is kept at acceptable temperature & humidity ; helium is kept is liquid state (-269°C)

The chillers that is used to keep the MRI cool malfunctions ; ad/hoc solutions are put in place (spray of water on the equipment)

MRI restrict system scanning. It may even shut down if helium temperature causes a change in its physical state from liquid to gas, leading to ice formation in the magnet.

LISTING ADAPTATION OPTIONS

List the relevant measures to address your risk

(Use the Database of adaptation measures)

- Spray water on the chiller to cool it down
- Upgrading chillers to standards for tropical climate
- Capturing and reusing heat from chillers
- Cooling tap water
- Using superconductors for the magnet, requiring a lower temperature
- MRI without chilled water (aerothermy)
- Improving thermal insulation in the examination room
- Switching to tropical-standard air-conditioning units
- Setting up backup air-conditioning units
- Installing a climate adaptation monitoring station (IT devices, PCs, data storage space)

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MRI restrict system scanning. It may even shut down if helium temperature causes a change in its physical state from liquid to gas, leading to ice formation in the magnet.

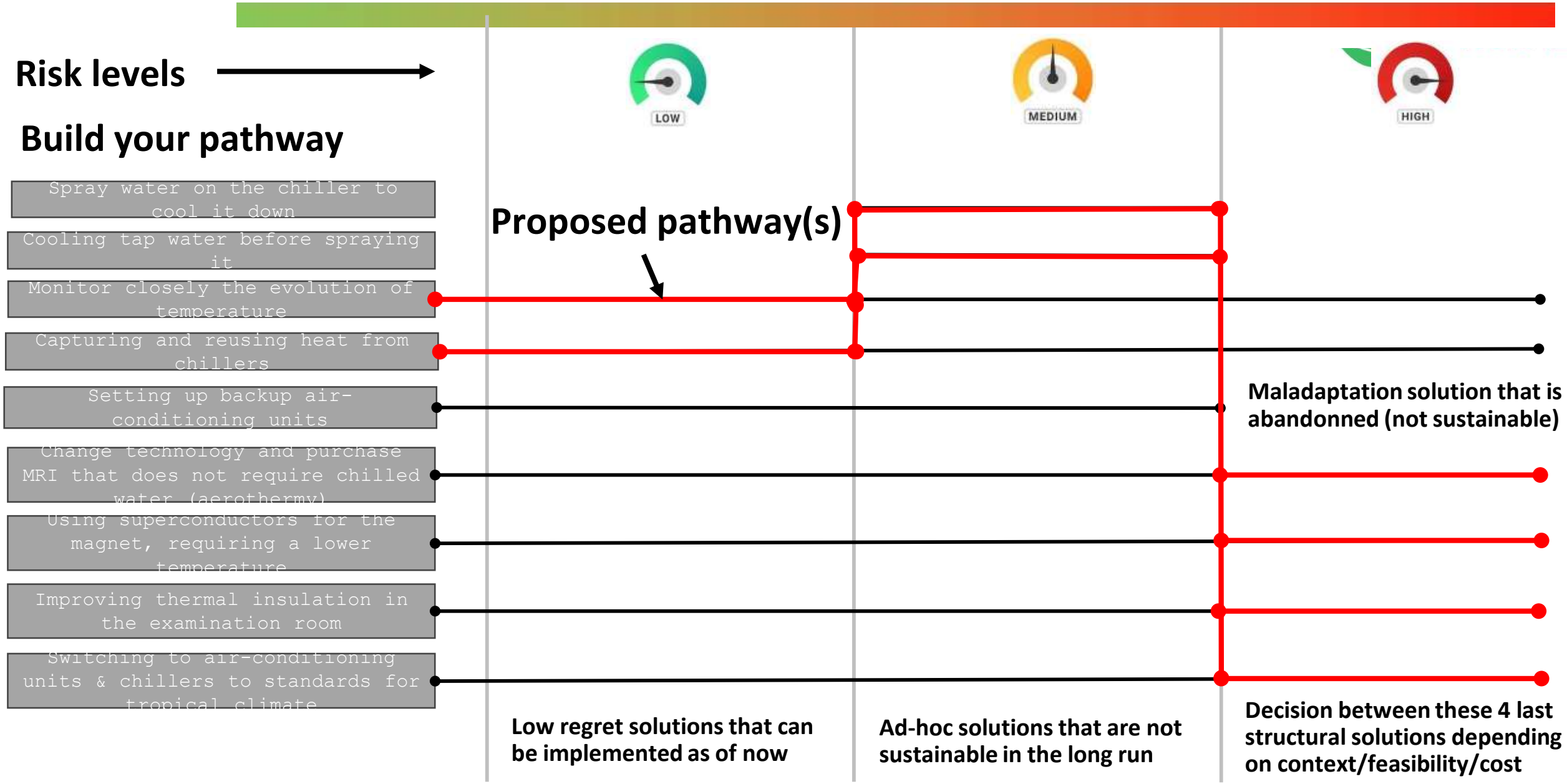
Position your measures under low, medium and high risk

- Spray water on the chiller to cool it down
- Cooling tap water before spraying it
- Monitor closely the evolution of temperature
- Capturing and reusing heat from chillers
- Setting up backup air-conditioning units
- Change technology & purchase MRI that does not require chilled water (aerothermy)
- Using superconductors for the magnet, requiring a lower temperature
- Improving thermal insulation in the examination room
- Switching to air-conditioning units & chillers to standards for tropical climate

Low regret measures (easy to implement but do not have a long shelf life; allow to buy time)…

Structural mesures that require large capital or have social ramifications

CLIMATE-RELATED RISK : DISRUPTION OF BIOMEDICAL EQUIPMENT (MRI) AT MILLAU HOSPITAL DURING TO HEATWAVES



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Thank you !

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RINA

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