Climate change REsilience framework for health SYStems and hospiTALs

DA2.2 - Guidelines to develop vulnerability and risk assessment	
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Executive summary

The current document describes the guidelines to be followed for the development of the vulnerability and risk assessment within the framework of the LIFE RESYSTAL project. The deliverable is directly linked to the A3, C1 and C2 actions, that comprises the specification for the methodology implementation in the Local Toolbox.

In the sections that follow, the documents and operational context the management is based on are presented, followed by the vulnerability framework, likelihood, and impact description and ultimately, the risk estimation.

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Table of abbreviations	
Abbreviations	**Meaning**
NIPP	National Infrastructure Protection Plan Risk Management Framework
CoP	Community of Practice
CI	Critical infrastructure
VRM	Vulnerability and Risk management
VR	Vulnerability and Risk
EPCIP	European Programme for Critical Infrastructure Protection
AR5 IPCC	Assessment Report 5, Intergovernmental Panel on Climate Change
WHO	World Health Organization

Introduction

For the purpose of LIFE RESYSTAL vulnerability[1] and risk[2] assessment, a series of relevant documents and sources were utilized. The assessment of vulnerability and risk is based on the following documents and operational contexts:

- International Standards on Risk management ISO 31000[3], AS/NZS 4360[4] and subsequent additions.
- Definitions and categorization of interdependencies between infrastructures from Rinaldi et al.[5] [6]
- The National Infrastructure Protection Plan Risk Management Framework (NIPP) of the U.S. Department of Homeland Security[7] [8] as introduced in chapter 2.
- The "Assessing Health Vulnerability to Climate Change A Guide for Health Departments"[9] US National Center for Environmental Health
- The "Checklists to assess vulnerabilities in health care facilities in the context of climate change"[10] from WHO
- The "WHO guidance for climate-resilient and environmentally sustainable health care facilities"[11]
- The "Climate change and health vulnerability and adaptation assessment"[12] from WHO

Ideal workflows for risk management are provided by international standards such as ISO 31000 and AS/NZS 4360 that could be adapted to the health sector. The following figures are extracted from the ISO 31000 standard and the "Checklists to assess vulnerabilities in health care facilities in the context of climate change" by WHO, and depict the ideal risk management process in general and summarize the links between all these concepts - and the importance of health infrastructure climate-resilience - graphically.

[1] Vulnerability refers to the quality or state of a CI being exposed to the possibility of being damaged physically by a hazard (climate in the current context)
[2] Risk is the potential for an unwanted outcome resulting from an incident, event, or occurrence, as determined by its likelihood - a function of hazards and vulnerabilities - and the associated consequences.
[3] ISO, 2009. Risk management – Principles and guidelines. First edition of 2009.
[4] AS/NZS, 1999. Risk Management. 4360:1999.
[5] Rinaldi et al., 2001. Identifying, Understanding, and Analyzing Critical Infrastructure Interdependencies'. IEEE Control Systems Magazine 21, no. 6 (December 2001): 11–25.
[6] Rinaldi, S., 2004. 'Modeling and Simulating Critical Infrastructures and Their Interdependencies', 8 pp. IEEE
[7] DHS, 2013. Supplemental Tool: Executing A Critical Infrastructure Risk Management Approach.
[8] DHS, 2013. Partnering for Critical Infrastructure Security and Resilience. Homeland Security Presidential Directive 7 (HSPD-7), Washington
[9] Manangan, Arie Ponce;Uejio, Christopher K.;Saha, Shubhayu;Schramm, Paul J.;Marinucci, Gino D.;Hess, Jeremy J.;Luber, George; "Assessing health vulnerability to climate change : a guide for health departments", National Center for Environmental Health (U.S.). Division of Environmental Hazards and Health Effects. Climate and Health Program, Climate and health technical report series, (2014).
[10] Checklists to assess vulnerabilities in health care facilities in the context of climate change. Geneva: World Health Organization; 2021
[11] WHO guidance for climate-resilient and environmentally sustainable health care facilities. Geneva: World Health Organization; 2020
[12] Climate change and health vulnerability and adaptation assessment. Geneva: World Health Organization; 2021

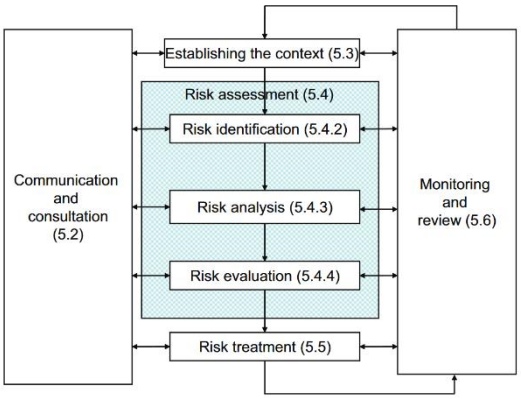

Figure 1: Risk management process proposed by ISO 31000

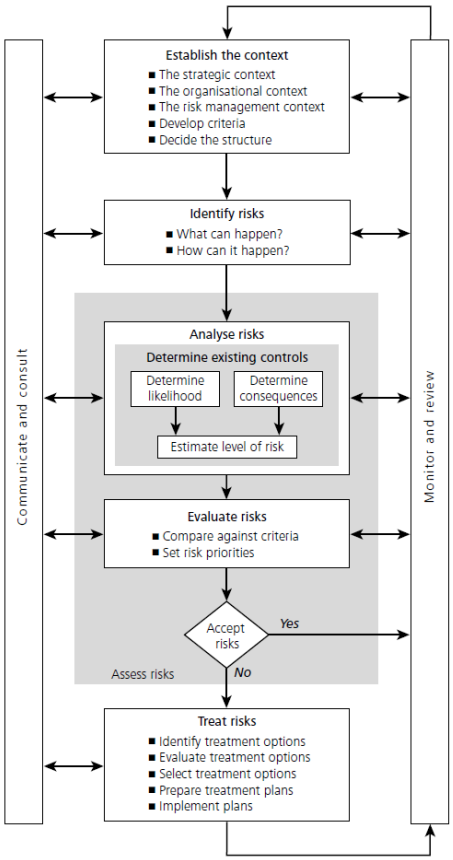

Figure 2: Risk management process proposed by AS/NZS 4360

Vulnerability and risk management process is depicted in Figure 1&2 standards identically. However, ISO 31000 is considerably more generic and abstract whilst AS/NZS 4360 provides more concrete advice by means of explanations, definitions and examples. The following figure presents the risk management process as proposed by AS/NZS. However, neither the ISO nor AS/NZS standards on risk management explicitly address resilience as a development objective or as a diagnostic approach.

Comprehensive studies on (national) frameworks as well as software tools dedicated to risk management, including risk assessment, are provided for example by Pederson et al.[13], Yusta et al.[14] and Giannopoulos et al.[15] Yusta analysed 55 methodologies and applications related to risk assessment and discovered variations between them in terms of:

- critical infrastructure sectors considered,

[13] Pederson, Dudenhoeffer, Hartley & Permann, 2006. Critical Infrastucture Interdependency Modelling - A Survey of US and International Research

[14] Yusta, M., Correa, G. & Lacal-Arantegui, R., 2011. Methodologies and applications for critical infrastructure protection: State-of-the-art. Energy Policy 39.

[15] Giannopoulos, G., Filippini, R. & Schimmer, M., 2012. Risk Assessment Methodologies for Critical Infrastructure Protection. Part I, Luxembourg: Publications Office.

- modelling techniques (such as agent based / systems dynamics / rating / network theory),
- maturity and availability of detailed methodological information and software tools (e.g. restricted access/ commercially available / in development), and
- risk assessment stages actually facilitated.

Further differences can be explained by the target audience. However, commonalities exist in the general approach to how risk is assessed, which is considered for the analytical stages and should be undertaken for the management of risk:

- hazard identification,
- risk assessment,
- prioritization of actions,
- programme implementation, and
- measurement of effectiveness.

Smaller differences obviously exist in the clustering of single procedural steps to more generic, aggregated working stages. For example: “prioritization of actions” can be conceived either as a single working step or can constitute one element within “program implementation”.

The “WHO guidance for climate-resilient and environmentally sustainable health care facilities” describes the aim of a vulnerability and risk management framework that is to establish the process for combining hazards, vulnerability, and risk. In general, the presence of climate hazards, exposures and vulnerabilities can lead to risks and impacts (Figure 3).

