Regionally-agreed Minimum Requirements for Climate-Resilient Health Facilities

Updated: 3 November 2025

Version 3

For Ministers' Endorsement
24th CAREC Ministerial Conference
20 November 2025

1. Introduction

1.1 About this report

The overarching aim of this project is to develop minimum requirements for climate-resilient health facilities, informed by engagement with the Central Asia Regional Economic Cooperation Countries (CAREC) Working Group on Health (WGH) and Working Group on Climate Change (WGCC).

The CAREC Program is a partnership of 11 countries and development partners that co-operate for mutual benefit and greater regional prosperity.[1] CAREC countries are highly vulnerable to climate hazards[2] and natural hazards[3] which are set to increase in the future.[4]

This report presents the final version of the minimum requirements for climate-resilient health facilities which were presented at the WGH and WGCC meetings on 7- 9 April 2025. Following the meeting, these requirements were finalised based on feedback from the meeting.

1.2 Purpose of the Minimum Requirements

The aim of the minimum requirements (hereafter referred to as 'the requirements') for climate-resilient health facilities is to guide stakeholders in developing and maintaining health facilities that are not only resilient to climate impacts but also capable of delivering continuous and effective health services in a changing climate.

Climate-resilient facilities support the delivery of high-quality and accessible health care throughout periods of acute and chronic climate stresses. Ultimately, we hope that the requirements will serve as a comprehensive framework to guide the development and implementation of climate-resilient health facilities, thereby contributing to improved health outcomes and greater community resilience in the face of climate-related challenges, while also contributing to health systems-related decarbonisation efforts.

1.3 Expected Users

The requirements are intended for a diverse range of stakeholders involved in the planning, design, construction, and operation of health facilities. Key users are expected to include:

---

[1] CAREC countries include Afghanistan, Azerbaijan, the People's Republic of China, Georgia, Kazakhstan, the Kyrgyz Republic, Mongolia, Pakistan, Tajikistan, Turkmenistan, and Uzbekistan. The Asian Development Bank (ADB) has placed its regular assistance to Afghanistan on hold, effective 15 August 2021.

[2] Hazards can be defined as the potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury, or other health impact, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources. The IPCC commonly uses the term "hazard" to refer to climate-related physical events or trends or their physical impact. (IPCC 2014)

[3] ADB. 2023. *CAREC 2030: Supporting Regional Actions to Address Climate Change. A Scoping Study*.

[4] Most CAREC countries rank with high or very high vulnerability to climate change and natural hazards, according to the *ND-GAIN Index*, which assesses countries' vulnerability to climate change and other global challenges in combination with their readiness to improve resilience to climate change.

- **Government health departments, policymakers, and regulatory bodies** – who are responsible for procuring facilities, and setting and enforcing requirements for health facilities.
- **Development Partners** – who will support implementation of these requirements through investments in health facilities (e.g. construction/upgrading)
- **Architects, engineers, and construction firms** – who will implement these requirements to ensure that new and existing health facilities are designed and built to withstand climate-related impacts.
- **Health facility managers and administrators** – who will implement these requirements in daily operations and maintenance practices.

By providing a list of requirements, we aim to guide all relevant stakeholders in developing health facilities that are resilient and capable of delivering essential health services in the face of climate change.

1.4 Scope of the Minimum Requirements

These requirements have been developed to set out minimum requirements for health facilities with regards to climate-resilience[5]. Health care facilities are classified as those which provide direct health treatment procedures for patients and include hospitals, health care clinics and other inpatient/outpatient facilities. More critical facilities may require higher standards.

These requirements are designed to enhance the ability of healthcare facilities to be prepared for, respond to, recover from, and adapt to climate-related shocks and stresses. This includes extreme weather events like heavy rainfall, cyclones and high winds, floods, and heatwaves, as well as long-term changes such as rising temperatures and sea levels.

There are many other features which contribute to high quality design of healthcare facilities which should be considered alongside these requirements. These include but are not limited to:

- Environmental sustainability and decarbonisation;
- Universal accessibility and inclusive design;
- Infection resilience and healing environments;
- Design of occupant safety to structural, fire and electrical hazards; and
- Design for natural hazards such as geological hazards (earthquakes, volcanic eruptions, tsunamis, and landslides).

The requirements encompass a range of considerations aimed at ensuring the climate resilience of the physical asset components of health facilities. The requirements:

---

[5] Resilience is defined as 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. (Source: Intergovernmental Panel on Climate Change (IPCC). 2014. Annex II Glossary.

- Are structured against five health facility asset types, including (i) building infrastructure, (ii) equipment & products, (iii) water, sanitation and hygiene (WASH) & waste, (iv) energy, and (v) systems and processes.
- Include multi-hazard requirements and climate-specific requirements (e.g. flooding, extreme heat, extreme cold, cyclones and high winds).

2. Background and Rationale

2.1 Background to ADB Technical Assistance

The TA 6535 – Addressing Regional Health Threats in Central Asia Regional Economic Cooperation Countries and the Caucasus[6] supports strengthening joint, cross-border approaches to regional health challenges with a focus on health security. It has supported the WGH in the development of the CAREC Health Strategy and Regional Investment Framework (RIF) 2022-2027 and supports their implementation. The 5th WGH meeting held in November 2023 in Almaty highlighted the importance of linking climate and health actions with regional health security, the need for closer regional cooperation and opportunities to leverage the CAREC platform. Building on the meeting in Almaty, the ADB's Climate and Health Initiative and aligned with CAREC Climate Change Action Plan,[7] this year's WGH meeting focused on addressing climate change and health in the context of health security and discussed two deliverables on climate and health to be tabled to the CAREC Ministerial Conference later this year. This report constitutes one of the two deliverables, and presents the final version of the minimum requirements for climate-resilient health facilities.

A.1 Climate Hazards in CAREC Countries

Across CAREC countries, all climate hazards exist (see Appendix 2 for sample data sources on climate hazards) but there is considerable variability both across and within countries.

---

[6] ADB. *Regional:Addressing Health Threats in Central Asia Regional Economic Cooperation Countries and the Caucasus | Asian Development Bank*

[7] ADB. 8 November 2024. *CAREC Ministers Endorse Climate Change Action Plan and 2030 Strategic Priorities, Launch Regional Climate Fund | Asian Development Bank*

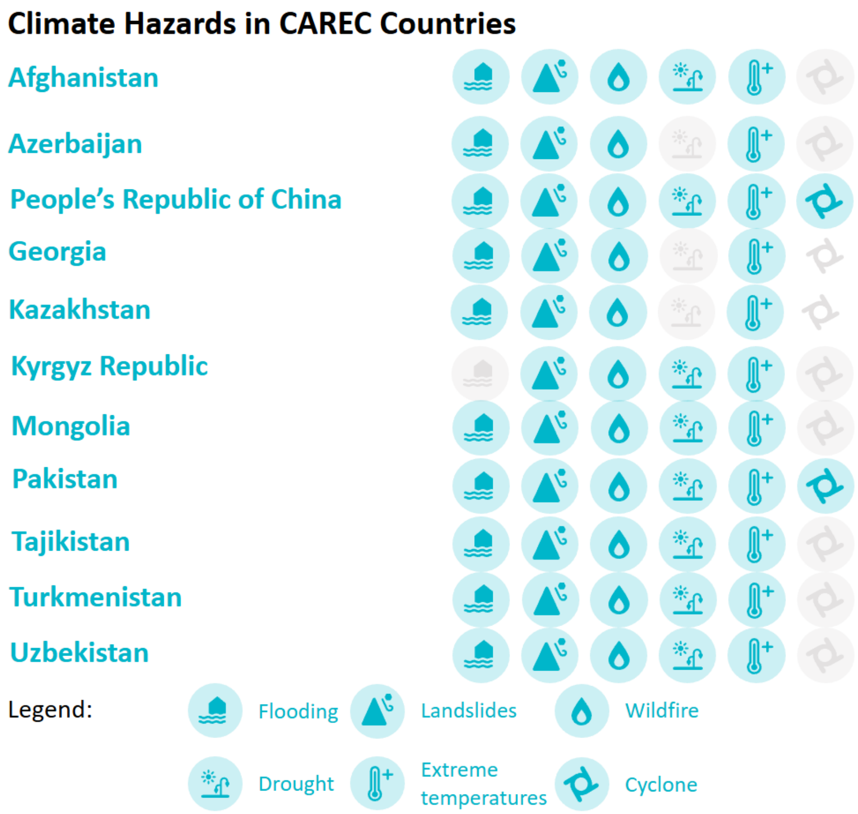


Figure 1: High Level Summary of Climate Hazards across CAREC Countries (ThinkHazard!). Refer to Appendix 2 for example data sources.

To understand the exposure[8] of a specific site to climate hazards, it is required to collect data on climate variables, relevant to each hazard (as shown in Table 1). The extent to which this has already been done and collated into hazard maps with sufficient resolution to inform building design, will be dependent on each country and likely to vary between different hazards. The required resolution will depend on the hazard type and location but will need to be able to inform the design criteria on which the new or upgraded facility will be based. For example, this could include expected flood levels, design wind speeds, ambient temperature ranges for plant operation. Feedback from CAREC countries indicates that while there is hazard data available in most countries, it is often not adjusted for future climate change and therefore may need to be reviewed. Additionally, the translation of this data into design criteria or regulatory requirements is also limited and should be considered in the planning of new or retrofitted health facilities.

Table 1: Summary of climatic hazards and associated climate variables[9]

Climate Hazard	Climate Variable

[8] Exposure is defined as the presence of people, livelihoods, species or ecosystems, environmental functions as well as services and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected. (Source: IPCC 2014).

[9] A climate variable refers to a parameter used to describe and monitor the climate system. Table adapted from: https://aushfg-prod-com-au.s3.amazonaws.com/Climate%20resilience%20and%20adaptation%20guide.pdf

Flood	Rainfall intensity
Drought	Average annual rainfall, soil moisture, evapotranspiration, Relative Humidity, Wet-Bulb Temperature
Extreme heat, extreme cold	Mean temperature, number of hot days, number of cold days, solar radiation, heatwaves – number, duration, amplitude, cumulative days
Cyclones and high winds	Wind speed
Coastal inundation and erosion, surge storm	Sea level
Wildfire	Temperature, rainfall, wind speed, humidity
Landslide (and other mass movements)	Rainfall intensity (indirectly e.g. through slope stability), mean and peak temperatures (indirectly e.g. through snow melt)

Other natural hazards such as geological hazards (earthquakes[10], volcanic eruptions, tsunamis) should also be considered as part of a quality design of health facilities but are outside the scope of these requirements.

