A.3 SEA-LEVEL RISE CHECKLISTS

IPCC states that "it is very likely that mean sea level rise will contribute to upward trends in extreme coastal high-water levels in the future. There is high confidence that locations currently experiencing adverse impacts such as coastal erosion and inundation will continue to do so in the future due to increasing sea levels, all other contributing factors being equal". This is of particular concern for small island developing states given the contribution of mean sea-level rise in increasing extreme coastal high-water levels, coupled with the likely increase in tropical cyclone maximum wind speed *(7)*. Unlike most climate hazards that vary in intensity and duration, sea-level is a very long-term phenomenon, which from the point of view of the life-span of a health care facility is permanent.

CHECKLIST FOR ASSESSING VULNERABILITY TO SEA-LEVEL RISE

SEA-LEVEL RISE			**Vulnerability level**		
High: unprepared; unable to respond (Higher risk) **Medium:** basic or incomplete preparation; low level of response (Medium risk) **Low:** prepared; able to respond (Lower risk)			**High**	**Medium**	**Low**
HEALTH WORKFORCE	**Is the health workforce,**				
	(Human resources)				
	aware of the potential risks of sea-level rise to the health care facility and to themselves?		☐	☐	☐
	equipped with a programme for assistance for mental health, injuries, medical treatment, etc.)?*		☐	☐	☐
	protected from impacts of storm surges?		☐	☐	☐
	equipped with an emergency plan to protect health workers from multiple biological and chemical hazards?*		☐	☐	☐
	provided with full personal protective equipment, especially, for clean-up crews (including waterproof safety boots, goggles, work gloves and masks?*		☐	☐	☐
	(Capacity development)				
	equipped with knowledge, experience, training and resources to manage risks and to be prepared to address actions to reduce impacts from sea-level rise?*		☐	☐	☐
	prepared and able to implement risk reduction actions and recover better than before the event?		☐	☐	☐
	trained on public health climate change issues related to effects of sea-level rise on human health?*		☐	☐	☐
	trained to manage hazardous chemicals in emergency situations?*		☐	☐	☐
	engaged in the development of plans and responses to sea-level rise and storm surge risks?		☐	☐	☐
	prepared and able to implement risk reduction actions for protecting themselves?		☐	☐	☐
	prepared with a contingency plan for storm surges and floods?		☐	☐	☐
	trained to maintain correct level of water safety, quality control and treatment supplies, in both routine and sea-level rise related events?		☐	☐	☐
	trained in multihazard assessments?		☐	☐	☐
	trained to an appropriate standard to maintain the correct level of safety of electrical power supply, in both routine and emergency/disaster situations?*		☐	☐	☐
	trained to detect posttraumatic stress disorder among staff to take prompt action?*		☐	☐	☐

SEA-LEVEL RISE	Vulnerability level		
High: unprepared; unable to respond (Higher risk) **Medium:** basic or incomplete preparation; low level of response (Medium risk) **Low:** prepared; able to respond (Lower risk)	High	Medium	Low
HEALTH WORKFORCE — **Is the health workforce,**			
(Communication and awareness raising)			
provided with an established information system for managing occupational safety and health in emergency situations?	☐	☐	☐
regularly participating in community disaster planning committees to: improve knowledge on how to reduce risks, be prepared and respond to sea-level rise risks, and recover better than before through adaptation measures?*	☐	☐	☐
aware of contingency plans for accessing and leaving the facility during flood, erosion and storm surge emergencies, and health workforce transportation?	☐	☐	☐
provided with a contingency plan for continuing to provide services at other facilities or in communities (primary health care), if necessary?*	☐	☐	☐
prepared with clear messaging about water and food safety during and after a storm surge event?	☐	☐	☐
informed on how to reduce risks and vulnerabilities to flood and storm surge events resulting from sea-level rise?	☐	☐	☐
WASH AND HEALTH CARE WASTE — **Does the health care facility,**			
(Monitoring and assessment)			
have an updated assessment plan to map risks to the water and sanitation infrastructure in place to identify where services could be disrupted from sea-level rise?	☐	☐	☐
regularly assess its sanitation system for any possible damage from sea-level rise impacts?*	☐	☐	☐
have an evaluation system to monitor its water system or supply before, during and after a storm surge event?	☐	☐	☐
have a contingency plan for monitoring and reducing contaminant concentrations in the facility's water supply system?	☐	☐	☐
regularly verify safety conditions and proper functioning of all elements of the water distribution system as early action for sea-level rise (e.g. storage tanks, cisterns, valves, pipes and connections, and water disinfection)?*	☐	☐	☐
have a water quality monitoring plan for human consumption?	☐	☐	☐
(Risk management)			
have a mechanism to protect freshwater sources around the facility from all types of contamination, including saline intrusion?	☐	☐	☐
have a safe water and wastewater management system for sea-level rise impacts, including standing water near the facility?	☐	☐	☐
store waste in a safe place to avoid release in case of flooding?*	☐	☐	☐
store hazardous chemical, radioactive and biological waste in a safe place and on a level above the ground floor?*	☐	☐	☐
have a schedule for emptying latrines regularly and in advance of flooding from high tides to avoid overflows?	☐	☐	☐
have safe waste disposal of debris after a high tide event?	☐	☐	☐
have an established safe management approach for health care waste transport (including hazardous waste) during and after a flood event due to sea-level rise?	☐	☐	☐