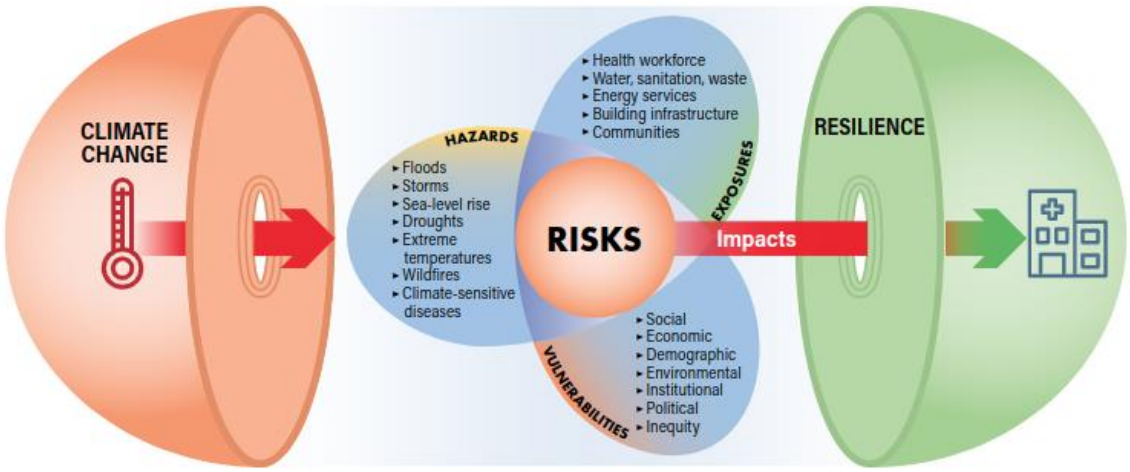

Figure 3: Impacts of climate-related risks on health care facilities by “Checklists to assess vulnerabilities in health care facilities in the context of climate change” from WHO

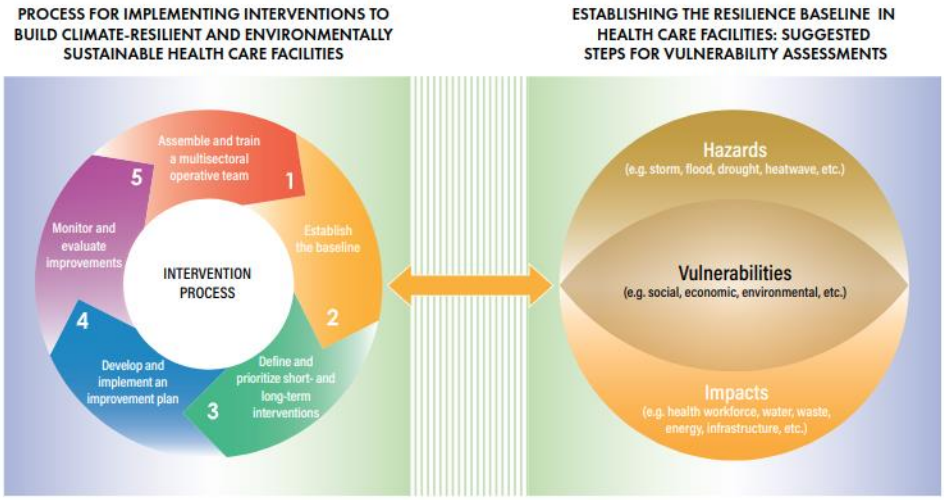

Figure 4: Complementarity between the WHO Guidance for climate -resilient and environmentally sustainable health care facilities and the Checklists to assess vulnerabilities in health care facilities in the context of climate change

Moreover, it aims to merge the efforts in the process for implementing interventions to critical infrastructures and establishing resilience baseline (Figure 4). The aforementioned provides the frame of reference for the LIFE RESYSTAL vulnerability and risk management framework, which has been modified according to the project's scope and objectives.

Vulnerability and Risk management framework in health sector

The vulnerability and risk assessment is based on a coherent methodical approach. Under the scope of providing the means to the health care facility to meet defined objectives, is measured. This kind of assessment allows risk-informed decision making and optimal allocation of resources. The following steps make up the LIFE RESYSTAL Vulnerability & Risk management (VRM) framework:

1. Identify the VRM team support by CoPs
2. Plan the VRM and define risk tolerance (accepted levels of risk)
3. Define the climate hazard
4. Establishment of CI (or regional) climate change resilience policy, or specific business-oriented decision that will be addressed within the proposed framework
5. Describe the health care facility via identification of assets, systems, networks, and functions – Interdependent Infrastructure analysis
6. Conduct risk assessment (likelihood of attack vs impacts) -> risk matrix
7. Scenario Building: Determine the most vulnerable path and develop worse-case scenarios
8. Identify and Quantify vulnerabilities, Determine areas for improvement
9. Re-evaluate the health care facility with proposed improvements (consider security/social aspects/urban planning)
10. Report results and recommendations

Step 1. Identify the VRM Team support by CoPs

An effective VRM framework requires an interdisciplinary team with extensive knowledge and experience in health care facility in operation procedure alongside various levels of governance and supporting organizations. The team requires (1) a project lead that can manage the entire VRM process and ensure the assessment and results are correct and (2) specialized experts in the fields of climate change adaptation / mitigation. Also, societal experts, urban planners, should be invited if needed. The specialized experts will comprise a Community of Practice (CoP) created specific for a health care facility, that will support and provide consulting to the health care facility under assessment.

Step 2. Plan the VRM

Once the team is assembled, the project lead develops a project plan that outlines how the VR assessment will be conducted. The project lead identifies team members' roles and responsibilities, develops the VR assessment schedule, and gathers and distributes preliminary data and information to prepare for the health care facility characterization survey.

Step 3. Define the climate hazard

This step involves the identification of the (climate related) pressures and parameters that influence the interconnected network of CI within a region of interest. It involves analysis of the historic climate (and secondary hazard) data, future climate projections from existing databases and/or if this required the provision of specialised simulations. The methodologies are presented in DA2.1 deliverable.

Step 4. Establishment of CI (or regional) climate change resilience policy, or specific business-oriented decision that will be addressed within the proposed framework.

This step includes the identification of the resilience policy(ies) of a CI or of a region within which interconnected CI networks reside. Typically, these policy objectives have a timespan of multiple years and may be related to specific issues or cross-sectoral matters. Typical questions to consider in this step include for example:

- What must and what should be protected?
- Which potential consequences are relevant (economic, social, environmental etc.) for this appraisal?
- What are the priorities?
- What is an acceptable risk and what is a non-acceptable risk?

Within this step, internal and external factors are also identified. According to ISO 31000, these includes – but are not limited - to:

- Social, cultural, political, legal environment;
- Key drivers and trends having an impact on the objectives;
- Policies, strategies already in place;
- Capabilities such as resources and knowledge;
- Organizational structures, roles and accountability, relationships between actors.

Step 5. Describe the health care facility via identification of assets, systems, networks, and functions – Interdependent Infrastructure analysis

This step will identify and characterize the infrastructure that is likely to be affected by climate hazards. To achieve this, a structured analysis of all CI elements that provide "critical services" will be undertaken.

Step 6. Conduct risk assessment (likelihood of attack vs impacts) -> risk matrix

Considering the identified threat scenario and potential importance, attractiveness of the examined sites a risk assessment and quantification (e.g. through a risk matrix) can be performed.

Step 7. (Scenario vulnerability) Scenario Building: Determine the most vulnerable assets and develop worse-case scenarios

The site data collected and assumptions agreed to in previous Steps are used to construct vulnerability's scenarios. Using site collected data it is possible to quantify each scenario, and the results are subsequently reviewed to determine the vulnerable assets. Worst-case scenarios can be developed by combining the most vulnerable assets with the health care facilities procedures.

Step 8. Identify and Quantify vulnerabilities, Determine areas for improvement

Perform an identification of the Vulnerabilities of the health care facilities, enable the assessment of the baseline current situation and makes a determination of the effectiveness of the infrastructure on the current and future climate condition.

Step 9. Re-evaluate health care facility with Proposed Improvements.

The information of vulnerable areas of health care facility is used in adaptation analysis. Adaptation pathways is proposed and the effect to the health care facility is assessed. The adaptation pathways analysis is presented in DA2.3 deliverable.

Step 10. Report Results and Recommendations.

The final step of the VRM assessment is reporting the results in a manner usable to the decision-makers responsible. The goal of the reporting phase is to provide accurate unbiased information that clearly and accurately defines the current security effectiveness and provides potential solutions if the setting is deemed ineffective.

The primary aim of the LIFE RESYSTAL vulnerability and risk assessment is to provide a common ground whereby different risk assessment methodologies and modelling schemes, from the critical infrastructure and the natural hazards communities can co-exist and interact in a logical manner. To achieve this, different risk assessment schemes will be harmonized into a single interoperable approach or alternatively "translating solutions" will be created between the different risk approaches.

The minimum basis of the proposed risk assessment framework is to be compatible with

- the National Risk Assessments
- EPCIP[16] program
- The AR5 IPCC report
- Sendai Framework with Disaster Risk Reduction International standards, e.g. ISO 31000 Risk Management.
- PARIS AGREEMENT[17]

[16] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=LEGISSUM:l33260

[17] The Paris Agreement. United Nations Framework Convention on Climate Change. New York: United Nations; 2015 (https://unfccc.int/sites/default/files/english_paris_agreement.pdf, accessed 2 February 2021).