2.2 Benefits and Drivers of Designing Health Facilities for Climate-Resilience

There are number of drivers and benefits for designing health facilities for climate-resilience. These include:

- Increasing Frequency and Intensity of Climate-Related Hazards: Health facilities face growing threats from extreme weather events like floods, cyclones, and heatwaves which can disrupt utilities and essential services (e.g. water, electricity) and damage infrastructure (e.g. buildings, transport networks).
- Health System Vulnerability: Many health facilities are not equipped to handle the additional impact from climate hazards on the building and infrastructure, making it harder to maintain essential services during extreme events. Climate-resilient facilities can maintain operations during and after extreme weather events, ensuring continuous care for communities.
- Regulatory and Policy Requirements: Governments and international bodies are increasingly mandating climate-resilience and sustainability measures in health care infrastructure.

10 In regions of high seismicity, it is important that health facility buildings and other critical infrastructure is designed for earthquake resilience as well as climate-resilience. While there are overlapping issues such as resistance to high lateral loading, there are a number of important design considerations and solutions which are distinct including mitigations such as: seismic structural detailing, avoidance of irregular building footprints, soft storeys or short columns, or inclusion of base isolation. These derive from the high dynamic loading which earthquakes impart on structures. Additionally, seismic events do not benefit from early warning systems or seasonal patterns on which climate hazard mitigation often considers as part of wider resilience response, therefore need to be addressed separately.

- Improved Health Outcomes: By being prepared for climate-related shocks, health facilities can better protect public health, reducing morbidity and mortality associated with climate events.
- Cost Savings: Investing in resilience can lead to long-term financial savings by reducing damage costs and operational disruptions
- Community Trust and Safety: Resilient health facilities enhance community trust and provide a sense of safety, knowing that essential services will be available during crises.

2.3 Impacts on Healthcare Infrastructure of Climate Hazards

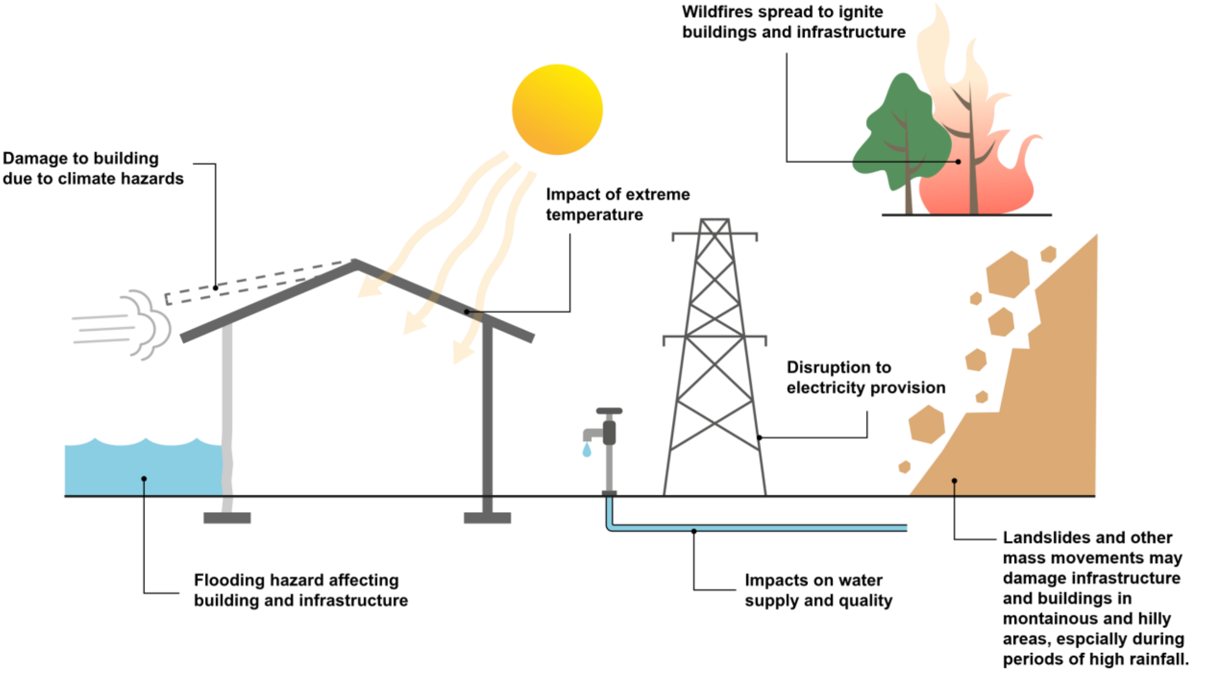
Climate hazards can have a variety of impacts on health infrastructure which reduce the ability of the facility to provide health services during and immediately after an extreme weather event.

For example, building infrastructure can be affected by high winds damaging roofs and windows as well as damage due to fire spread or changes in ground conditions. Climate hazards can also affect the lifespan of buildings increasing the severity of carbonation and corrosion of structural elements.

Aside from the building itself, the infrastructure within, and supplied to, the building can also be affected. Water and electricity supplies can be affected by climate hazard either through physical damage such as floodwater intrusion causing short circuits or water contamination or demand surges during extreme weather events (e.g. AC during heatwaves).

Landslides trigged by intense rainfall can also severely impact health facilities by causing structural damage and blocking transportation routes which isolate communities, delaying critical medical interventions. Public health risks also increase due to potential contamination from broken sewage and water lines, and the spread of respiratory illnesses from dust and debris. Additionally, facilities rely on several systems and processes to function effectively, these can also be affected if appropriate planning and mitigation is not implemented by the management of the facility. These include medical information systems, evaluation and monitoring systems, communication networks, and emergency response protocols.

Figure 2: Potential Impacts from Climate Hazards



See Appendix 3 for more detail on the impact of climate hazards on different asset types.

2.4 Economic Considerations

Implementation of these requirements require investment to assess and develop interventions across the portfolio of health facility assets within a given jurisdiction. This document does not cover the specific implementation strategies or analysis for this but an important part of this will clearly be the financial and economic assessment and constraints which exist in all public health systems. The cost of upgrading works or additional specification for new construction to achieve these requirements should be considered against the economic impacts of climate hazards within this sector.

Broadly, these fall within two key areas: the financial cost of responding to and repairing the damage caused by climate hazard events and the impact of lost economic output as result of climate hazard events. Some aspects which will be important to consider within any analysis are included in the table below:

Table 2: Financial Costs and Lost Economic Output

Financial Cost of Climate Hazard Event	Impact of Lost Economic Output
• Avoided repair or reconstruction cost of health infrastructure following a climate hazard event. • Reduction in ordinary operational costs due to improved infrastructure performance (e.g. lower running costs of AC due to lower heat gain or passive cooling) • Replacement of destroyed medical supplies or equipment.	• Business continuity – loss of GVA due to downtime of a facility (both from health facility staff and patients) • Loss of productivity due to poor working environment for staff. • Poorer health outcomes of the target population – e.g. excess mortality, quality or disability-adjusted life years.

• Mitigated or reduced emergency response costs (e.g. additional staff services, equipment or recovery activities) • Avoided cost of temporary sites or patient relocation • Additional financing costs from reconstruction loans	• Reduced quality and effectiveness of service delivery – e.g. recovery time, mortality rates

3. Methodology

This section of the document sets out the development process and literature review.

3.1 Development Process

We developed the minimum requirements through the following process:

- **Produce a long list of documents** – we produced a long-list of documents for review including international guidelines and standards (e.g. WHO, World Bank); country specific guidelines or regulations from a range of countries for global benchmarking and academic publications.
- **Prioritise documents based on relevance to scope** – we prioritised the long-list of documents to create a shortlist for detailed review based on three aspects: (i) documents that specifically addressing physical infrastructure for healthcare; (ii) documents that cover climate hazards relevant to CAREC countries; and (iii) to ensure a diverse evidence base, other independent documents
- **Set framework for organisation of requirements** – the requirements could be organised by climate hazard (e.g. Australasian Health Infrastructure Alliance, AHIA and US Department of Health and Human Services, USDHHS standards) or by asset type (e.g. WHO and Indian standard). We agreed with the ADB team to organise the framework by asset type to ensure that it is accessible to the end users who are likely to be responsible for the design and/or operation of a specific type of facility.
- **Extract and organise requirements under each framework element** – we created a raw data list with references from each of the prioritised documents. We then amalgamated similar requirements from different documents to create a draft set of requirements.
- **Categorise draft requirements** – we categorised the draft requirements by applicable climate hazard and by applicable facility type.

3.2 Literature Review

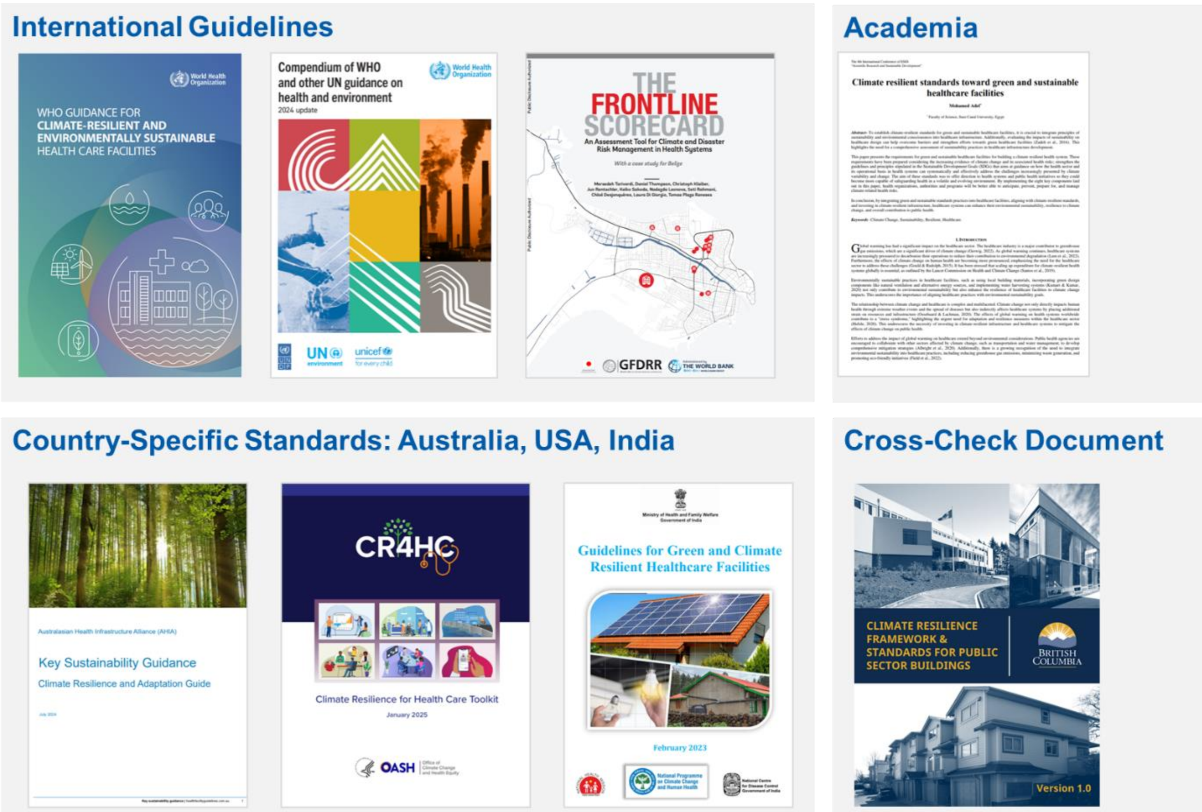
A literature review was undertaken to identify existing documents and guidelines which set out requirements for climate-resilience in healthcare facilities. These were identified through pre-existing knowledge and research of the team, google keyword searches and review of academic papers (using the Arup in-house tool "Arup Discovery"). These are presented in the document registers provided in Appendix 1.