SEA-LEVEL RISE

High: unprepared; unable to respond (Higher risk)
Medium: basic or incomplete preparation; low level of response (Medium risk)
Low: prepared; able to respond (Lower risk)

		Vulnerability level		
		High	Medium	Low
WASH AND HEALTH CARE WASTE	**Does the health care facility,**			
	provide appropriate covers for water storage tanks to prevent damage, water contamination and saline water intrusion in case of flooding related to sea-level rise?	☐	☐	☐
	have nonreturn valves installed in water supply pipes to prevent backflows, in case of flooding?	☐	☐	☐
	build waste pits to withstand flood events?	☐	☐	☐
	have onsite water purification equipment to provide safe drinking water?	☐	☐	☐
	(Health and safety regulation)			
	have an alternative water source to supply the facility?*	☐	☐	☐
	have a water safety plan in place, in case of water contamination?*	☐	☐	☐
	have a mechanism or regulation to carry out sanitary inspections of water supply, and when necessary, establish a temporary ban on use, until improvements are made?	☐	☐	☐
	have a contingency plan to ensure effective and timely delivery of safe water during floods and emergencies over the short- and mid-term?*	☐	☐	☐
	have a coordinated cross-sectoral water management plan to protect local or alternative water sources?	☐	☐	☐
ENERGY	**Does the health care facility,**			
	(Monitoring and assessment)			
	regularly assess its energy system to ensure that it can cope with sea-level rise events (including flooding)?*	☐	☐	☐
	have an emergency backup generator (including fuel, where relevant) that is able to cover at least all critical service areas and equipment during and after the event?*	☐	☐	☐
	periodically check the emergency backup generator (including fuel, where relevant)?*	☐	☐	☐
	assess whether renewable energy (if available, such as solar) is sufficient to power critical equipment?	☐	☐	☐
	(Risk management)			
	have a secure place to protect the backup generator (e.g. an elevated place; including fuel or battery storage, where relevant) from damage?*	☐	☐	☐
	have appliance thermometers in the refrigerator and freezer to determine if food, vaccines and other essential refrigeration-dependent medical supplies are safe?	☐	☐	☐
	have adequate daylight to ensure proper visibility during power outage?	☐	☐	☐
	have power-operated doors that can be opened manually to permit exit in case of power failure?	☐	☐	☐
	have a safety backup for telecommunication and information systems (e.g. via cloud and satellite)?*	☐	☐	☐
	have a clear guidance to alert staff on safety measures (e.g. never restore power when the power is off, until a professional inspects and ensures the integrity of the electrical system; do not use electrical equipment that has been exposed to flood waters until checked by an electrician; unless power is off, never enter flooded areas or touch electrical equipment if the ground is wet)?	☐	☐	☐

SEA-LEVEL RISE

High: unprepared; unable to respond (Higher risk)
Medium: basic or incomplete preparation; low level of response (Medium risk)
Low: prepared; able to respond (Lower risk)