Vulnerability

To better understand the baseline conditions and current and future vulnerabilities of healthcare facilities to climate change, facilities may consider conducting a climate change and health vulnerability assessment using WHO suggested methodology[18]. The results will also inform the prioritization of improvement interventions. The components for vulnerability assessment of climate change and health are as follows:

1. identify, describe, and prioritize key climate-sensitive health outcomes.
2. analyze the relationships between current and past weather and climate conditions and health outcomes.
3. identify trends in upstream drivers of climate-sensitive health outcomes and the geographical distribution of risks.
4. identify vulnerable populations and geographical regions.
5. document baseline information for monitoring changes in future vulnerability and evaluating adaptation options.

Vulnerabilities could exist prior to hazards affecting healthcare facilities, and such hazards in turn could increase vulnerability. The various types of vulnerabilities, including social, economic, demographic, environmental, institutional and political, can all occur simultaneously. In healthcare facilities, vulnerabilities can increase impacts on each or all of the key components of a health care facility, i.e. health workforce; energy services; infrastructure, technologies, products and processes.

Table 1: Vulnerability areas and objectives

KEY AREAS	OBJECTIVES
Vulnerabilities in the health workforce	**Human resources:** Health care facilities with capacity to deal with health risks from climate change, having healthy and safe working conditions and sufficient number of health workers who are aware and empowered to ensure environmentally sustainable actions
	Capacity development: Training, information and knowledge management targeted at health care workers to respond to climate risks and minimize environmental threats resulting from the operation of the health care facility
	Communication and awareness raising: Communicating, coordinating and increasing awareness related to climate resilience and environmental sustainability among health workers, patients, visitors, target communities, and with other sectors
Vulnerabilities in WASH and health care waste management	**Monitoring and assessment:** Information regarding water, sanitation, chemical use and health care waste management considering climate-resilience and environmental sustainability for promoting action

[18] Climate change and health vulnerability and adaptation assessment. Geneva: World Health Organization;

	Risk management: Strengthened capacity of health care facilities to manage water, sanitation, chemicals and health care waste risks to workers, patients and served communities, by including assessments of climate-resilience and environmental sustainability in responding to hazards, and identifying and reducing exposures and vulnerabilities
	Health and safety regulation: Water, sanitation, chemical safety and health care waste regulations are implemented taking into consideration climate variability and change, and environmental sustainability
Vulnerabilities related to energy management	**Monitoring and assessment:** Information regarding energy services to consider climate-resilience and environmental sustainability for promoting action
	Risk management: Strengthened capacity of health care facilities to manage energy related risks to workers, patients and served communities, by including assessments of climate-resilience and environmental sustainability in responding to hazards, and identifying and reducing exposures and vulnerabilities
	Health and safety regulation: Regulations on energy use and access are implemented taking into consideration climate variability and change, and environmental sustainability
Vulnerabilities related to infrastructure, technologies, products and processes	**Adaptation of current systems and infrastructures:** Building regulations implemented in the construction and retrofitting of health care facilities to ensure climate-resilience and environmental sustainability
	Promotion of new systems and technologies: Adopting new technologies and processes that can provide climate-resilience, environmental sustainability and enhanced health service delivery
	Sustainability of health care facility operations: Adopting and procuring low environmental impact technologies, products, processes and services to enhance climate-resilience and environmental sustainability

Likelihood

Likelihood (probability of occurrence) refers to the initial probability of a risk scenario to occur and is usually defined as:

- frequency of one or more incidents at various time scales (as defined by CZ, IE, LT, NO, PL, HU in their NRAs)
- probability of occurrence within 1 year (as defined by EE, EL in their NRAs)

Within LIFE RESYSTAL the number of different categories of likelihood/probability of occurrence can be user defined, although the most common approach (e.g. NRAs) followed is the 5x5 risk matrix process:

VERY LOW or VERY RARE	LOW	MEDIUM	HIGH	VERY HIGH or VERY LIKELY

The levels of likelihood, in the framework of LIFE RESYSTAL, are defined by the internationally accepted descriptive terms, classified into a set of five categories, corresponding to numerical values from the NRAs and IPCC (Table 2) :

Table 2: Examples from classifications of likelihood by the MS in their NRAs.

Country	Very Low	Low	Medium	High	Very High
CZ	Occurs less than once in 1000years	Occurs once in 100 – 1000 years	Occurs once in 10 – 100 years	Occurs once in 1– 10 years	Occurs more than once in 1year
EE	Probability within 1 year: 0.005% to 0.05%	Probability within 1 year: 0.05% to 0.5%	Probability within 1 year: 0.5% to 5%	Probability within 1 year: 5% to 50%	Probability within 1 year: 50% +
EL	Probability within 1 year: less than 0.001%	Probability within 1 year: 0.001% to 0.01%	Probability within 1 year: 0.001% to 0.01%	Probability within 1 year: 0.01% to 0.1%	Probability within 1 year: more than 1%
IE	Once every 500+ years	Once every 100-500 years	Once every 10-100 years	Once every 1-10 years	More than once every 1 year
LT	Less than once in 100 years	Once in 50 to 100 years	Once in 10 to 50 years	Once in 1 to 10 years	More often than once a year
PL	1 in 500 years or even more rarely	1 in 100 years	1 in 20 years	1 in 5 years	Once a year or more
SE	≤0.0001 on a yearly basis	0.0001 – 0.001 on a yearly basis	0.001 – 0.01 on a yearly basis	0.01 – 0.1 on a yearly basis	>0.1 on a yearly basis
UK	Between 1 in 20,000 and 1 in 2000	Between 1 in 2,000 and 1 in 200	Between 1 in 200 and 1 in 20	Between 1 in 20 and 1 in 2	Greater than 1 in 2

IPCC	Exceptionally unlikely	Very unlikely	Unlikely	Medium	Likely	Very likely	Virtually certain
IPCC	<1%	1-10%	10-33%	33-66%	66-90%	90-99%	>99%

The Table 3 is the transformation matrix proposed within the LIFE RESYSTAL project, and can be modified according to selected application.

Table 3: Likelihood classification table

	VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
LIKELIHOOD/CLASS	1	2	3	4	5
Return Period	Occurs less than once in 100 years	Occurs once in 50 – 100 years	Occurs once in 10 – 50 years	Occurs once in 1– 10 years	Occurs more than once in 1 year
or					
Probability of occurence	Probability within 1 year: 0.005% to 0.05%	Probability within 1 year: 0.05% to 0.5%	Probability within 1 year: 0.5% to 5%	Probability within 1 year: 5% to 50%	Probability within 1 year: 50% +

Moreover, there are cases that a climate driver isn't characterized as a hazard, but a sequential appearance of different drivers, which change the probability of occurrence of a hazard. Such a hazard is called compound. The LIFE RESYSTAL vulnerability and risk assessment incorporates compound hazards in likelihood estimation. Besides the frequency of one or more incidents, the calculation takes into account the probability of occurrence of climate drivers that enhance the hazard under investigation.

Impacts

Consequence of a risk is defined as a measure of the disruption and impact of a climate hazard not only on a single asset, but to society in general and is thus used in conjunction with likelihood to assess its overall severity. This approach is followed in the LIFE RESYSTAL for the determination of the incident consequences will build upon a two-level hierarchy:

- **Direct impacts** to the health care facility are identified, and described and quantified through different indicators and
- **Indirect impacts** to society, that are directly resulting from the health care facility not being able to function according to their intended scope

Direct impacts

This category of impacts directly affects the health care facilities in multiple pathways which are presented in the following points:

Damages to assets

Assets that are completely or partially damaged (significant destruction from its as-built build state) due to a climate hazard. The enumeration of this category could be through different indices such as:

- number of assets fully damaged (beyond reparability)
- number of assets partially damaged
- number of assets with a [over] certain per cent (%) or range of damages
- highest per cent (%) of damage per network
- average damage per network
- Enumerated damage per [asset / network]. Value depending on network specific properties (e.g. km of roads destroyed, km of railways, km of water pipelines, km of electricity transmission network, etc.)

Performance

This category refers to the change of the capacity of the health care facility to maintain its fully functional performance level, as identified in the baseline category of normal operation. The following parameters could be relevant:

- Changes in generation capacity
- Changes in demand capacity
- Time that CI is not able to serve its intended function
- Total time that person is left without any CI services
- Total time that person is left without two or more CI services

Economic and Financial Perspectives

Economic losses are estimated on the facility where the incident occurred and accounts for the following elements:

- Costs of damaged assets
- Loss of income as a result of not servicing demand
- Loss due to possible penalties from violating service level agreements with buyers
- Costs for replacements of services
- Restoration and recovery costs
- Maintenance costs after hazard

Total economic costs and losses can be calculated as follows:

total economic costs & losses =

[cost of economic losses & costs damaged assets] @

(the damage absorption stage A2) +

[cost of economic losses + cost of response + cost of replacement] @

(the response stage A3) +

[economic losses + recovery cost] @

(recovery stage A4) +

[loss of income from not servicing + maintenance costs] @

(all stages of this incident)

Additionally, the risk premiums maybe alternated in the light of changing climatic conditions and exposure to increasing levels of risk.