A prioritised shortlist of documents was selected for inclusion within the review of existing practice to include:

- 3 international guidelines
- 3 country specific standards
- 1 academic paper
- 1 "validation" document which is not healthcare specific

The documents selected are those highlighted red in the Document Register (see Appendix 1) and are shown in Figure 3, below.

Figure 3: Reference Documents Used in the Development of the Minimum Requirements



4. How to use this document

This document outlines a set of requirements that health facilities can implement to enhance their resilience to climate-related hazards. Not all requirements will be applicable to every user or facility. It is essential for users to identify the areas most impacted by climate change by using the results of a climate risk[11] assessment to

[11] Climate risk is defined as the potential for adverse consequences where something of value is at stake and where the occurrence and degree of an outcome is uncertain. In the assessment of climate impact, the term

prioritize requirements that effectively mitigate these specific impacts, acknowledging the difficulty of addressing all climate risks across all time periods.

Therefore, users should review these requirements according to the criteria provided below to determine which measures will most effectively improve their facility's resilience.

4.1 Structure of the Minimum Requirements

Section 5 of this document sets out the requirements organised under five asset type headings:

- Building infrastructure
- Equipment and products
- Water, sanitation, and hygiene and waste
- Energy
- Systems and processes

Under each of these asset types, the requirements are further categorised by:

- Hazard type: Multi hazard or hazard-specific; and
- Phase of implementation: Design and Construction or Operation and Maintenance.

4.2 Selecting Relevant Requirements

When using this guide, the user should determine which of the requirements are pertinent to their specific context. This process should involve an assessment of several factors to ensure that the selected requirements are both applicable and effective.

The user should consider the following aspects:

a. **Relevance of climate hazards:**

Requirements which are specific to a climate hazard should be selected based on which hazards are prevalent in the location where the facility is situated and the level of hazard that the specific site is exposed to for each. Some requirements contradict other requirements and therefore, understanding which climate hazards present the highest levels of exposure to the facility is useful to prioritise interventions. This document is not designed to provide detailed guidance on the undertaking of this assessment however the points below provide an initial outline of the steps required.

"risk" is often used to refer to the potential for adverse consequences of a climate-related hazard on lives, livelihoods, health and well-being, ecosystems and species, economic as well as social and cultural assets, services, and infrastructure. Risk results from the interaction of vulnerability, its exposure over time (to the hazard), and the (climate-related) hazard and the likelihood of its occurrence. (Source: IPCC 2014).

A climate hazard exposure assessment [12] should be conducted to determine the extent to which health facilities are exposed to various climate hazards over selected time periods. This assessment should use available hazard maps and models from local government authorities, such as flood data, maps, and wildfire hazard mapping considering also past hazard events which have occurred in that location. Existing hazard mapping and modelling should be reviewed to verify whether they represent current or future exposure based on climate change projections.[13] If existing data or maps are not available, additional hazard and exposure mapping should be carried out for priority climate hazards. Geographic information systems (GIS) can be used to overlay climate hazard data and health facility location to facilitate analysis of relevant climate hazards.

Once climate hazards have been identified, a climate change risk assessment is required to qualitatively assess the likelihood and consequence levels for each risk impact. Climate risk is a function of hazard likelihood (likelihood of hazard occurring), vulnerability (impact on receptor if hazard occurs) and exposure (presence of receptor in location affected by the hazard). Risk criteria typically established at a Ministry level (or regional health agency, depending on government structure), define what level of risk is acceptable. These criteria should be based on a comprehensive understanding of potential impacts and be regularly reviewed and updated. This assessment can be done in line with established frameworks such as those provided in ISO 14091 and the assessed risks used to determine priority climate hazards. Stakeholder engagement is crucial to confirm the outcomes of the risk analysis (risk levels based on assessment of consequence and likelihood) and the priority risks for mitigation through the application of the minimum standards. For resource-limited settings, it is recommended to initially conduct a rapid risk assessment including qualitative discussions with health care staff, engineers and local authorities, and then move on to detailed modelling as needed.

Risk analysis begins by identifying hazards and asset components, followed by a qualitative assessment of the likelihood and consequence levels for each risk impact. This produces a qualitative risk level using a risk rating matrix, which can align with established criteria like AS5334:2013 or existing risk management frameworks. For more complex scenarios, quantitative analysis and modelling are necessary to inform cost-benefit analyses and support decision-making for adaptation [14] investments. These assessments estimate direct risks, such as

[12] Where possible it is recommended to leverage relevant planned or ongoing assessments. For instance, Climate Change Assessments or Climate Risk and Vulnerability Assessments are commonly undertaken as part of preparing ADB-financed investment projects) to support developing member countries (DMCs). A detailed climate risk and vulnerability assessment is carried out for projects classified with a medium or high-risk during project preparation to quantify risks and identify adaptation options that can be integrated into project design. Some countries are developing or have developed Health Facility Masterplans. There is an opportunity to integrate and/or enhance climate considerations undertaken in such assessments to ensure that climate change has been considered appropriately, especially where resources are limited.

[13] Climate change projections are defined as the simulated response of the climate system to a scenario of future emission or concentration of greenhouse gases and aerosols, generally derived using climate models. Climate projections are distinguished from climate predictions by their dependence on the emission/ concentration/radiative-forcing scenario used, which is in turn based on assumptions concerning, for example, future socioeconomic and technological developments that may or may not be realized. (Source: IPCC 2014)

[14] Adaptation is defined as an adjustment process to the actual or expected climate and its effects. In human systems, adaptation seeks to moderate harm or exploit beneficial opportunities. In natural systems, human

financial loss from asset damage and life safety risks, as well as indirect risks like economic costs of downtime and community impacts. It is also important to consider cumulative effects, such as a simultaneous increase in temperature and power outage, which could be critical for the operation of maternity hospitals or intensive care units. Qualified climate risk professionals should conduct these quantitative assessments.

Risk evaluation compares the determined risk levels with established risk criteria to prioritize risks for treatment. These criteria, typically defined at the enterprise level or per industry standards, outline acceptable, tolerable, or unacceptable risk levels. High-priority risks exceed the acceptable threshold and require treatment through adaptation planning. Stakeholder engagement is essential to validate the risk analysis outcomes and prioritize risks for treatment according to the organization's risk appetite and established criteria.

b. **Phase of Implementation:**

The stage of implementation will impact what the available scope of interventions. For example, some requirements highlight actions which require a specific set of construction works to be undertaken (either new buildings or alterations of existing buildings). While others should be integrated into regulation operation and maintenance practices. The relevance of these will depend on the scope of the proposed intervention or investment programme.

Design and Construction: this can be works on either for proposed or existing buildings.

i. *New construction:* For new construction, requirements may reference incorporating resilient design principles and materials from the outset.

ii. *Repair or retrofit of existing buildings:* When dealing with existing structures, requirements may reference assessment of the current condition of the building and identify areas that require strengthening or upgrading.

Regular operation and maintenance: for facilities in regular operation, requirements may prioritise ongoing maintenance and operational practices that enhance resilience.

5. Minimum Requirements

This section sets out the minimum requirements, organised under the asset type headings of (i) Building infrastructure, (ii) Equipment & products, (iii) WASH & waste, (iv) Energy, and (v) Systems and processes. Requirements are tagged to design and construction or operation and maintenance phases.

intervention may facilitate adjustment to the expected climate and its effects (United Nations International Strategy for Disaster Reduction 2009).

The proposed list of interventions does not cover every action that may be needed. However, this list provides a minimum set of interventions that would significantly increase climate-resilience across short- and long-term horizons.

5.1 Building Infrastructure

Buildings Infrastructure refers to the physical structures and facilities that house healthcare services. It includes the design, construction, and maintenance of buildings such as hospitals, clinics, and laboratories.

5.1.1 All / Multi-Hazard:

Design and Construction
When constructing new infrastructure, consider a range of climate-related risk scenarios, such as flood, drought, prolonged rainfall, landslides, strong winds and heatwaves. Consult available climate data relevant to the facility's location.
Design buildings adhering local building codes and standards. Where the relevant Building Codes are not yet considering climate change, exceeding these standards for hazard load cases (e.g. wind load) and climate conditions (e.g. temperature and rainfall) is recommended to ensure future resilience.
Undertake a holistic fire strategy which considers means of escape, detection, compartmentation, materials and firefighting requirements at site and building level.
Ensure windows are resistant to high winds, protected from the sun, leak-proof and high r-ratio[15].
Install vapour barriers and waterproofing to prevent water ingress.
Maximize green space on ground level and on facility roofs to mitigate heat and flooding considering constraints on water usage and fire load.
Provide and maintain safe, shaded pathways between the property line or patient drop-off point and the facility entrance for multiple modes of transportation
Ensure roofing materials are securely fastened and maintain adequate roof drainage systems. Where there are solar installations, also ensure roof structure has sufficient capacity for loading (including uplift).
Construction or retrofitting considers corridors with exterior walls to maximize use of daylight and natural ventilation. Include openable windows with screens where appropriate (e.g. non-clinical areas).
Orient buildings to minimise exposure to prevailing winds and potential fire spread

Operation and Maintenance
Undertake and regularly update site specific assessments of climate hazard vulnerability and integrate findings into regular upgrade and maintenance programmes including stress testing for continuity of care.
Building is regularly inspected, both internally and externally, for signs of deterioration such as broken plaster, cracks or sinking structural elements, and the causes determined with appropriate remedial action taken.