		Vulnerability level		
		High	Medium	Low
ENERGY	**Does the health care facility,**			
	(Health and safety regulation)			
	have an emergency plan for power outages in the short- and long-term (before, during and after a sea-level rise flood event)?	☐	☐	☐
	work with energy utility agencies to prevent suspension of electricity services?	☐	☐	☐
	have a management plan for intermittent energy supplies or system failure?	☐	☐	☐
	have a plan or regulation to determine ways to reduce overall energy use?	☐	☐	☐
	have an emergency plan to ensure availability of adequate lighting, communication and information systems, as well as refrigeration and sterilization equipment during a flood?*	☐	☐	☐
INFRASTRUCTURE, TECHNOLOGIES, PRODUCTS AND PROCESSES	**Does the health care facility,**			
	(Adaptation of current systems and infrastructures)			
	provide health workforce training to cover climate change risks and responses regarding sea-level rise?	☐	☐	☐
	have a monitoring and early warning system integrated with other areas to manage and reduce risks from storm surges and floods related to sea-level rise?	☐	☐	☐
	have knowledge, experience (considering previous damages) and resources (including human, material, financial, supplies chain and logistics) to manage risks from sea-level rise?	☐	☐	☐
	work with the local government to support vulnerable local populations to actively participate in risk reduction management, policy making, planning and implementation?	☐	☐	☐
	map the facility's location relative to sea-level rise hazards?	☐	☐	☐
	assess the performance and vulnerabilities of each critical part of the facility (structural and nonstructural elements) that can be affected by sea-level rise hazards?*	☐	☐	☐
	have a plan for assessing vulnerable public infrastructure along the coastal area of the health facility (e.g. transit systems and roads, water and sewage systems, energy infrastructure, alternative route for other health care facilities, logistics and supply chain for medical and laboratorial supplies, drinking water, food and other supplies)?*	☐	☐	☐
	in their annual planning consider how climate risks may change in future?	☐	☐	☐
	have resources available to adopt risk reduction measures to the facility and its infrastructure, technologies, products and processes?	☐	☐	☐
	regularly update these assessments, considering emerging scientific information?	☐	☐	☐
	have a schedule to inspect the facility regularly, both internally and externally, for signs of deterioration (e.g. broken plaster, cracks, corrosion, or sinking structural elements) to avoid or reduce sea-level rise impacts?	☐	☐	☐
	evaluate the condition and safety of structural and nonstructural elements impacts resulting from previous exposure to sea-level rise event?*	☐	☐	☐
	have evaluation tools (e.g. forms) to check and identify damages and the minimum needs in terms of health workers, medical supplies and other essential supplies and services to ensure that operational care service functions continue during and after a storm surge event?*	☐	☐	☐
	have funding to protect the facility and vulnerable assets from sea-level rise?	☐	☐	☐
	have an evacuation plan to transfer critical medical, laboratorial and administration equipment to another health care facility or to a safety storage or location in a storm surge emergency situation?	☐	☐	☐

SEA-LEVEL RISE

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Medium: basic or incomplete preparation; low level of response (Medium risk)
Low: prepared; able to respond (Lower risk)

INFRASTRUCTURE, TECHNOLOGIES, PRODUCTS AND PROCESSES	Vulnerability level		
Does the health care facility,	**High**	**Medium**	**Low**
have established procedures for safely procuring, transporting and storing medical supplies (medical devices, pharmaceuticals, vaccines, laboratorial supplies, parenteral nutrition and blood supplies, and other essential health care supplies)?	☐	☐	☐
have established procedures for safely procuring, transporting and storing bottled water and food supplies during an emergency?*	☐	☐	☐
have an effective emergency risk communication plan to reduce risks and impacts for health workers and patients?*	☐	☐	☐
have a contingency plan in place for safe and efficient personnel evacuation (including health staff and patients) before, during and following a flooding or a storm surge?*	☐	☐	☐
have a clear and consistent mechanism for secure evacuation of health workers and patients?*			
have evacuation routes above flood elevation?*	☐	☐	☐
have a plan to transfer critical equipment and medical supplies to another facility or to a safe storage?	☐	☐	☐
implement anti-mosquito breeding measures?	☐	☐	☐
have walls protected and insulated against moisture and mold?	☐	☐	☐
have machine rooms resistant to storm surge damage?	☐	☐	☐
have water-resistant interior construction?	☐	☐	☐
ensure removal of equipment and power supplies from basements and ground floor level to avoid damage from flooding?	☐	☐	☐
have a coordinated mechanism across the health sector in different levels of government, to manage the response and risks of public health emergencies and disasters (including sharing of resources and supplies, transferring of patients, and health workforce support)?*	☐	☐	☐
estimate the possible risks and losses, and adapt to reduce impacts?	☐	☐	☐
(Promotion of new systems and technologies)			
have an information system between the health sector and meteorological services to communicate about storm surge hazards?	☐	☐	☐
have electronic patient health records to make available to other receiving health care facilities in case of evacuation?	☐	☐	☐
have implemented measures to respond to sea-level rise scenarios and threats (e.g. seawater pump stations, floodplain mapping, assessing future sea-level rise impacts)?	☐	☐	☐
have mitigation measures in place to respond to sea-level rise scenarios and threats identified, including engineering, planning, as well as preparedness solutions for the facility and community surroundings (e.g. stormwater pump stations, floodplain mapping, assessing future climate change impacts)?	☐	☐	☐
(Sustainability of health care facility operations)			
review building code design baselines against sea-level rise to assess the risks, impacts and possible loss?	☐	☐	☐
have adaptive governance capacity regarding evaluation and measures for risk identification, risk reduction and response to sea-level rise conditions?	☐	☐	☐
have established partnerships between the facility, community and local authorities to reduce vulnerabilities in the surrounding areas?	☐	☐	☐