All economic effects shall use the same metric, preferably in a common currency. Furthermore, due to the change of the monetary value over time all losses that last more than a year should be annualized using the Net Present Value (NPV) method.

Environmental Losses

As health care facility operation is expected to have an impact on future climate, especially the operation of highly susceptible infrastructures such as energy, the production of Greenhouse Gases can also be considered as an impact within the proposed approach. The following types of pollutants are considered, the estimation of which will be done based on emission factors from existing international databases

- Air pollutants affecting local air quality (NOx,SOx, CO, PM of various dimensions, VOC) and toxics (EMEP/EEA air pollutant emission inventory guidebook 2013)

- Greenhouse gases[19]
- Hazardous materials & toxics, that may be classified according to the chemicals danger classification obtained from the related web site of the Globally Harmonized System of Classification and Labelling of Chemicals[20]

Indirect

This category pertains to the impacts affecting society that is served by the health care facility. As such they correspond to impacts on diverse groups of people accounting for a holistic assessment and quantification of the role of health care facility.

Impact on societal groups

This category accounts for the part of society whose demand for health care services is not (or is partially) met due to the infrastructure not being able to meet the required demand. This can be further expanded into the following elements

- Number of people exposed / affected
- Number of in-need societal groups (in people) not-served, such as infants, elderly, patients, etc.
- Number of houses not-served
- Number of enterprises not-served
- Number of special facilities not-served (elderly care, kindergarten, schools, etc.)

Additionally, psychological effects can be accounted for, as a measure of the citizen confidence in the health care system and is directly related to their motivation in continuing using the network in the future. The psychological impacts are classified as:

- Annoying: Irritating for the individual, but not disruptive for his/her daily routine
- Disruptive: The individual will have to adapt his/her daily routine
- Disturbing: The individual will have to make significant alterations to his/her daily routine
- Dysfunction: the individual is no longer able to continue his/her daily routine

[19] http://www.ghgprotocol.org/Third-Party-Databases/IPCC-Emissions-Factor-Database
[20] http://www.unece.org/trans/danger/publi/ghs/ghs_rev01/01files_e.html

Risk

The aim of risk assessment is the health facilities to have a quantify why to plan and design interventions for environmental sustainability. The latter is the key to move from higher risk (see left side of graphic in Figure 5) to lower risk situations (see right side of graphic in Figure 5).

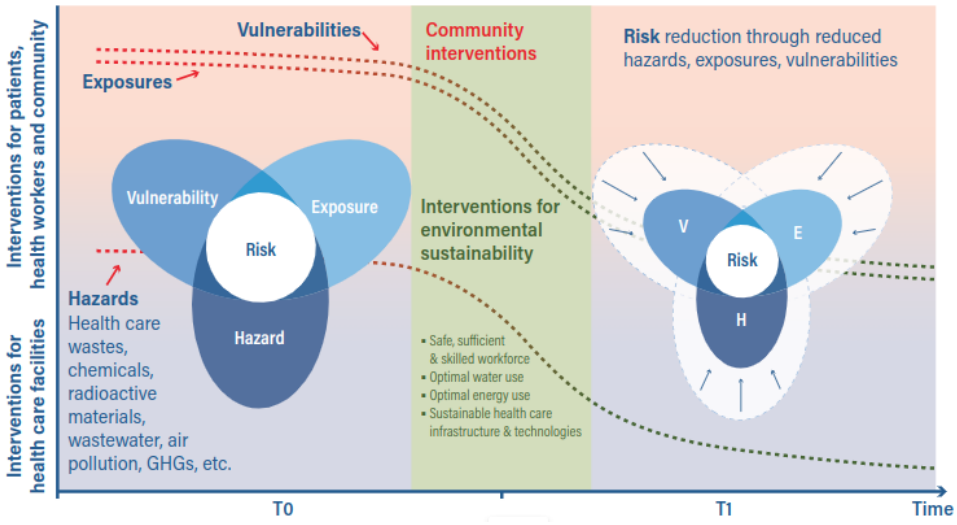

Figure 5: Environmental sustainability in health care facilities "WHO guidance for climate-resilient and environmentally sustainable health care facilities"

In the current concept, a common understanding and clear elucidation of the final risk estimation allows for the easy and direct interpretation of the derived risk metric. Within LIFE RESYSTAL different alternatives could be employed such as numeric estimation of risk (given restrictions in providing a single number from different types of impact estimates) and/or using the risk matrix approach in accordance with recent practices and with a finite number of classes. As an example, risk matrices in national risk assessment plans have been set with quantified probability/likelihood and impacts/consequences on a 5x5 scale (the Risk Matrix approach in Figure 6), these categories differ and could lead to different interpretations of severity of risks and, ultimately, different conclusions. According to this report some of the risk matrices are numbered 1 to 5 or use letters A to E; 1 and A being low probability/impact and 5 and E being high probability/impact, whereas other approaches use a specific terminology to express ranges.

Additionally, within LIFE RESYSTAL the "acceptable level of risk" should be determined by users of the Local Toolbox, which will guide the analysis of adaptation policies and mitigation options and provide a reference level for comparison. The acceptable level of risk is a "user defined" parameter.

Probability / Likelihood	Very likely/Certainly					**Critical**
	High				**High**	

	Medium			**Medium**		
	Low			**Low**		
	Very low, unlikely	**Very low**				
		Negligible, minor,	Small	Medium, moderate	high	Severe
	Consequences					

Figure 6: Example 5x5 Risk matrix

The level of very low risk (blue) usually is considered as broadly acceptable or negligible risk. On the other hand, a level of Critical risk (red) is considered as a non-acceptable risk i.e. this risk cannot be justified on any grounds. The rest of the risk levels within the risk matrix (green, yellow and brown) are usually considered as tolerable risk, meaning that it is tolerable only if risk treatment (reduction) is impractical or if its resource requirements (financial and human) are grossly disproportionate to the improvement gained.

Conclusions

Climate change threatens to exacerbate the multiple challenges facing health care systems and facilities around the world. Vulnerability and risk assessment is a key element to establish a baseline for health care facilities under stress due to climate hazards. LIFE RESYSTAL is taking into account a series of generic risk assessment methodologies, suggestions and best practices from WHO, to provide an up to date and customized European health facilities, vulnerability, and risk management framework.

The guidelines provided in the current deliverable will be utilized in the development of vulnerability and risk assessment module integrated in LIFE RESYSTAL Local Toolbox. For gathering the data needed for the performing the health facilities, a questionnaire is compiled that is presented in Annex 1.

Annex 1

Leadership, Governance and Data

Section objective: Review i) if climate change is explicitly incorporated in the hospital's organizational structure, in processes/procedures/budgets/plans and if the hospital's leadership team is committed to climate change adaptation, ii) if relevant stakeholders (internal and external) are involved and supporting the hospital's climate change adaptation endeavour (including financially), iii) the hospital's mechanisms in place to monitor and inform on climate risks and vulnerabilities within the hospital/health system.

Potential participants: Hospital Director/Management, Board Member, Chief financial officer, Human resources director, IT manager, Staff responsible for addressing climate change issues

Illustrative supporting documentation: Hospital's Organizational chart, Documentation on how roles and responsibilities are defined within the organization, guidance or policies for acquiring, assessing the quality of and monitoring climate change adaptation, annual reports, surveys or interviews of staff

Leadership and Organizational Capacity to Build Climate Resilience

1. Is there someone on the leadership team who is accountable for guiding the climate change mandate, mission or policy? (Yes, Somewhat, No, Unknown, N/A)
2. Does the hospital have a written plan to implement its climate change mission or objectives? (Yes, Somewhat, No, Unknown, N/A)t be
    a. When was the plan elaborated?
    b. Is it publicly available? (Yes, Somewhat, No, Unknown, N/A)
    c. Is the plan—and its climate change objectives - used in guiding management decisions and operational planning? Can you give some examples? (Yes, Somewhat, No, Unknown, N/A)
    d. Did you benefit from technical support to elaborate this plan? (Yes, Somewhat, No, Unknown, N/A) Can you name the institution(s) which supported you in plan elaboration?
    e. Are you regularly monitoring the implementation of the plan? (Yes, Somewhat, No, Unknown, N/A)
3. Are financial resources to increase resilience to climate variability and climate change included as a line item in the hospital investment plan? (Yes, Somewhat, No, Unknown, N/A)
4. Has your hospital secured funding for actions with climate co-benefits (such as improvement of building soundness)? (Yes, Somewhat, No, Unknown, N/A)
    a. Is this funding co-financed by other institutions? In that case, can you name the funders?
5. **Based upon the responses to questions above, rank the level of effective leadership and organizational capacity to build climate resilience (3 - Exemplary, 2- Functional, 1- Marginal, 0-None, N/A)**