[15] R Ratio is the radiant heat gain ratio which refers to the ratio of radiant (e.g. sunlight through window) to total heat gain. High r-ratio windows prevent heating of the internal space due to sunlight. Also referred to as u-value in some countries where the u-value is the transmittance value so low u-values of glazing prevent heating of the internal space.

5.1.2 Climate Hazard-Specific

Changes in temperature including extreme heat	Relocate HVAC systems into optimal spaces for efficiency (for example, well-ventilated shaded areas or within buildings). Consider any implication on specification (load change or performance e.g. weatherproofing).
	Introduce internal electrical load shedding capability in the building management system to turn off non-essential equipment when needed to ration power to critical equipment.
	Use building design strategies, like insulation and shading devices, to maintain safe temperatures inside the healthcare facility during extreme heat and cold events. This may also include reflective white roofs to reduce heat impact.
Wildfire	Orient buildings to minimise exposure to prevailing winds and potential fire spread
	Install native, drought- and wildfire-resistant landscaping at an appropriate distance from the building to reduce the production of fuel before a wildfire and the risk of erosion afterward
	Incorporate underground services where possible including power and communications and gas supply lines.
Flooding	Incorporate water-sensitive urban design infrastructure including porous paving/surface, rainwater harvesting, desalination basins and swales
	Raise (essential) external services including sewage pumping stations and associated electricity supply to levels above future flood levels, accounting for climate change amplification over the life of the service. This may require liaison with the utility supplier if outside the ownership of the facility.
	If locating in flood-prone areas is unavoidable, elevate new buildings, infrastructure and equipment above future flood levels to minimise the risk of inundation. If not possible to elevate the entire building, consider the level of key services and arrange layouts to minimise impact of water ingress into lower levels.
	Relocate and raise external switchboards. Location should ensure safe access during intense rainfall events
	Elevate internal power sockets on the ground level.
Cyclones and High Winds	Ensure that the structure (including windows and roofs) are resistant to winds of at least 200–250 km/h (depending on design wind speeds for specific location).
	Use strategic placement of trees and shrubs to create buffer zones and minimise the impact of windborne debris on structure
Drought	Ensure foundations are designed to withstand changes in soil moisture content during drought conditions. Use deep foundations or pile systems to reach stable soil layers unaffected by drought induced subsidence
	Install moisture barriers beneath concrete slabs and foundations to prevent excessive moisture loss and soil shrinkage during drought periods
	Monitor subsidence on and near the healthcare campus and modify facility infrastructure in affected areas to reduce the risk of disruption to utility and transportation infrastructure.
Landslides	Assess slopes around or below health facilities and where needed, stabilise using terracing, planting, retaining walls or other supporting systems such as geotextiles or soil nails.

5.2 Equipment and Products

Equipment and Products encompasses all the tools and devices necessary for healthcare delivery. It includes:

- Medical Equipment: Devices used for diagnosis, treatment, and monitoring of patients (e.g., MRI machines, ventilators).
- IT Infrastructure: Systems for managing patient data, electronic health records, and telemedicine services.
- Essential Tools: Other necessary items like surgical instruments, laboratory supplies, and personal protective equipment (PPE).

5.2.1 All / Multi-Hazard

Design and Construction
Implement climate-resilient standards for healthcare facilities, such as providing natural shade for facility users to mitigate the impact of extreme heat events.

Operation and Maintenance
Store essential medical supplies, food, and fuel for 5–7 days to enable rapid deployment when extreme weather events disrupt supply chains and/or infrastructure. Consider potential access constraints such as those in mountainous regions when deciding on level of stockpiling required.
Identify and prepare suitable storage space for additional supplies.
Maintain an updated inventory of equipment monthly.
Establish contingency agreements with vendors to ensure the procurement and prompt delivery of equipment, supplies, and other resources in times of shortage (e.g. clauses for priority access, expedited deliveries flexible payment terms).
Protect critical supplies such as emergency power, medicines, and patients' records, in case of flood.
Ensure backup arrangements for water, power, and oxygen.
Provide vaccine refrigerators with adequate holdover times through periods of power outages.
Store medical gases and chemicals securely in well-ventilated areas.
Purchase equipment and supplies locally when possible.
Train staff on effective procurement practices.
Establish procedures for procuring, storing, dispensing, and proper disposal of all pharmaceuticals.
Conduct preventive maintenance for building systems to ensure that service is not compromised during climate events.
Review and establish backup telecommunications channels to ensure power and communications outages are mitigated.
Regularly test emergency generators, water supplies, and transportation plans to ensure that they are ready to deploy in the event of an emergency and are valid in all seasons.
Integrate climate change projections into the organisation's supply chain emergency planning process.

5.2.2 Climate Hazard-Specific

Wildfire	Implement wildfire mitigation and smoke protocols.
Flooding	Place EMR servers in climate-controlled spaces above the flood line.

	Consider storage locations and setup in lower ground, basement, and ground floor levels to avoid flood damage to stored equipment or products.
Extreme heat / cold	Ensure that all critical equipment (e.g., HVAC systems, medical devices, refrigeration units) is specified to be rated for operation in expected temperature ranges that include relevant extreme heat and cold conditions.

5.3 Energy

Energy infrastructure in health facilities ensures a reliable and sustainable power supply. This includes:

- Electricity: For lighting, medical equipment, and IT systems. Prevent overloading during high demand periods and mitigate impact of power outages.
- Backup Power: Generators and alternative energy sources to maintain operations during outages.

5.3.1 All / Multi-Hazard

Design and Construction
Install and optimize hybrid energy systems - this includes renewable energy sources, batteries, and backup generators, ensuring they are optimized for on-site use.
Design and integrate building management systems to regulate indoor temperature, ventilation, lighting (and to reduce energy consumption during off-peak, night hours)
Develop a comprehensive plan to address intermittent energy supplies or system failures. The plan should include provisions for an adequate backup energy source, to maintain continuity if the primary energy source fails during extreme weather events. For supplies which require uninterrupted supply (such as oxygen concentrators), install charger-inverters with automated transfer switches.
Power health care facilities with decentralized, renewable energy sources (e.g., solar photovoltaic cells with batteries) with sufficient capacity for essential installations such lighting, life-preserving equipment and provision of uninterrupted cold chain.
Install solar water heaters for provision of hot water for health care facilities
Design features that maximize natural ventilation such as high ceilings, large windows and skylights (without compromising the structural integrity of the building)
Assess the location of energy backup or renewable energy infrastructure for exposure to extreme weather events (such as strong winds, hail, floods).
Ensure mechanisms are in place to filter indoor and ambient air pollutants
Install voltage stabilizers to protect equipment from electrical damage that may be caused by voltage frequency fluctuations (when using a generator), or voltage surges (such as due to power transmission problems in the grid)

Operation and Maintenance
Assess all heating, ventilation and air conditioning ductwork pipes, ensuring they are in good condition and supported adequately by the facility building structure at least once annually.
Perform regular audit processes for energy and loads.
Use devices to measure the heat and humidity for monitoring all the electrical equipment; and the results are documented and integrated into planning of maintenance.

5.3.2 Climate Hazard-Specific

Flood	For new installations ensure critical energy equipment is raised above future flood levels of a relevant return period considering asset importance and lifespan, accounting for climate change amplification over the life of the service of the building.
Wildfire	Clean and cool solar arrays during and after wildfire smoke events to reduce the risk of impaired performance caused by smoke residue
	Ensure that tanks containing combustible liquids (including fuel for generators) are accessible clearly marked and labelled and are a safe distance from key clinical and nonclinical facilities.
Extreme heat	Use building design strategies, like insulation and shading devices, to maintain safe temperatures inside the healthcare facility during extreme heat and cold events
Landslide	Consider utility routes to avoid landslide prone areas where possible (e.g. location of pylons and buried services)

5.4 Water, sanitation, and hygiene and waste

WASH stands for Water, Sanitation, and Hygiene. This aspect covers:

- Water Supply: Ensuring clean and safe water for drinking, sanitation, and medical use.
- Sanitation: Proper facilities for waste disposal and sewage management.
- Hygiene: Practices and infrastructure to maintain cleanliness and prevent infections.
- Waste Management: Systems for disposing of medical and non-medical waste safely and sustainably

5.4.1 All / Multi-Hazard

Design and Construction
Undertake an assessment of climate change risks to the WASH infrastructure of health care facilities in place to identify where services (supply and sanitation) could be disrupted from floods, water scarcity, landslides, sea-level rise.
Water supply system has sufficient reserves or storage, with backup arrangement, to satisfy the facility's demand for at least three days, at all times.
Separate stormwater (i.e. rainwater) or greywater drainage system from blackwater systems (including contaminated water) so that stormwater can be diverted away from the facility into a safe drainage or leach field and does not carry contamination from the healthcare setting to the surrounding environment
Separate potable and process water systems from each other and source an emergency water supply to maintain water pressure during water outages
Install non-return valves on water supply and wastewater pipes to prevent back flows
Integrate rainwater harvesting, water saving and grey water reuse as feasible
Long-term water collection system in place with safe storage to ensure water access during extreme climate events (such as capturing rain during the monsoon season and storing water in tanks for use during the dry season)
Improved storage areas for storing extra waste generated through higher demands on health care facilities (such as in outbreaks or impacts from climate-related events),
Waste pits are built to withstand climate events and emergencies

Operation and Maintenance
Plan in place for water system supplies (such as chlorine, filters or other water treatment technology, rapid water testing kit), during an emergency and disaster response.

Water supply and quality monitored regularly during emergencies to ensure adequate access throughout the duration of the event, ensuring that protocols are in place to guide rationing if required
Health care facility drinking water treated with a residual disinfectant to ensure microbial safety up to the point of consumption or use, especially after a flood related disaster
Health workforce and facilities' managers trained to an appropriate standard to maintain the correct level of safety of water quality controls, supplies and alternative sources to the health care facility in both routine and emergency/disaster situations.
Ensure only authorized staff have access to waste storage areas, and waste is not stored for longer than the maximum storage times for infectious waste, which depend on the temperature
Increased health workforce knowledge on waste stream constituents and waste related health care hazards for better monitoring and control in climate-related emergency situations
Health care waste transport (including health care facility hazardous waste) properly managed in case of extreme weather events

5.4.2 Climate Hazard-Specific

High winds	Water storage tanks supported and anchored to resist strong winds
Flood	Natural floodwater infiltration in place to reduce risk of facility flooding
	Planned schedule for emptying latrines in advance of flood seasons to avoid overflows
	Installation of sealed covers for septic tanks and non-return valves on pipes to prevent back flows
	Vents on sewers and septic tanks are above expected flood lines
Wildfire	Ensure that water storage tanks and covers are made from fire-resistant materials to prevent melting or burning during fire incidents, enhancing the facility's resilience to fire hazards.
Landslide	Consider water supply and drainage routes to avoid landslide prone areas where possible (e.g. location supply pipes, sewer lines and storage infrastructure)

5.5 Systems and Processes

Systems & Processes includes the operational frameworks that support the health facility operation:

- Maintenance processes: routine upkeep of facility assets.
- Disaster risk management: planning for during and immediately extreme weather events.
- Operational Systems: Procedures, protocols, staff roles and specified responsibilities required within the facility which support patient care, staff management, and facility maintenance.