SEA-LEVEL RISE	Vulnerability level		
High: unprepared; unable to respond (Higher risk) **Medium:** basic or incomplete preparation; low level of response (Medium risk) **Low:** prepared; able to respond (Lower risk)	High	Medium	Low
INFRASTRUCTURE, TECHNOLOGIES, PRODUCTS AND PROCESSES			
Does the health care facility,			
have health care coalitions and partnerships with local health care providers for strategic decision-making on health services and clinical resources?	☐	☐	☐
have a route for public transportation which is likely to remain operational during or immediately following a flood event?	☐	☐	☐
have salt-resistant trees and plants?	☐	☐	☐
have trees planted in a secure place that will not block access to the facility or fall on the building in case of land erosion or wave actions?	☐	☐	☐
have a secure storage for hazardous chemicals to avoid their damage or release during an event?*	☐	☐	☐
undertake risk assessments of the supply chain for essential medical and nonmedical products?	☐	☐	☐
have secure access to essential backup services such as sterilization, laundry and cleaning services, via multiple agreements with different facilities to maintain functioning of critical services during or immediately following an event?	☐	☐	☐
have secure access to essential backup food sources via multiple agreements with different vendors and through cooperative agreements with other facilities to maintain functioning of critical services during or immediately following a sea-level rise related event?*	☐	☐	☐
have a coordinated plan with municipal health department heads to ensure appropriate preparations for ongoing sea-level rise?*	☐	☐	☐
have a postflood recovery plan related to sea-level rise for the entire infrastructure (structural and nonstructural elements) of the facility (e.g. clearance, removal and disposal of debris; demolition of critically damaged, or repair of less damaged, structural elements; reposition of equipment and furniture; reassessment of risks)?*	☐	☐	☐
have a plan to consider relocating the facility?*	☐	☐	☐

Note: For WASH and health care waste details see WASH FIT (3).

**For further details see Hospital Safety Index (2).*

IMPACTS CHECKLIST FOR SEA-LEVEL RISE

HEALTH WORKFORCE		
LEVEL OF IMPACT		
MAJOR	**MODERATE**	**MINOR**
☐ Increased risk of indoor mold growth from excess dampness, with impacts on respiratory disease	☐ Possible increased risk of infectious diseases for the health workforce from water and health care waste contamination	☐ Reduction of health workforce functions
☐ Health professionals not able to arrive or depart from the health care facility	☐ High water salinity leading to increased risk of hypertension in the health workforce	☐ Service delivery and programme delays
☐ Loss of work capacity	☐ Minor injuries to health workers requiring short-term medical treatment	☐ Minor injuries to health workers not requiring immediate medical treatment
☐ Increased demand for health care due to infectious and noncommunicable diseases (renal effects, cardiovascular diseases, respiratory diseases) and injuries (electrical shocks, chemical exposure)	☐ Significantly reduced performance capacity needing additional support (local, regional or national)	
☐ Cessation of several programmes or services with possible overflow of patients to other locations	☐ Restrictions to provide health care services and programmes	
	☐ Increased work overload resulting in stress	

WASH AND HEALTH CARE WASTE		
LEVEL OF IMPACT		
MAJOR	**MODERATE**	**MINOR**
☐ Permanent damage to water, wastewater and sewage infrastructure systems	☐ Saltwater intrusion in water and wastewater containment systems leading to reduced capacity for water treatment and distribution	☐ Increased water and wastewater management and repairs due to inundation or erosion
☐ Increased saltwater intrusion into aquifers, resulting in increased salinity of groundwater basins and well water	☐ Limited access to water for drinking and cooking	☐ Shortage of safe water
☐ Water contamination	☐ Reduced volume of stored freshwater	☐ Damage to alternative emergency water sources
☐ No access to drinking water	☐ Reduced capacity to provide disinfection or sterilization processes and hygiene services	☐ Reduced capacity to provide safe cleaning services (floor, toilets, patient rooms, emergency room and other rooms of the facility)
☐ Leakage from septic tanks, sewer systems and instability of storage tanks and pipes	☐ Surface water ingress into septic tanks leading to overflow of effluents into streams, rivers and oceans	☐ Reduced capacity to use laundry and dishwashing machines
☐ Increased corrosion of the water and wastewater drainage system	☐ Risk of sharps containers and specific biological and medical waste bins lost or damaged	☐ Possible damage to emergency water sources
☐ Possible contamination of medical devices, instruments and equipment		
☐ Risk of environmental contamination by biological and chemical hazards		
☐ Loss of water pumping and treatment systems		