Enabling Environment

6. Are the supervisory bodies of the hospital (Health Regional Agency, Health Ministry) equipped with knowledge, experience and resources to support the hospital in disaster risk reduction and climate change adaptation? (Yes, Somewhat, No, Unknown, N/A)
7. Are local governments (communes, municipalities, provinces, regions, etc.) equipped with knowledge, experience and resources to manage disaster risk reduction and climate change adaptation at a community or neighborhood level? (Yes, Somewhat, No, Unknown, N/A)
    a. Is there an assessment of the sensitivity of the territory to climate hazards (extreme temperatures, flooding and other extreme weather hazards that will likely increase admissions during an extreme event)? (Yes, Somewhat, No, Unknown, N/A)
    b. Is there an assessment of the health vulnerabilities of the community that will likely increase admissions during an extreme event? (Yes, Somewhat, No, Unknown, N/A)
    c. Are there particular health vulnerabilities in the community that you could mention?
    d. Are there any measures implemented like education or prevention programs to diminish disease burden linked to climate hazards? (Yes, Somewhat, No, Unknown, N/A)
    e. Does local government communicate to your organization and the community information on local extreme weather hazard trends, including likely hazard impacts? (Yes, Somewhat, No, Unknown, N/A)
8. Does your hospital have partnerships with universities or other climate and health-focused organizations to inform your understanding of climate and health risks? (Yes, Somewhat, No, Unknown, N/A)
9. Beyond the EU LIFE RESYSTAL project, were projects and programmes on building health system resilience submitted to and granted by organizations funding climate adaptation / climate mitigation actions, including international climate change funds? (Yes, Somewhat, No, Unknown, N/A)
10. **Based upon the responses to questions above, rank the degree of inclusion and support of other organizations in the hospital's climate adaptation (3 - Exemplary, 2- Functional, 1- Marginal, 0-None, N/A)**

Mechanisms to Collect and Monitor Climate Data

11. Has the hospital experienced extreme weather events over the past 20 years (such as the 2003 European heatwave)? (Yes, Somewhat, No, Unknown, N/A)
    a. Has a comprehensive feedback/an ex-post evaluation been conducted following this climate event to assess the hospital's crisis management response?
    b. Did the feedback help you get better prepared to face other extreme weather and crisis events? (Yes, Somewhat, No, Unknown, N/A)
    c. Do you think feedbacks are relevant tools to increase the hospital's emergency preparedness? (Yes, Somewhat, No, Unknown, N/A)
12. Has your hospital reviewed, evaluated and cataloged the impact of extreme weather risks in each site (extreme temperatures, flooding and other extreme weather hazards)? (Yes, Somewhat, No, Unknown, N/A)
    a. When identifying climate risks, is uncertainty around changing weather patterns, including future climate variability, considered? (Yes, Somewhat, No, Unknown, N/A)
    b. Does your hospital consider how indirect climate risks (drought, food prices, water availability, fossil fuel price increases) may affect future vulnerabilities or risks? (Yes, Somewhat, No, Unknown, N/A)
    c. Is this assessment periodically reviewed for improvements or deterioration of vulnerabilities? (Yes, Somewhat, No, Unknown, N/A)
13. Does your health care facility collect best practices and lessons learned regarding infrastructure and related systems resilience from other health care facilities that have experienced extreme weather disasters? (Yes, Somewhat, No, Unknown, N/A)

14. Is there a monitoring system to identify climate-related injuries and/or death impacting healthcare staff or (vulnerable) patients, including elderlies? (Yes, Somewhat, No, Unknown, N/A)
15. **Based upon the responses to questions above, rank the level of climate data collection and monitoring mechanisms (3 - Exemplary, 2- Functional, 1- Marginal, 0-None, N/A)**

Health Workforce

Section objective: Review i) the level of knowledge & awareness of hospital staff on threats to hospital operation and public health posed by climate change, ii) their capacity to act in case a climate disaster happens and their engagement in climate change and disaster planning activities.

Potential participants: Any staff (medical staff, support staff, management) or interviews of staff

Illustrative supporting documentation: Survey or interview of staff

Awareness of Climate Issues and their impact on Health

16. Link the concept to the corresponding definition. Concepts : vulnerability, exposure, mitigation, resilience, adaptation
    a. The degree to which a system is susceptible to, or unable to cope with, adverse effects of. climate change, including climate variability and extremes ;
    b. The process of adjustment to actual or expected climate and its effects. In human systems, it seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects ;
    c. The presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected ;
    d. The capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation
17. Can you name the climate hazards impacting your workplace / hospital site?
    a. Extreme heat,
    b. Extreme cold,
    c. Extreme weather (Freezing rain, ice storm, hailstorm, snow),
    d. Drought,
    e. Sea level rise (including coastal water storm surges),
    f. Flash floods,
    g. Erosion of the coastline,
    h. Wildfire,
    i. Tornado,
    j. Thunderstorm (lightning),
    k. Avalanche, rock-, mud- and landslide,
    l. Poor air quality and smog,
    m. Food-borne contamination and/or diseases,
    n. Water-borne contamination and/or diseases,
    o. Vector-and rodent-borne diseases,
    p. New and emerging infectious diseases,
    q. I don’t know
18. Do you think extreme climate events are becoming more intense and frequent over the years ? (Yes, Somewhat, No, Unknown, N/A)
19. Are you able to identify the impacts of climate change on health ? (Yes, Somewhat, No, Unknown, N/A)

20. Are you aware of the 4 steps of the Disaster Risk Management cycle? (Yes, Somewhat, No, Unknown, N/A)
21. **Based upon the responses to questions above, rank your level of understanding of climate & disaster risk management issues (3 - Exemplary, 2- Functional, 1- Marginal, 0-None, N/A)**

Perception of the Role of Health Systems in Addressing Climate Change

22. Is climate change currently impacting your professional practice? (Yes, Somewhat, No, Unknown, N/A). If yes or somewhat, how ?
23. Will climate change impact your professional practice in the future? (Yes, Somewhat, No, Unknown, N/A). If yes or somewhat, how ?
24. Do healthcare facilities have a role to play to address the climate challenge ? (Yes, Somewhat, No, Unknown, N/A)
25. Should health systems' emergency/crisis management strategies be adapted to respond to the evolution of climate parameters? (Yes, Somewhat, No, Unknown, N/A)
26. Do you think your hospital has the necessary (human, financial) resources to address the climate challenge? (Yes, Somewhat, No, Unknown, N/A)
27. Are there takeaways from the Covid-19 crisis to build on in order to face the climate crisis? (Yes, Somewhat, No, Unknown, N/A)
    a. If yes, please elaborate.
28. **As a healthcare/hospital professional, from a level of 1 to 10, how important do you perceive your role in addressing climate change? (1 - not important ; 10 - very important/crucial)**

Building & Infrastructure

Section objective: Review if measures have been taken to build the adaptive capacity & resilience to climate change of i) buildings, ii) infrastructure?

Potential participants: Technical services / Engineering department of the hospital, Maintenance company

Illustrative supporting documentation: Survey or interview of staff, Environmental impact assessment study, Feasibility studies for adaptation measures, field observation if possible, etc.

Site location

29. Understand the physical parameters of each site or facilities located in areas that are subjected to higher levels of hazards. Is/are the site located:
    a. near a coastal region?
    b. on or near 100-year floodplains or wetlands/valley?
    c. in close proximity to major levees or dams?
    d. in close proximity to steep slopes subject to erosion?
    e. in close proximity to an area subject to fire risk (near a dense forest)?
30. If you answered 'yes' or 'somewhat' to the questions above, have you or any public agency developed a comprehensive hazard vulnerability assessment or hazard mitigation plan for affected hospital sites? (Yes, Somewhat, No, Unknown, N/A)

Buildings

OBJ Status of Critical Building Construction

Develop **inventory of buildings vulnerable to each risk**:

31. How many buildings / sites comprises your hospital?
32. When have the buildings been constructed?
33. Are they in a sound state? (Yes, Somewhat, No, Unknown, N/A)
34. Have you mapped building locations relative to hazard maps (for floods, heatwaves, wildfires, other climate hazards)? (Yes, Somewhat, No, Unknown, N/A)
35. Have you compiled building envelopes and performance vulnerabilities for each critical building? (Yes, Somewhat, No, Unknown, N/A)
    a. Are they resistant to extreme weather events (high wind speeds, extreme precipitation, flood elevation especially)? (Yes, Somewhat, No, Unknown, N/A) More especially:
    b. Is the roof leak-proof and well insulated? (Yes, Somewhat, No, Unknown, N/A)
    c. Are there any heat sensitive elements under the roof (air conditioning, IT systems/data center?) (Yes, Somewhat, No, Unknown, N/A)
    d. Are the glasses and windows leakproof and protected from shattering during disasters? (Yes, Somewhat, No, Unknown, N/A)
    e. Are they far enough from the patients' beds? (Yes, Somewhat, No, Unknown, N/A)
    f. Are vertical transportation systems (elevators) dispersed to allow for partial use if some infrastructure is damaged or disabled? (Yes, Somewhat, No, Unknown, N/A)
    g. Is the capacity of the existing stormwater management system adequate for anticipated 50- or 100-year storm events today? (Yes, Somewhat, No, Unknown, N/A)