5.5.1 All / Multi-Hazard

Design and Construction
Ensure clinical space allocation/design and supplied equipment and medication in the facility address the likely health issues arising from climate-related hazards. E.g. oxygen provision to address respiratory illnesses resulting from poor air quality.

Operation and Maintenance
Track national and/or local early warning systems to be notified of extreme weather events including heat risk and enable prompt action.
Implement early warning mechanisms and protocols to notify healthcare facility staff, patients, catchment communities and visitors of heatwaves and air pollution advisories and warnings.
Develop and update disaster preparedness plans: Include risk reduction, security measures, evacuation, transportation, and rapid recovery to prevent indoor air quality issues.
Train health workforce through ongoing capacity building and institutional strengthening: Implementation of disaster response plans, safety in extreme weather events, ability to handle increased clinical demands, and maintain strong communication during emergencies.
Establish operational protocols: Ensure food service response, provide alternative transportation and housing for staff, and maintain continuous operation during extreme weather events.
Offer post-disaster support through multidisciplinary psychosocial teams for staff, their families, and patients. Engage the health workforce in community health programs to improve community health during particular climate risks such as extreme heat.
Ensure rapid clean-up and recovery from extreme weather events to prevent indoor air quality issues like mould growth.
Supervise compliance with related laws and regulations, and work on improving environmental performance, carbon footprint, and climate-resilience through a multidisciplinary committee
Raise ongoing awareness among healthcare facility managers, staff, patients, visitors, and the community about risks to health from climate-related hazards such as extreme heat and effective health protection measures.
Identify minimum needs in terms of healthcare workers to ensure the operational sufficiency of every healthcare facility department in case of climate-related disaster or emergency.
Enhance climate disaster preparedness by adding climate-related illness screening to the healthcare organization’s electronic medical record system and increase analytical skills to identify changes in human health due to climate change.

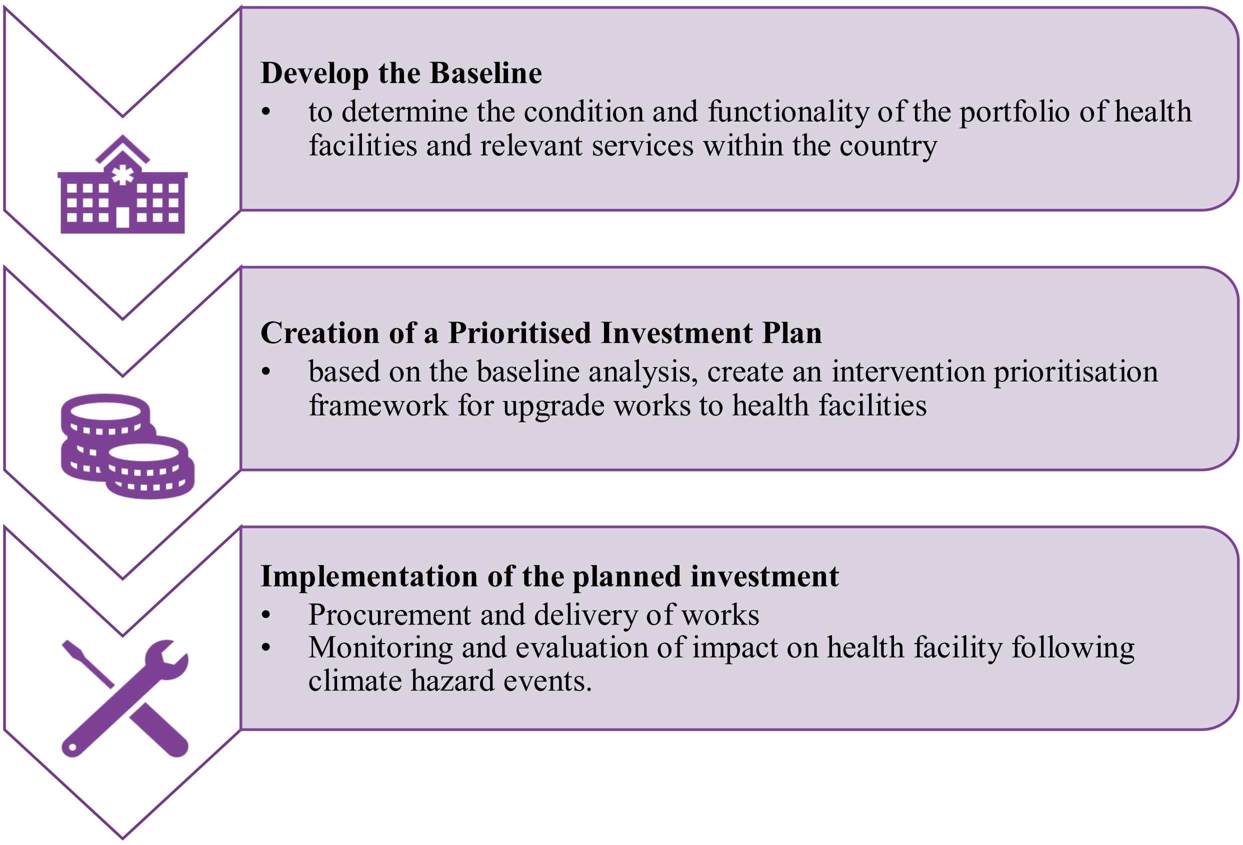
5.5.2 Climate Hazard-Specific

Flooding / wildfires	Ensure patient medical records are safely stored, particularly in flood- and fire-prone areas, and have a plan in place for relocating hospital equipment, medicines, and medical devices during floods and fires or permanent relocation to higher floors.
Extreme heat	Schedule outdoor work for cooler parts of the day and reduce physical demands during hot days or heatwaves. Set staff expectations for their role during climate-related extreme weather events, including collaboration with local communities.

6. Monitoring and Evaluation

This section provides a high-level process for countries to collect data on and report on progress in achieving the above requirements. This process will need to be expanded in future to support countries in the implementation of these at scale.

Phases of work:



6.1 Preliminary Maturity Assessment Matrix

This provides an initial set of tasks to define country's maturity in each phase of the work for self-scoring allowing a multi-country view on progress of implementation of the minimum requirements[16]. This should be tested and validated during a pilot.

Phase	Maturity stage	Task
DEVELOP THE HEALTHCARE INFRASTRUCTURE BASELINE	Starting	Define responsible bodies for implementation of minimum requirements.
		Compile and organise available information about healthcare facilities.
		Collate available natural hazard information and other geospatial context information.
	Intermediate	Create Management Information System (MIS) for healthcare infrastructure.
		Define the structure of the baseline and carry out a field inspection campaign.
		Define standardised typologies for healthcare facilities.

[16] Adapted from the NHS Climate Adaptation Change Adaption Capability Matrix and the GPSS Roadmap for Safer and Resilient Schools.

	Advanced	Analyse standardised typologies and define relevant requirements for each.
		Ensure climate hazard information is adjusted for future climate scenarios.
		Cost implementation of requirements for each typology.
	Mature	Establish a regular program to maintain an up to date baseline.
		Define post hazard event damage assessment plan.
CREATE THE PRIORITISED INVESTMENT PLAN	**Starting**	Undertake review of the regulatory and policy landscape for healthcare facility implementation.
		Undertake mapping of institution stakeholders and decision makers.
		Undertake climate hazard analysis for health facility sites within portfolio.
		Identify ongoing healthcare infrastructure investment plans.
	Intermediate	Identify regulatory strengthening needed to implement requirements.
		Evaluate the institutional capacity strengthening to implement requirements.
		Identify and evaluate available funding mechanisms.
		Define prioritisation criteria for investment planning.
	Advanced	Undertake economic loss analysis of future climate hazard events.
		Evaluate selected requirements against defined prioritisation criteria to create intervention plan.
		Integration of intervention plan into MIS.
		Finalised investment plan including phasing.
	Mature	Identify future period financing options.
		Identify and evaluate multiple investment scenarios.
IMPLEMENT PLANNED INVESTMENT PROGRAM	**Starting**	Identify specific roles and responsibilities of stakeholders.
		Implement regulatory and policy reform programme.
		Implement institutional capacity building programme.
	Intermediate	Define procurement mechanisms for implementation of requirements.
		Define quality monitoring system and protocols.
		Pilot phase of intervention of requirements completed.
	Advanced	Scale- up implementation of requirements through distributed implementation units.
		Establish monitoring of facility downtime post climate hazard event.
		Put health facility staff training program in place.
	Mature	Put feedback loops in place from each phase to inform adjusted implementation.
		Monitor changing context (including hazard profile), and feed into updated requirements.

7. Supporting Implementation of the Requirements

In line with the Regional Healthcare Decarbonization Strategy produced alongside this document, it is proposed to establish a Community of Practice (Strategic Area 3), which could start with a Sub-Working Group on Climate and Health. This group would facilitate strengthening regional collaboration on climate risk, allow for focused knowledge exchange and peer-to-peer support during implementation and jointly monitor and evaluate progress against these minimum requirements.

8. Addendum 1: Impact of Climate Hazards on Healthcare Infrastructure in mountainous and remote regions

Mountain ecosystems are highly sensitive to variations in climate and human activities, and slow to recover from adverse impacts. Hazards such as landslides and mudflows in such areas can cause severe damage to access roads and building infrastructure, disrupt supply chains, and cause interruptions in water and electricity which can last for weeks or longer. As a majority of CAREC countries are impacted by mountainous terrains, this section will present climate-resilience considerations specific to mountainous and remote regions.

8.1 Climate hazard considerations for mountainous and remote areas

An important first step is to conduct comprehensive climate risk assessments on all healthcare infrastructure as discussed in the minimum requirements in the sections above. The use of Geographic information systems (GIS) can be particularly helpful in identifying relevant climate hazards in mountainous and remote regions. Health facilities are often located in difficult to access terrain, at the foot of mountain slopes, in valleys between slopes and/or near rivers with seasonal changes to water flows.