ENERGY		
LEVEL OF IMPACT		
MAJOR	**MODERATE**	**MINOR**
☐ Damage to power lines causing outage ☐ Power failures ☐ Shutdown of cold storage systems ☐ Interruption of health care services which require electricity such as dialysis, oxygen therapy, diagnostic equipment ☐ Disruption of internal and external communication and information systems ☐ Disruption of the fuel supply chain	☐ Disruption of electricity generation and delivery ☐ Reduced capacity to follow boil water advisories ☐ Possible damage to emergency generator or other sources of energy ☐ Reduced capacity to provide critical health care service deliveries such as dialysis, oxygen therapy, diagnosis equipment ☐ Patients need to be transferred to other locations ☐ Loss of vaccines, laboratorial supplies, drugs, pharmaceuticals, milk, parenteral nutrition and blood supplies, and other essential refrigeration-dependent medical supplies	☐ Temporary power supply interruption ☐ Possible delay in restarting power, thereby affecting health care ☐ Reduced capacity to provide cleaning services that need electricity (laundry, dishwashing machines) ☐ No ambient cooling ☐ Loss of food or difficulty in providing food refrigeration ☐ Reduced capacity to provide disinfection services that need electricity

INFRASTRUCTURE, TECHNOLOGIES, PRODUCTS AND PROCESSES		
LEVEL OF IMPACT		
MAJOR	**MODERATE**	**MINOR**
☐ Infrastructure destruction (structural and nonstructural; full or parts of the facility) ☐ Building collapse from coastal erosion and material corrosion ☐ Increased water treatment (desalinization process) ☐ Increased maintenance and repair of the facility building ☐ Ongoing facility flooding during high tides ☐ Blocked transport systems and flooded ambulance stations ☐ Blocked building access ☐ Damage to critical medical equipment ☐ Damage to essential supplies (medications, treatments, medical devices, drugs, laboratorial supplies, pharmaceuticals, vaccines, blood, milk, nutritional supplies and other critical supplies) requiring prompt repositioning ☐ Interruption in complex and emergency health care services (surgery, complex treatments, urgent care, blood banks, etc.) ☐ Disruption of health care service delivery and operations, such as ambulatory, immunization, maternity room, pharmacy, medication for chronic diseases, and other primary services ☐ Cessation of services or prolonged service disruption due to loss or damage ☐ Interruption of supply chains ☐ Damage to internal access systems (e.g. elevators, ramps, corridors, garage) ☐ Increased costs of building maintenance ☐ Damage to medical and administration equipment and furniture	☐ Infrastructure damage (structural and nonstructural; full or parts of the facility) ☐ Partial disruption of health care facility functions resulting from coastal erosion or corrosion ☐ Disruption of the food chain due to saline intrusion in agriculture ☐ Damage to road access ☐ Difficulty in transporting patients due to damaged or disabled transportation systems ☐ Reduced capacity to deliver health care services due to damage and reduced access to clinical, laboratorial and medical supplies ☐ Temporary suspension of service deliveries ☐ High demand for cleaning services for the entire facility building, after a flood event ☐ Long-term effect on the environment needing external assistance/interventions ☐ Increased costs from the water desalinization process ☐ Possible replacement of sections of the health facility's building ☐ Increased costs due to demand for repositioning of all damaged or lost medical equipment and devices ☐ Increased demand for providing all necessary essential or critical supplies (medications, treatments, medical devices, drugs, laboratorial supplies, pharmaceuticals, vaccines, milk, parenteral nutritional and blood supplies, and other critical supplies) ☐ Increased costs of recovery of infrastructure, postevent	☐ Localized disruption of services with minor loss and damage ☐ Increase in costs to maintain and repair the facility building and its assets ☐ Damage or loss of documents and medical records ☐ Minor impact on local operations without compromising health care services ☐ Minimal impact on the supply chain ☐ Short-term negative effect on the environment

Sources for tables of vulnerabilities and impacts: (1–3,8,21,41,44–46,49,50).

SEA-LEVEL RISE: PROPOSED ACTIONS TO RESPOND TO THE IDENTIFIED IMPACTS

Health workforce
WASH and health care waste
Energy
Infrastructure, technologies, products and processes