36. Are buildings regularly inspected (exterior and interior) for signs of deterioration? (Yes, Somewhat, No, Unknown, N/A)
    a. Which frequency do these inspections occur?
    b. Do site and building maintenance procedures include specifications on how weather may affect the safety and continued functioning of your facility? (Yes, Somewhat, No, Unknown, N/A)
    c. Are the individuals responsible for maintenance of your health care campuses and building envelopes trained to manage an extreme weather-related emergency or disaster (for example of climate-related hazards)? (Yes, Somewhat, No, Unknown, N/A)
    d. Is the inspection systematic after a (climate) hazard? (Yes, Somewhat, No, Unknown, N/A)
37. If mechanical/electrical systems are disabled for an extended period of time, during extreme heat:
    a. Are windows operable to provide for ventilation air and to maintain habitable conditions? (Yes, Somewhat, No, Unknown, N/A)
    b. Are there exterior shading devices, trees or other architectural features that mitigate solar gain? (Yes, Somewhat, No, Unknown, N/A)
    c. Have you assessed the length of time people can remain in place before overheating requires evacuation? (Yes, Somewhat, No, Unknown, N/A)
38. If mechanical/electrical systems are disabled for an extended period of time, during extreme cold:
    a. Do building orientation, glazing and/or shading devices provide for supplemental daytime solar gain? (Yes, Somewhat, No, Unknown, N/A)
    b. Is the building well-insulated, with high efficiency glazing systems? (Yes, Somewhat, No, Unknown, N/A)
    c. Does the building have significant thermal mass to reduce heat loss? (Yes, Somewhat, No, Unknown, N/A)
    d. Are there any sources of supplemental building heat? (Yes, Somewhat, No, Unknown, N/A)
    e. Have you assessed the length of time people can remain in place before extreme cold requires evacuation? (Yes, Somewhat, No, Unknown, N/A)
39. Are there buildings that are more sensitive than others? (Yes, No, Unknown)
    a. If yes, which ones and why?
    b. Have measures been taken to reduce the vulnerability of these buildings? (Yes, Somewhat, No, Unknown, N/A)
40. **Based on answers to the above, rank the overall status of critical building construction for each campus? (3 - Exemplary, 2- Functional, 1- Marginal, 0-None, N/A)**

Measures to Enhance Climate Resilience

41. Do new buildings or upgraded buildings comply with contemporary energy codes regarding building insulation & windows? (Yes, Somewhat, No, Unknown, N/A)
42. Do you design and construct buildings use green design best practices, standards or guiding principles (e.g. Leadership in Energy and Environmental Design (LEED), Living Building Challenge, or equivalent)? (Yes, Somewhat, No, Unknown, N/A)
43. Regarding heat island contributors:
    a. Have you installed reflective white roofs on buildings to reduce heat island impacts? (Yes, No, Unknown, N/A)
    b. Do you have high-albedo, light colored paving on parking areas and walkways? (Yes, No, Unknown, N/A)
    c. Have you installed green roofs to mitigate heat-island impacts? (Yes, No, Unknown, N/A)
44. Regarding stormwater management practices: does your facility practice any of the following sustainable stormwater management practices to reduce local flooding in extreme rain events?
    a. Permeable paving (Yes, No, Unknown, N/A)
    b. Green roofs (Yes,No, Unknown, N/A)
    c. Bioswales (Yes, No, Unknown, N/A)
    d. Open space for groundwater recharge (Yes, No, Unknown, N/A)

45. **Based on answers to the above, rank the commitment of your hospital to build the climate resilience of its buildings and sites? (3 - Exemplary, 2- Functional, 1- Marginal, 0-None, N/A)**

Utilities & Infrastructure

OBJ Green Infrastructure & Biodiversity Conservation

Green infrastructure practices have a key role to help your hospital prepare for and manage the effects of climate change, and more especially: i) manage flooding, ii) prepare for droughts, iii) reduce urban heat island effect, iv) lower building energy demand, v) protect coastal areas but also vi) enhance the hospital's food security. Review the hospital's green infrastructure vulnerability and resilience capacity.

46. Is your facility or campus inside the limits of any of the following sensitive sites:
    a. Endangered species habitat
    b. Wetlands
    c. Prime agricultural land
    d. Prime forest
47. If yes, have you implemented measures to mitigate negative impacts from your site development (measures may include applying setbacks, land covenant protections, etc)?
48. Inventory plant material and landscape vulnerabilities (on site)
    a. Are existing trees and plants resilient to climate change effects, both in general climate terms and pest/disease risks? (Yes, Somewhat, No, Unknown, N/A)
    b. Are they drought tolerant? (Yes, Somewhat, No, Unknown, N/A)
    c. In coastal areas, are they salt-tolerant to storm surge? (Yes, Somewhat, No, Unknown, N/A)
49. Does your hospital practice any of the following sustainable stormwater management practices to reduce reliance on water supplies for landscape irrigation in droughts?
    a. Native and drought tolerant species (Yes, Somewhat, No, Unknown, N/A)
    b. Rainwater harvesting (Yes, Somewhat, No, Unknown, N/A)
50. Does your campus or facility actively seek opportunities to preserve vegetative cover, preserve open space, or create habitat through any of the following measures?
    a. Structured parking lots in lieu of surface parking
    b. Dedicated open space
    c. Green roofs
    d. Bioswales
    e. On site food production
    f. Landscaping with native and adapted plant species
51. Sustainable food programs can include a variety of elements that enhance resilience. Does your health facility undertake any of the following sustainable food activities?
    a. Diversify suppliers to include local food (Yes, Somewhat, No, Unknown, N/A)
    b. On-site food production (greenhouse, roof gardens) (Yes, Somewhat, No, Unknown, N/A)
    c. Support or host community farmers markets (Yes, Somewhat, No, Unknown, N/A)
    d. Organic food procurement (Yes, Somewhat, No, Unknown, N/A)
52. Does your facility or system compost food waste? (Yes, Somewhat, No, Unknown, N/A)
53. **Based on answers to the above, rank the commitment of your hospital to enhance climate resilience through green infrastructure & biodiversity conservation? (3 - Exemplary, 2- Functional, 1- Marginal, 0-None, N/A)**

Energy

Status of Energy Infrastructure

Climate change may result in more power outages in your community, which may result in increased frequency and/or duration of power disruptions at your hospital. Review energy and utility infrastructure vulnerabilities and parameters of operating without essential utilities (island operation) that may be required in extreme weather events.

Power system

54. What is the current anticipated length of time you can operate without grid power or refueling? (96 hours is the minimum requirement, but some campuses may have circumstances that require a longer period of time.)
55. Is this adequate to meet the projections for extreme weather event durations? (Yes, Somewhat, No, Unknown, N/A)
56. Are all critical facilities equally equipped to operate without grid power for extended outages? (Yes, Somewhat, No, Unknown, N/A)
57. If not, are there plans in place to address identified shortfalls and vulnerabilities? (Yes, Somewhat, No, Unknown, N/A)
58. Do you produce electricity (from renewable sources, or CHP - Combined Heat and Power) on-site for normal power provisions? (Yes, Somewhat, No, Unknown, N/A)
    a. If yes, what is the percentage of electricity produced on site?
59. What percentage of your base electrical demand is covered by emergency generators? (Yes, Somewhat, No, Unknown, N/A)
60. Is food refrigeration equipment on emergency power? (Yes, Somewhat, No, Unknown, N/A)
61. Do you have external connections for portable emergency generators? (Yes, Somewhat, No, Unknown, N/A)
62. Does the emergency generators have a dedicated fuel source? (Yes, Somewhat, No, Unknown, N/A)

Thermal system

In extreme events, thermal (cooling & heating) energy systems may be taxed. Review the following items related to thermal systems:

63. What is the duration of “island operation” that may be required for the thermal (heat or cooling) plant in extreme weather events?
64. What is your heating system's energy source?
    a. Electricity
    b. Fuel (Boiler)
    c. Gas from the municipal grid
    d. Other sources, please specify:
65. If the heating system relies on electricity, is it on the emergency power system? (Yes, No, Unknown, N/A)
66. If it relies on fuel, how many hours of steam production are possible with fuel reserves?
67. What is your hot water system's energy source?
    a. Electricity.
    b. Fuel (Boiler).
    c. Gas
    d. Other sources, please specify:

68. If the hot water system relies on electricity, is it on the emergency power system?
69. Is your cooling plant capable of operating when grid power is lost? (Yes, Somewhat, No, Unknown, N/A)

70. **Based on your answers above, rank the capability of your energy systems to continue functioning in a climate-related emergency (3 - Exemplary, 2- Functional, 1- Marginal, 0-None, N/A).**

Measures to Build Energy Climate Resilience

Energy efficiency initiatives contribute to resiliency by reducing future climate-related health risks (through greenhouse gas emission reductions) and reducing reliance on energy on a regular basis (to be better prepared when power supply is disrupted).