In mountainous and highland areas, in addition to using flood zone mapping, temperature anomaly data, wind loads, and mudflow and landslide frequency to identify the most relevant requirements for enhancing climate-resilience, it is also important to prioritize practical aspects such as ensuring transport accessibility and sustainable power supply during extreme weather events or climate hazards.

The sections below follow the same style as the minimum requirements, however these suggestions are specific to health facilities located in mountainous and remote areas. As above, the adoption of these suggestions should be based on local context and needs.

8.2 Asset type 1: Building infrastructure

Construction of health facilities is not recommended on slopes with impaired drainage and deforestation as these conditions place the area at a higher risk of mudflows and landslides. Given resource constraints, it is recommended to identify and prioritize measures which require minimal input but have a significant impact on the climate-resilience of the health facilities. Examples of such interventions are window insulation, awnings, stand-alone water filters, door seals, etc.

Design and construction considerations
Facilities located at altitudes greater than 1,500 m above sea level should implement a combined system of protection against heat and cold. It is necessary to avoid temperature changes of more than 30°C during the day. Building design strategies, such as insulation and shading devices, should be implemented to maintain safe temperatures inside the healthcare facility.
Regularly assess the risk of floods, mudflows and landslides in the area around the healthcare facility and along the main access roads. Mitigation measures to consider

implementing are drainage channels, retaining walls, slope reinforcement, soil moisture monitoring and early warning systems.
For new constructions, it is worth considering: • conducting a geotechnical assessment of the site prior to construction of new facilities to identify unstable slopes and saturated soils. • determining the optimal location of the buildings based on prevailing wind directions, solar insolation, potential directions of fire spread and/or other characteristics of the geographical conditions of the region. For example, in areas with excess heat, it is suggested to orient facades towards directions where solar exposure is limited as a way of reducing the accumulation of heat within the premises. • the possibility of constructing with locally used materials and design solutions which take into account temperature differences and limited access to heating resources. Examples of local solutions are multi-layer walls, thermal insulation panels, and the use of clay blocks and/or gabions.

Operation and maintenance considerations
Implement landslide and mudflow early warning systems based on monitoring soil moisture, precipitation and ground movements.
Ensure that multi-hazard emergency response plans are developed for all health facilities and are easily accessible and available to all relevant staff to ensure preparedness before any type of emergency event. Plans should: • Include scenarios for prolonged weather anomalies (multi-day heat waves, prolonged snowstorms) and hazards (landslides, mudslides, earthquakes) and the types of actions required for the operation and maintenance of equipment during and directly after the emergency event. • Identify and plan for the emergency health needs of vulnerable groups (children, older persons, pregnant women, persons with chronic diseases, etc.) • Have a clear budget line
Identify backup emergency access routes, especially for institutions located in mountainous and hard-to-reach areas, taking into account possible impacts on roads from extreme climatic hazards.

8.3 Asset type 2: Equipment and products

In the context of climate change and increased emergency situations, it is important to evaluate equipment not only for its clinical significance, but also for its sustainability, mobility, energy efficiency and ability to operate autonomously.

Design and construction considerations
In remote areas, interruptions in water and electricity supplies can last for a long period of time (weeks), so the availability of autonomous sources of essential supplies (water tanks, solar panels, diesel generators), stable cable routes and protection of the building and equipment from moisture are especially important.
Medical equipment, especially stationary equipment (e.g. ventilators, autoclaves), must be protected against power surges, have the ability to connect to alternative energy sources (generators) and be located in areas with minimal exposure to climatic hazards.

Storage facilities need to be located in areas protected from flooding, overheating, and with adequate ventilation. It is advisable to provide insulated or underground containers protected from snowdrifts and mudflows.
Use waterproof and fire-resistant cabinets or containers for storing medical documentation. Electronic systems should regularly create data backups in the cloud or on external servers located outside the risk zone.

Operation and maintenance considerations
Preventative maintenance on buildings and systems is especially important in areas with strong seasonality, where systems may be subject to sudden temperature changes and/or long periods of inactivity (e.g., due to high altitude).
Develop emergency mobile kits with basic diagnostic and protective equipment. For mountainous and hard-to-reach regions, portable and energy-independent devices (for example, hand-held pulse oximeters, mechanical aspirators, solar lamps for obstetrics, etc.) are a priority. It is also advisable to include mountaineering/emergency gear for moving across snowy or damaged terrain.
Provide trainIng to personnel on how to work in conditions of power failure and loss of communication. Related to this, it is worthwhile to conduct regular training on using alternative channels of communication and test remote access to control systems such as cloud storage, secure servers and backup systems.

8.4 Asset type 3: Energy

Design and construction considerations
In mountainous and remote areas where power outages are frequent and fuel delivery is difficult, it is recommended to prioritize solar photovoltaic systems with batteries suitable for harsh climate conditions (low and freezing temperatures). It is necessary to install these panels, batteries, and control units in locations protected from snow and mudflows, with orientation for maximum solar exposure in high-altitude environments. Fuel tanks should be housed in metal or concrete enclosures with protection against sparks and solar heating, and fire-resistant partitions should be provided between storage areas and facility buildings.
Provide physically protected (covered or buried) areas for the placement of generators and batteries, especially in areas with a risk of flooding, avalanches and strong winds. Flexible connections are recommended to minimize the risk of power lines and pipes breaking or being damaged by ground movement.
IT systems must ensure data backup in the cloud, autonomous operation of servers and resistance to Internet outages. Given the growing role of telemedicine in remote, mountainous and high-altitude areas, it is important to provide for an uninterrupted power supply and protection of network equipment.
For key infrastructure elements, provide backup energy lines along alternative safe routes. Ensure the ability to manually disconnect unstable power lines and install an early warning system for overload, especially when using unstable network sources in poorly connected areas.

Operation and maintenance considerations

At facilities with high generator dependency, it is important to monitor fuel levels, battery status, and the load on each power line on a monthly basis. Energy audits of facilities should be conducted to determine the minimum set of vital loads that can be supplied by renewable energy sources for 24–72 hours of autonomous operation. Monitoring results should be used not only for preventive maintenance, but also for annual updates to the facility's energy independence plan, including 24, 48, and 72-hour off-site power scenarios.
Solar-powered or battery-powered refrigerators certified by WHO (e.g. PQS label) are recommended, especially in facilities not connected to a stable power grid.
In areas prone to mudflows and landslides, it is recommended to provide for the installation of equipment on reinforced concrete platforms or in protective containers with anti-corrosion treatment. Water drainage, retaining walls and channels for the removal of mudflows should also be provided.

8.5 Asset type 4: Water, sanitation, and hygiene and waste

Design and construction considerations
It is important to consider the vulnerability of water catchments in mountainous areas, where water supply may depend on snowmelt, seasonal springs and unstable network pressure. Frost- and erosion-resistant drainage systems should be provided, especially on slopes, with protection against soil movement.
In remote medical facilities, it is recommended to provide a water reserve for 5-7 days, taking into account the possibility of the facility being isolated from the centralized supply due to mudflows, avalanches, or pipe breakages.
Water system installation suggestions: • Water tanks should be located in ground recesses or near load-bearing walls rather than on roofs to reduce the risk of tipping and to ensure easy access in the event of an emergency. • Water tanks should also be protected from sparks and potential fire exposure, for which stone, concrete, or metal screens can be used. • In areas with low water pressure, it is recommended to install gravity tanks on elevated surfaces or use solar-powered pumps. • The use of closed containers to protect against contamination and evaporation is also recommended, especially in dry areas and at high temperatures. • Use flexible pipe connections, anchors and protective casings where potentially unstable slopes are crossed. Also consider ground motion sensors or visual monitoring of cracks at risk areas. • In conditions of drying up water sources, it is advisable to integrate rainwater collection and filtration systems, the use of dry sanitary solutions (if necessary), and water supply monitoring using sensors.
In relation to sanitary facilities and sewers: • Install check valves on water and sewer pipes to prevent backflow. In mudflow-prone areas and seismic zones, valves and connections must be flexible and able to be quickly closed manually. • In areas with a high risk of mudflows and landslides, sanitary facilities must be located outside the basement and equipped with a mechanical pressure loss relief system. Provide for emergency bio-toilets in case of failure of the main sewerage system. • Provide a system for draining waste and rainwater on a slope away from the institution.

Operation and maintenance considerations
Drinking water in healthcare facilities should be treated to ensure microbiological safety prior to consumption or use, especially after hazards associated with floods, floods, mudflows and landslides.
Pits and sites for burning/burial of waste must be fenced, equipped with drainage and located at a safe distance from water sources. In mountainous regions, it is advisable to use a container waste collection with centralized removal off the mountain.
Temporary waste storage areas should be flood-resistant and labelled according to hazard categories. Mobile containers and biodegradable bags should also be provided.
Regular training of personnel on safe handling and waste disposal of chemicals and infectious waste in conditions of heat, fire and ventilation shutdown should be conducted.

8.6 Asset type 5: Systems and Processes

Design and construction considerations
Facilities in remote areas must have the ability to operate autonomously for at least 72 hours, including telemedicine consultations, autonomous data storage and local patient routing plans.
Consider the geographical and climatic characteristics and risks of the facility location (e.g. high altitude, seasonality, frequency of mudflows and landslides) when planning the logistics of medicines, oxygen and personnel movements.
Establish agreements with local authorities and transport owners (including those with off-road vehicles, tractors, and helicopter landing pads) for support during times of need and identify safe alternate routes in case there is the need to bypass damaged access roads.

Operation and maintenance considerations
Update patient recordkeeping to include climate hazard tags in recording templates (for example, heat, smoke, flood, air pollution) to enable tracking the increase in morbidity associated with climatic factors and contribute to epidemiological surveillance and preventative responses
Following damage to the facility from any type of hazard, conduct disinfection, drying of premises, and replacement of damaged materials (e.g., tiles, wallpaper), especially in rooms designated for children, maternity, and surgical procedures.
Proactively identify key staff members who can assume extended functions in the absence of specialized experts, along with establishing legal frameworks for reassigning responsibilities.
Conduct annual staff training drills on responding to mudflows, avalanches, water and heating outages, and prolonged transportation disruptions.

9. Addendum 2: Health security preparedness and response considerations for healthcare infrastructure

Preparedness and response planning are key components of health system resilience and health security. Public health threats and emergencies occur following climate hazards, natural hazards or disease outbreaks with epidemic potential. Preparedness and response plans are important to outline the implementation strategies required to minimize disruptions to health service provision and identify ways to ensure continuity of care during these events.

The declaration of a public health emergency triggers the activation of resources and protocols to address the emergency, such as allocating funding, deploying additional healthcare professionals, and implementing public health measures. However, many preparedness measures can be implemented to strengthen a health system's resilience and capacity to respond prior to an emergency. This can mitigate the resultant negative impacts on economic and community well-being and lead to better community health outcomes.

These measures involve supporting essential public health functions and promoting universal health coverage, strengthening disease surveillance and laboratory capacities, developing resilient and low-carbon health infrastructure, ensuring availability of adequate numbers of trained health care workers, ensuring sufficient and flexible funding, establishing reliable supply chains, developing data sharing agreements for emergency and routine data within and across countries, and fostering multisectoral, evidence-based planning, coordination and financing mechanisms.

The table below presents the core concepts of resilient health facility infrastructure and operations as aligned with core health security considerations. Taken together these considerations can form the basis for preparedness and response planning on the health facility infrastructure level.

Harmonizing health facility asset types and functions with health security considerations

Asset Type	Core Concepts
Building infrastructure	Design and infrastructure required for • Accessible, climate-resilient and low-carbon health care facilities of all levels (primary, secondary, tertiary) • Laboratories for verifying notifiable diseases (including food and water borne pathogens), sentinel surveillance, wastewater monitoring. • Health screening points and/or quarantine spaces in points of entry and border crossings and/or crowded public spaces,
Equipment and products	• Affordable, quality medicine and supplies including adequate personal protective equipment for healthcare workers • Laboratory equipment and supplies • Reliable Supply chains coupled with efficient inventory management systems and cold chain capacities

Energy	Appropriate energy system to power essential systems in facilities and laboratories, with a focus on reliable uninterrupted power supply to the extent possible to enable continuous clinical care and ongoing laboratory services as needed
Water, sanitation, and hygiene and waste	• Infection prevention and control (IPC) protocols and training for staff in health facilities, points of entry, and public spaces • Climate-resilient and geographically appropriate WASH infrastructure and sustainable, segregated waste management systems for biohazardous and normal waste • Appropriate burial protocols

Systems and processes	• Regular monitoring and review of the buildings, equipment, inventory, energy load, ventilation and air conditioning systems, WASH and waste systems
	• Training and drills for healthcare workers, psychologists, community health workers and other relevant professionals on emergency protocols for
	  o Hazard induced emergencies (e.g. fire, extreme heat/cold, earthquake, landslides, mudflow, flooding etc)
	  o Damage or disruption to facilities or equipment (e.g. structural damage, outages of water, power, inaccessibility to roads)
	  o Responding to and containing outbreaks with epidemic potential including surveillance and contact tracing, testing and safe handling and disposal of laboratory specimen and biohazardous waste, case management, IPC, epidemiological analysis, risk assessment and communication and awareness raising
	• Community engagement and awareness raising:
	  o Use visual materials, infographics, and multimedia presentations in clinics, hospitals, schools, and through mobile applications to raise awareness on topics such as hygiene promotion, water conservation, protection against extreme heat and cold, proper behavior during floods and landslides, and nutritional advice in situations of food scarcity
	  o Establish an alert system for communities such as by using short messaging service (SMS), walkie-talkies, loudspeakers and/or local radio stations to provide information during emergencies or share public health advisories
	  o Set up systems for community-based disease surveillance
	  o Updating of evacuation guidelines in case of disaster risks and emergencies for healthcare entities (especially for vulnerable population groups)

9.1 Additional information and resources

Pandemic preparedness and response: exploring the role of universal health coverage within the global health security architecture. Lal A, Abdalla SM, Chattu VK, Erondu NA, Lee TL, Singh S, Abou-Taleb H, Vega Morales J, Phelan A. 2022.

Healthcare System Preparedness and Response. CDC. 2024.

Pandemic preparedness and health system resilience in 14 European countries. Radford KH, Karanikolos M, Cylus J. 2024.

Essential public health functions: the key to resilient health systems. N Squires, R Garfield, O Mohamed-Ahmed, B Iversen, A Tegnell, A Fehr, J Koplan, JC Desenclos, AC Viso. 2023.

Joint External Evaluation Tool. International Health Regulations (2005). WHO. 2016.

Appendix 1: Document Register

No.	Document Title	Author(s)	Date	Category	Link	Main content	Prioritisation
1	AHIA Climate-resilience and adaptation guide	AHIA	Jul 2024	Country Specific - Australia	Link	Climate risks for healthcare facilities and adaptation measures for new and existing facilities in Australasia	Selected for review
2	Envisioning the sustainable and climate resilient hospital of the future	Pascale et al.	2024	Academia	Link	Creates a vision of how future hospitals would look like	
3	Primary Protection - Enhancing Health Care Resilience for a Changing Climate	US DHHS	Dec 2014	Country Specific - USA	Link	Climate risks for healthcare facilities, Hazard and Vulnerability assessment and Infrastructure solutions in US	Secondary priority
4	Safe, climate-resilient and environmentally sustainable health care facilities	WHO	3 Nov 2024	International Guidelines	Link	Actions to achieve safe, climate-resilient and environmentally sustainable health care facilities	Same content as #11
5	Checklists to Assess Vulnerabilities in Healthcare Facilities in the Context of Climate Change	WHO	8 Apr 2021	International Guidelines	Link	Checklist document supports users in establishing a baseline with regards to climate change resilience in health care facilities (Can be used to develop survey questions/ Indicators)	Secondary priority
6	Frontline Scorecard	WB	3 Apr 2024	International Guidelines	Link	Country assessment tool that evaluates the resilience of a country's health system to natural hazards (disasters) and climate change	Selected for review
7	Resilience Strategies of Healthcare Facilities Present and Future	Achour et al.	1 Oct 2010	Academia	Link	Explores UK healthcare resilience strategies; define gaps and provide suggestions based on international best practice	
8	Target setting for low carbon sustainable health systems	WHO	24 Sep 2024	International Guidelines	Link	Advice and resources on how to set credible and ambitious decarbonization targets for low carbon sustainable health systems	
9	Report of the WHO South East Asia Regional meeting on nutrition and climate	WHO	2025	International Guidelines	Link	Highlights the interlinkages between climate change, biodiversity, nutrition and its impact on health outcomes	

No.	Document Title	Author(s)	Date	Category	Link	Main content	Prioritisation
	change 14–16 May 2024 Kathmandu, Nepal						
10	Compendium of WHO and other UN guidance on health and environment	WHO	3 Jul 2024	International Guidelines	Link	Contains standards of climate resilient healthcare facilities	Selected for review
11	WHO Guidance for Climate-Resilient and Environmentally Sustainable Health Care Facilities	WHO	2020	International Guidelines	Link	Informs on indicators for climate resilient HCF	Selected for review
12	Operational framework for building climate resilient and low carbon health systems	WHO	9 Nov 2023	International Guidelines	Link	Contains framework for implementing climate resilient and low carbon health systems	Secondary priority
13	Safe Healthcare Facilities	Nenkovic et al.	2024	Academia	Link	Defines a methodology of determining resilience of healthcare facilities through determining the hospital safety index and compares this climate change. Case study of a private hospital in Serbia	
14	Exploring context-specific perspectives: a qualitative study on building climate-resilience health care facilities in southeast Asias - a qualitative study	Gan et al.	2021	Academia	Link	Research focuses on the practical implementation of climate resilient facilities strategies	
15	ISO 14091	ISO	2 Mar 2021	International Guidelines	Link		
16	NHS Net Zero Building Standard	NHS	22 Feb 23	Country Specific - UK	Link	Provides technical guidance to support the development of sustainable, resilient, and energy efficient buildings	
17	Climate-Resilience for Health Care Toolkit	OASH	Jan 2025	Country Specific - USA	Link	Has climate risks and strategies for mitigation for healthcare facilities	Selected for review
18	Towards Climate Resilient and Environmentally Sustainable Health Care Facilities	Corvalan et al	28 Nov 2020	Academia	Link	Focuses on green energy for public hospitals in Philippines	

No.	Document Title	Author(s)	Date	Category	Link	Main content	Prioritisation
19	Guidelines for Green and Climate Resilient Healthcare Facilities	National Centre for Disease Control, Govt of India	1 Feb 2023	Country Specific - India	Link	Contains standards for climate resilient health facilities in India	Selected for review
20	Guidelines for climate-resilient and environmentally sustainable health care facilities in Fiji	Ministry of Health and Medical Services	1 Feb 2020	Country Specific - Fiji	Link	Contains standards and monitoring for climate resilient health facilities in Fiji	Same content as #11
21	Climate resilient standards toward green and sustainable healthcare facilities	Mohamed Adel	1 Feb 2024	Academia	Link	Presents the requirements and indicators for green and sustainable healthcare facilities for building a climate resilient health system.	Selected for review
22	The Climate-Resilience Guidelines for BC Health Facility Planning & Design (Version 2.0)	Green Care	1 May 2024	Country Specific - Canada	Link	Contains high level climate resilient strategies for health care facilities in BC	
23	Climate change resilient health facilities: a scoping review of case studies in low and middle-income countries	Schwerdtle et al	25 Jun 2024	Academia	Link	Presents concrete examples of activities to build resilience under 11 elements in LMICS	Secondary priority
24	Learning from Practice: A Rapid Review of Climate Resilient and Low Carbon Health Systems Case Studies in Six Western Pacific Countries	Schwerdtle et al	4 Dec 2024	Academia	Link	Assesses case studies of interventions implemented towards climate resilient and low carbon health systems in six Western-Pacific countries (Australia, Fiji, South Korea, Laos PDR, Mongolia, and Viet Nam) - Just list of documents reviewed. No examples of practical case studies	
25	Towards sustainable health facilities: Developing green, safe, and climate resilient design principles and practices for DOH hospitals in the Philippines	June Philip Obsania Ruiz	2020	Academia	Link	Focuses on green energy for public hospitals in Philippines	
26	Building climate-resilient WASH services in health care facilities	WHO	2024	International Guidelines	Link	Provides instructions on how to conduct tabletop simulation on building climate-resilient WASH services in health care facilities	

No.	Document Title	Author(s)	Date	Category	Link	Main content	Prioritisation
27	Health Care Facilities Resilient to Climate Change Impacts	Paterson et al	Dec 2024	Academia	Link	Toolkit developed for health care facility officials to assess the resiliency of their facility to climate change impacts. Also Informs on indicators for climate resilient HCF	Secondary priority
28	Climate resilient and environmentally sustainable health systems special focus on health care facilities PPT	WHO	2020	International Guidelines	Link	Same as 11 (PPT for the document)	Same content as #11
29	Building Climate Resilient and Environmentally Sustainable Health Systems in Africa	WBG		Country Specific - Africa	Link	Focuses on climate resilient health systems	
30	Climate-Resilience Framework and Standards for Public Sector Buildings	British Columbia (B.C.) Climate Action Secretariat	2023	Country Specific - Canada	Link	Comprehensive standards but not specific to healthcare facilities	Cross-check document

AHIA = Australasian Health Infrastructure Alliance, ADB = Asian Development Bank, ISO = International Organization for Standardization, NHS = National Health Service, OASH = Office of the Assistant Secretary for Health, US DHHS = United States Department of Health and Human Services, WHO = World Health Organization, WBG = World Bank Group

Source: ADB.