71. Does your health care facility have an energy conservation program? (Yes, Somewhat, No, Unknown, N/A)
72. Have you set energy or greenhouse gas reduction targets? (Yes, Somewhat, No, Unknown, N/A)
73. Do you monitor or track energy use? (Yes, Somewhat, No, Unknown, N/A)
74. Do you evaluate energy reduction strategies, monitor cost savings, and greenhouse gas reductions? (Yes, Somewhat, No, Unknown, N/A)
75. Do you educate staff, patients and visitors about energy reduction strategies (energy awareness campaigns)? (Yes, Somewhat, No, Unknown, N/A)
76. Have you engaged in any of the following energy conservation measures?
    a. Central plant or mechanical equipment upgrades? (Yes, Somewhat, No, Unknown, N/A)
    b. Low-energy lighting, such as T-5 or LED? (Yes, Somewhat, No, Unknown, N/A)
    c. Install lighting control systems to minimize energy consumption? (Yes, Somewhat, No, Unknown, N/A)
    d. Install energy efficient equipment? (Yes, Somewhat, No, Unknown, N/A)
77. Has your facility or system investigated the possibility of diversifying energy sources and including renewable energy sources for your buildings or campuses ?
    a. Solar (photovoltaic or thermal) (Yes, Somewhat, No, Unknown, N/A)
    b. Wind (Yes, Somewhat, No, Unknown, N/A)
    c. Methane (from landfill or industrial/agricultural sources) (Yes, Somewhat, No, Unknown, N/A)
    d. Biomass (Yes, Somewhat, No, Unknown, N/A)
78. Extreme weather could have cost implications for your health care facility (if air conditioning units will need to run at higher intensities and for longer periods of time). Do you consider how future climate variability, increasing utility or energy costs could affect costs to run equipment when developing future plans, strategies and programs (e.g. when investments are made)? (Yes, Somewhat, No, Unknown, N/A)

79. **Based on your responses, assess the commitment of your hospital to build the climate resilience of its energy system (3 - Exemplary, 2- Functional, 1- Marginal, 0-None, N/A).**

Water & Sanitation

Status of Water & Sewage

80. Climate change may cause more water restrictions or contamination. Does your health care facility have sufficient plans for water resources in the event of a water related emergency? (Yes, Somewhat, No, Unknown, N/A)
81. Are there two independent water sources to the facility? (Yes, No, Unknown, N/A)

82. Is there a functioning well on your site? (Yes, Somewhat, No, Unknown, N/A)
    a. If yes, is it adequate to supply the facility? (Yes, Somewhat, No, Unknown, N/A)
    b. Is the water source potable without treatment? (Yes, Somewhat, No, Unknown, N/A)
    c. If treatment is required, is there a sufficient supply? (Yes, Somewhat, No, Unknown, N/A)
83. Is there a surface water source; ie, pond, lake, etc that can provide process water needs in an emergency? (Yes, Somewhat, No, Unknown, N/A)
84. How much on-site emergency water storage do you have (liter)?
85. What duration of operation can this storage provide (hours)?
86. Do you rely on bottled drinking water for emergencies? (Yes, Somewhat, No, Unknown, N/A)
87. If so, how much do you store and for what duration?

Sewage and Wastewater systems may be impacted by climate related events. Inventory backflow prevention systems for all critical buildings or campuses.

88. Do buildings have check valves or equivalent backflow prevention devices installed on the main sewer discharge line to prevent sewage from flowing back into the building during a major flood event? (Yes, Somewhat, No, Unknown, N/A)
89. Are all floor drains below flood elevation outfitted with drain plugs? (Yes, Somewhat, No, Unknown, N/A)
90. Do you have any provisions for storing sewage in the event municipal systems are disabled or lost? (Yes, Somewhat, No, Unknown, N/A)

91. **Based on your response above, rank your overall water supply & wastewater infrastructure resilience (3 - Exemplary, 2- Functional, 1- Marginal, 0-None, N/A).**

Measures to Build the Water & Sanitation System's Climate Resilience

92. Water usage tracking and benchmarking can help you understand needs and vulnerabilities. Have you audited and benchmarked your water usage (L/day)? (Yes, Somewhat, No, Unknown, N/A)
    a. If yes, do you track or monitor water use for performance measures? (Yes, Somewhat, No, Unknown, N/A)
    b. Do you monitor cost savings of water use reduction strategies? (Yes, Somewhat, No, Unknown, N/A)
93. Do you have a campaign to increase awareness about water conservation/use in the facility among staff, visitors and patients? (Yes, Somewhat, No, Unknown, N/A)
94. A water conservation program could include a variety of initiatives. Has your health care facility adopted any of the following water conservation related strategies?
    a. Low flow showers and faucets? (Yes, Somewhat, No, Unknown, N/A)
    b. Low flow toilets? (Yes, Somewhat, No, Unknown, N/A)
    c. Water efficient landscaping practices (drip or no irrigation systems)? (Yes, Somewhat, No, Unknown, N/A)
    d. Water efficient laundry equipment? (Yes, Somewhat, No, Unknown, N/A)
    e. Water efficient food service equipment? (Yes, Somewhat, No, Unknown, N/A)
    f. Water efficient sterilization equipment? (Yes, Somewhat, No, Unknown, N/A)

95. **Based on the above, rank your water usage patterns and opportunities for improvement to build climate resilience (3 - Exemplary, 2- Functional, 1- Marginal, 0-None, N/A).**

Solid Waste management

96. A climate-related emergency may affect waste management practices at your health care facility. Does your health care facility have a contingency waste management plan if primary waste management processes are limited or unavailable in a climate-related emergency scenario? (Yes, Somewhat, No, Unknown, N/A)
97. Minimizing waste production can have co-benefits (cost-savings, environmental benefits, health benefits) and contributes to a climate resilient health care facility. Has your health care facility adopted any of the following sustainable waste management strategies?
    a. Audit all waste streams (Yes, Somewhat, No, Unknown, N/A)
    b. Conserve and reduce all waste streams, measure and report progress (Yes, Somewhat, No, Unknown, N/A)
    c. Segregate waste to minimize regulated medical waste (RMW) (Yes, Somewhat, No, Unknown, N/A)
    d. Purchase reusable products and products that minimize packaging and waste (Yes, Somewhat, No, Unknown, N/A)
    e. Alternative disposal and treatment technologies (e.g., anaerobic digestion of organic waste, autoclave landfill) (Yes, Somewhat, No, Unknown, N/A)
    f. Recycling programs (Yes, Somewhat, No, Unknown, N/A)

98. **Rank the overall performance of your waste management programs, based on answers to the questions above. (3 - Exemplary, 2- Functional, 1- Marginal, 0-None, N/A).**

Communication & Information

Communication Means

99. Climate related events can disrupt power and communication systems. Does your facility have multiple communication systems in the event of extreme weather emergencies ?
    a. Landline telephone systems
    b. Mobile phone systems
    c. Radio systems
    d. Other (specify)
100. Is your hospital part of a regional network with coordinated communication systems and protocols? (Yes, Somewhat, No, Unknown, N/A)
101. **Rank your communication and information system resilience based on the answers to the questions above. (3 - Exemplary, 2- Functional, 1- Marginal, 0-None, N/A).**

Medical Information Infrastructure

102. Hospitals require Medical Information Systems (MIS) to remain available in order to continue to deliver patient care. Does your facility or system have the following systems in place?
    a. Electronic Medical Records
    b. Paper record storage in appropriate location (above flood level or in safe rooms)
    c. Off-site data center(s)
103. In the event of extreme weather emergencies:
    a. Are Medical Information Systems on emergency power? (Yes, Somewhat, No, Unknown, N/A)
    b. Is there an off-site data center or backup to on-site Medical Information Systems? (Yes, Somewhat, No, Unknown, N/A)
    c. Are paper medical records safe from flooding? (Yes, Somewhat, No, Unknown, N/A)

104. **Rank your Medical Information System resilience based on the answers to the questions above. (3 - Exemplary, 2- Functional, 1- Marginal, 0-None, N/A).**

Mobility and Site Access Resilience

Access roads & evacuation routes:

105. Have you assessed evacuation routes during or following an extreme weather event? (Yes, Somewhat, No, Unknown, N/A)
106. Are evacuation routes vulnerable to falling trees, utilities (fallen wires or poles)? (Yes, Somewhat, No, Unknown, N/A)
107. Are evacuation routes above flood elevation? (Yes, Somewhat, No, Unknown, N/A)
108. Is there an alternative route in case the first one is blocked? (Yes, Somewhat, No, Unknown, N/A)
109. Are pavements designed to withstand extreme temperatures, freezing and thawing, or solar radiation? (Yes, Somewhat, No, Unknown, N/A)
110. Does your hospital have a system to provide "essential personnel" credentials to all required staff during or following extreme weather events, when traffic may be restricted and gasoline rationed? (Yes, Somewhat, No, Unknown, N/A)

Transportation systems:

111. Is the building or campus served by public transportation systems?
    a. Light rail
    b. Subway
    c. Bus
112. If so, have local public transportation systems undertaken climate resilience efforts? (Yes, Somewhat, No, Unknown, N/A)
113. Is public transportation likely to remain operational during or immediately following an extreme weather event? (Yes, Somewhat, No, Unknown, N/A)
114. Does your health care facility take any of the following measures to contribute to sustainable & resilient transportation?
    a. Support local suppliers to reduce transportation miles for supplies (Yes, Somewhat, No, Unknown, N/A)
    b. Support mass transit, carpooling or ride sharing (Yes, Somewhat, No, Unknown, N/A)
    c. Support active transportation (walking or biking) (Yes, Somewhat, No, Unknown, N/A)

Helipad:

115. Is there a helipad?
116. Have you evaluated the location of the helipad against extreme weather risks? (For example, at grade flooding or rooftop vulnerability to damage from high winds.) (Yes, Somewhat, No, Unknown, N/A)

117. **Based on answers to the above, rank the resilience of transportation and site access. (3 - Exemplary, 2- Functional, 1- Marginal, 0-None, N/A).**

Emergency Preparedness & Management

Section objective: Review the level of preparedness of the hospital to face disasters & crisis events (including climate related ones)

Potential participants: Medical staff and staff involved in emergency response (crisis unit to face an exceptional health situation, etc.), IT Department

Illustrative supporting documentation: Survey or interview of staff, contingent plan, crisis management plan, business continuity plans, feedbacks, etc.

Sensitivity to Climate Risks

118. Determine the appropriate length of time for self-sustaining care within the facility without re-supply of equipment, supplies and staff
119. Determine Average Daily Occupancy in 2019 and in 2020 (the average daily number of occupied beds)

Personnel Availability

120. Have you calculated the number of personnel that will not likely report to work due to inability to travel, illness or safety concerns (e.g., 40% or 200 out of 500)?
121. Have you prepared a Staffing Strategy during a surge? (who can work from home, who can work from an alternate location; who is necessary at the hospital?) (Yes, Somewhat, No, Unknown, N/A)
122. Does your health care facility have a protocol to receive external assistance from outside partners (e.g. other health care facilities, regional agency, national agency) in the event of a climate-related emergency, including through a relocation plan (for instance in case of flood)? (Yes, Somewhat, No, Unknown, N/A)

123. **Assess your overall understanding of personnel availability in an extreme weather event based on your answers to the questions above. (3 - Exemplary, 2- Functional, 1- Marginal, 0-None, N/A).**

Exposed locations

124. Inventory the locations of critical medical care departments, support services and diagnostic equipment listed below. Are these departments or services accessible and with functioning capacity (including electricity, air conditioning, heating system, ventilation system, water supply system, telecommunications) in case of an extreme weather event?
    a. Urgent Care
    b. Emergency Services
    c. Main Lobby/ Building Entrances
    d. Helipad
    e. Imaging
    f. Critical Care and/or Bed Units
    g. Pharmacy
    h. Medical Records/ IT
    i. Emergency Command Center
    j. Kitchen/ Food and Potable Water Storage
    k. Clinical Supplies accessible

l. Clinical Laboratories
m. Hazardous Waste Storage
n. Morgue
o. Ambulance Fleet Refueling/ Garage
p. Internal building connecting corridors/links

125. Based on your inventory above, do you have workaround and/or contingency plans for possible disruption of vulnerable services and functions related to an extreme weather related event? (Yes, Somewhat, No, Unknown, N/A)

126. **Assess your overall clinical care and support vulnerabilities in an extreme weather event based on your answers to the questions above (3 - Exemplary, 2- Functional, 1- Marginal, 0-None, N/A).**

Emergency Response Capacity

Response System

127. Do you have an early warning system in place to be informed about climate-related emergencies? (Yes, Somewhat, No, Unknown, N/A)
128. Do you have a crisis management plan? (Yes, Somewhat, No, Unknown, N/A)
129. Does the crisis management service integrate climate-related risks? (Yes, Somewhat, No, Unknown, N/A)
130. Are such plans regularly evaluated and updated? (Yes, Somewhat, No, Unknown, N/A)
131. Are feedback sessions organized following crisis events to assess crisis management performance & gaps (Yes, Somewhat, No, Unknown, N/A)
    a. If yes, was this performed for the Covid-19 pandemic? (Yes, Somewhat, No, Unknown, N/A)
    b. Are you able to identify emergency management dysfonctions from Covid-19 pandemic? (Yes, Somewhat, No, Unknown, N/A). What are they?
    c. Are you able to identify strong points? (Yes, Somewhat, No, Unknown, N/A)
132. Is hospital staff involved in community disaster planning activities/committees (e.g. when emergency management or community vulnerability assessments are undertaken, or when simulation exercises are organized)? (Yes, Somewhat, No, Unknown, N/A)
133. **Based upon the responses to questions above, rank the level of preparation of your hospital to cope with extreme weather events (3 - Exemplary, 2- Functional, 1- Marginal, 0-None, N/A)**

Location for Anticipated Patient Surge

134. Have you inventoried and assessed Expanded Treatment Areas (ETA) (additional areas on campus or off-campus at locations owned or operated by the hospital) for treating lower acuity patients, either admits or transfers from the hospital? (Yes, Somewhat, No, Unknown, N/A)
135. Have you inventoried and ranked Alternate Care Sites (off-campus locations owned or operated by businesses other than the hospital) to which lower acuity hospital patients may be transferred for treatment by attending hospital staff? (These may be churches, schools, hotels/motels, etc., not large regional community-wide alternate care sites established by the community.) (Yes, Somewhat, No, Unknown, N/A)
136. Do you have a plan for Mass Fatality management and accommodation associated with extreme weather events?
    a. Morgue Capacity (Yes, Somewhat, No, Unknown, N/A)
    b. Portable Refrigerated Trailers (Yes, Somewhat, No, Unknown, N/A)
    c. Spaces capable of additional cooling (Yes, Somewhat, No, Unknown, N/A)

137. **Assess overall provisions for anticipated patient surge during and following extreme weather events based on your responses to the questions above. (3 - Exemplary, 2- Functional, 1- Marginal, 0-None, N/A)**

Personnel

Baselines on existing human resources, technical and health service delivery capacity established, with identification of weaknesses

138. Have you identified Temporary Staffing Sources - ie, Red Cross, Emergency Response Teams, etc? (Yes, Somewhat, No, Unknown, N/A)
139. Have you identified and equipped Essential Staff Sleeping Area(s)? (Yes, Somewhat, No, Unknown, N/A)
140. Do you have a Dependent Care Plan that Identifies essential staff dependent care options, both on and off-site? (Yes, Somewhat, No, Unknown, N/A)
141. Do your response and recovery plans for climate-related emergencies or disasters include the provision of psychological support to address mental health impacts of health care facility staff in the short term and long-term? (Yes, Somewhat, No, Unknown, N/A)
142. **Rank overall provisions for personnel and their accommodation during and following extreme weather events based on your responses to the questions above. (3 - Exemplary, 2- Functional, 1- Marginal, 0-None, N/A)**

Healthcare supplies

143. Do you have a plan to accommodate increased supply storage for the extended period of time that the facility will be self-sufficient? (Yes, Somewhat, No, Unknown, N/A)
144. Do you currently have access to sufficient inventories of essential supplies and resources to continue to provide care during one or more climate-related emergencies? Please respond according to essential back-up supplies listed below.
    a. Medications, treatments, drugs, pharmaceuticals, vaccines (Yes, Somewhat, No, Unknown, N/A)
    b. Medical equipment: dialysers, etc. (Yes, Somewhat, No, Unknown, N/A)
    c. Food (Yes, Somewhat, No, Unknown, N/A)
    d. Water (Yes, Somewhat, No, Unknown, N/A)
    e. Non-medical materials, such as bed linens, cleaning supplies (Yes, Somewhat, No, Unknown, N/A)
145. **Rank your overall supply chain preparedness, based on your answers to the questions above (3 - Exemplary, 2- Functional, 1- Marginal, 0-None, N/A)**