Appendix 2: Climate Hazard Data Sources for CAREC Countries

The following tables extract climate hazard levels for CAREC countries from several data sources. This is not intended to represent a comprehensive multi-hazard risk assessment for each country, more to provide insight into a selection of the data that is publicly available to demonstrate that between them, CAREC countries are exposed to all climate hazards.

A.2 InformRISK[17]

Country (a-z)	ISO3 (a-z)	River Flood (0-10)	Tropical Cyclone (0-10)	Coastal flood (0-10)	Drought (0-10)
Afghanistan	**AFG**	7.3	0.0	0.0	8.7
Azerbaijan	**AZE**	6.6	0.0	0.0	5.3
PRC	**PRC**	9.3	7.8	9.0	4.6
Georgia	**GEO**	6.1	0.0	6.0	5.1
Kazakhstan	**KAZ**	7.6	0.0	0.0	6.1
Kyrgyzstan	**KGZ**	4.8	0.0	0.0	6.3
Mongolia	**MNG**	6.7	0.0	0.0	6.2
Pakistan	**PAK**	9.5	7.1	4.4	4.9
Tajikistan	**TJK**	6.6	0.0	0.0	7.6
Turkmenistan	**TKM**	8.3	0.0	4.4	4.7
Uzbekistan	**UZB**	8.3	0.0	0.0	6.6

[17] Disaster Risk Management Knowledge Center. https://drmkc.jrc.ec.europa.eu/inform-index (Country data accessed on 15 August 2025, Turkmenistan data accessed on 25 October 2025)

ThinkHazard![18]

Country	River Flood	Urban Flood	Landslide	Wildfire	Water Scarcity	Extreme Heat	Cyclone	Coastal Flood
Afghanistan	High	High	High	High	High	High	Low	No Data
Azerbaijan	High	High	High	High	Low	Medium	No Data	No Data
PRC	High	High	High	High	High	High	High	High
Georgia	High	High	High	High	Low	High	No Data	No Data
Kazakhstan	High	High	High	High	Low	Medium	Very Low	No Data
Kyrgyzstan	Low	High	High	High	Medium	Medium	Very Low	No Data
Mongolia	High	High	High	High	High	Medium	Low	No Data
Pakistan	High	High	High	High	High	High	High	High
Tajikistan	High	High	High	High	Medium	Medium	Very Low	No Data
Turkmenistan	High	High	Low	High	High	High	Very Low	No Data
Uzbekistan	High	High	High	High	High	High	Very Low	No Data

[18] Global Facility for Disaster Reduction and Recovery. https://thinkhazard.org/ (Country data accessed on 15 August 2025, Turkmenistan data accessed on 25 October 2025)

Appendix 3: Climate Hazard Impacts on Healthcare Infrastructure[19]

	External building structure	Internal assets (mechanical, electric)	Interdependent infrastructure	Building users and occupants
Changes in temperature including extreme heat	• Greater instances of superficial peeling, cracking and corrosion to facades including glazing and cladding, structures and surfaces • Greater instances of material degradation to facades, structures and surfaces	• Increased energy and water demand across the site • Higher frequency heating, ventilation and air conditioning (HVAC) system replacement requirements • Increased need to cool buildings or work sites • Increased stress on vital equipment and services (for example, elevators and plant) leading to greater response demands	• Deterioration of utilities (such as telecommunications and energy network) or increased incidence of blackouts/brownouts due to heat • Need for increased waste disposal or storage due to risk of pest, disease or nuisance risk with warmer conditions Impact to quality of water supply, with increased contamination and algae blooms • Impacts on landscaping and plantings, including loss of biodiversity and ecosystem function • Higher evaporation rates of water storage sites • Greater failure of transport infrastructure, making it difficult for staff and patients to access services	• Impacts on the thermal performance levels of buildings leading to reduced comfort levels for building occupants (patients, staff, visitors) • Unsafe working conditions due to extreme heat, with increased heat stress • An exacerbation of urban heat island effects affecting comfort and amenity • Health outcomes for vulnerable patients (for example, cardiovascular and respiratory conditions) compromised by exposure to hotter conditions inside building • Increased occupancy or load on services with extreme events • Staff unable to travel to work due to failure of support services – for example, road closures and transportation failure • Increased demand for outdoor respite and refuge areas resulting in insufficient capacity • Increased demand on the building as a potential area of respite
Wildfire	• Reduced accessibility to external wellness and recovery spaces • An accumulation of ash in roof drainage • Full or partial fire damage to buildings and public spaces	• Reduced air quality within internal areas • Smoke and embers affecting the ventilation and air- conditioning systems • Internal smoke damage as a result of unsealed areas	• Damage to infrastructure and assets that deliver public services (for example, buildings, telecommunications) • Impacts on landscaping and plantings, including loss of biodiversity and ecosystem function • Higher evaporation rates of water storage sites • Greater failure of transport infrastructure, making it difficult for staff and patients to access services	• Health outcomes for vulnerable patients (for example, heart and respiratory conditions) compromised by exposure to hotter conditions • Increased occupancy or load on services with extreme events • Staff unable to travel to work due to failure of support services – for example, road closures and transportation failure • Increased demand on the building as a designated 'safer place' or evacuation centre

[19] Derived from AHIA, Climate-Resilience and Adaption Guide.

	External building structure	Internal assets (mechanical, electric)	Interdependent infrastructure	Building users and occupants
			• Higher levels of water contamination (for example, ash or fire retardant entering waterways) • Interrupted access to site due to road closures	• Increased demand on emergency services and health services, including increased hospital presentations
Flooding	• Full or partial flood damage to buildings and public spaces • Increased levels of rain/moisture penetration in the building and facades affecting durability and functionality • Greater strain on drainage systems • Floodwater intrusion increasing degradation of building materials (for example, foundations)	• Higher frequency HVAC system repair/replacement requirements • Internal flood damage as a result of unsealed areas • Damage to underground services (for example, plant machinery, car parking) during flooding requires more frequent repair or replacement • Damage to ground floor services (for example, plant machinery) during flooding requires more frequent repair or replacement	• Damage to infrastructure and assets (for example, buildings, telecommunications) • Impact to water quality and water supply with contamination • Greater failure of transport infrastructure, making it difficult for staff and patients to access services • Sewerage services can be disrupted if sewerage pipes are compromised during flooding (for example, sewerage back flow) • Interrupted access to site due to road closures	• Increased occupancy or load on services with extreme events • Ponding of water can increase disease risks, particularly from vector-borne diseases and impact on vulnerable building users • Staff unable to travel to work due to failure of support services – for example, road closures and transportation failure • Increased demand on the building as a designated 'safer place' or evacuation centre • Increased demand on emergency services and health services, including increased hospital presentations
Drought	• Degraded building foundations and other below-ground infrastructure (for example, wiring) as a result of decreased soil moisture	• Degraded integrity of building materials (for example, adhesives, wiring) as a result of warmer and drier conditions	• Damage to infrastructure and assets (for example, buildings, telecommunications) • Reduced access to water leading to potential restrictions, particularly affecting irrigation • Higher levels of water contamination and algae	• Increased occupancy or load on services with extreme events
Extreme storms and cyclones (including dust and sand)	• Increased storm and hail damage to building structure and façade • Increased levels of rain/moisture penetration • Structural damage due to greater wind load being exerted on	• Increased levels of rain/moisture penetration into buildings and assets • Reduced air quality within internal areas • Dust and sand affecting ventilation and air conditioning systems	• Impact to water quality and water supply • Interruption to power supply and communications • Impacts on the transport network reducing accessibility • Sewerage services can be disrupted if sewerage pipes are compromised during flooding	• Increased occupancy or load on services with extreme events • Staff unable to travel to work due to failure of support services – for example, road closures and transportation failure • Impacts on the spread of water-borne diseases and distribution of pest species affecting vulnerable users

	External building structure	Internal assets (mechanical, electric)	Interdependent infrastructure	Building users and occupants
	assets Greater strain or loss on building fixtures, fittings and fastenings • Damage from unsecured debris	• Internal wind/rain/dust/sand damage as a result of unsealed areas		• Increased incidence of hospital presentations including mental health and emergency department presentations • Increased safety issues for patients, visitors and staff (including operations and maintenance staff) • Increased demand on the building as a place of refuge and/or as a designated evacuation centre
Humidity	• Accelerated carbonation of concrete structures, which decreases the durability of concrete structures • Greater instances of material degradation to facades, structures, and surfaces	• Build-up of mould and condensation leading to increased operations and maintenance requirements and costs • Increased energy demand across the site • Internal moisture damage as a result of unsealed areas and air leaks	• Interruption to power supply and communications • Impacts on the transport network reducing accessibility to buildings	• Increased occupancy or load on services with extreme events • Changes in relative humidity resulting in decreasing thermal comfort resulting in health impacts or decreased productivity • Impacts on the spread of water-borne diseases and distribution of pest species affecting vulnerable users
Coastal inundation and erosion	• Drainage capacity issues for buildings and hard landscaping • Corrosion of exterior infrastructure from salt spray (for example, concrete) • Saltwater intrusion, contaminating water sources, increasing degradation of building materials (for example, foundations) • More frequent and higher storm surges, including localised flooding causing damage to assets and higher maintenance costs • Increased coastal erosion impacting on building foundations	• Internal water damage as a result of unsealed areas • Increased levels of moisture penetration • Higher frequency HVAC system repair/replacement requirements	• Damage to infrastructure and assets (for example, buildings, telecommunications) • Sewerage services can be disrupted if sewerage pipes are compromised during coastal inundation • Impact to water quality and water supply with contamination of salt water • Greater failure of transport infrastructure, making it difficult for staff and patients to access services	• Increased occupancy or load on services with extreme events • Staff unable to travel to work due to failure of support services – for example, road closures and transportation failure • Increased demand on the building as a designated ‘safer place’ or evacuation centre

	External building structure	Internal assets (mechanical, electric)	Interdependent infrastructure	Building users and occupants
	• Drainage capacity issues for buildings and hard landscaping			