Building Climate Resilience in Water Safety Planning

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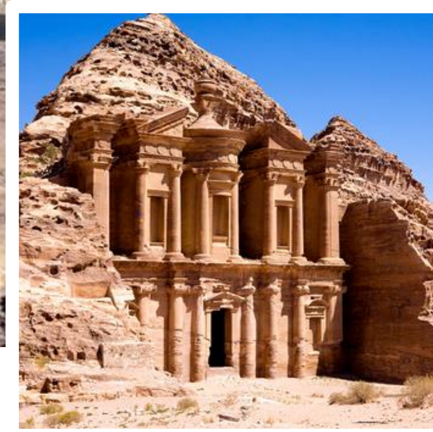

inspiring change

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Potential climate change impacts on water quality

- Changes in the spatial distribution, timing and intensity of weather-related events
  - More frequent and intense extreme weather events
  - Long term stresses on water resource availability
- Increased concentration of contaminants in drier conditions
- Receving waters become dominated by effluent flows with increased sediment loads, pathogens and nutrients
- Higher temperatures favour increased algal bloom formation and NOM
- Sea level rise causing saltwater intrusion

Climate change will have impacts on all aspects of a water supply system

What is a WSP?

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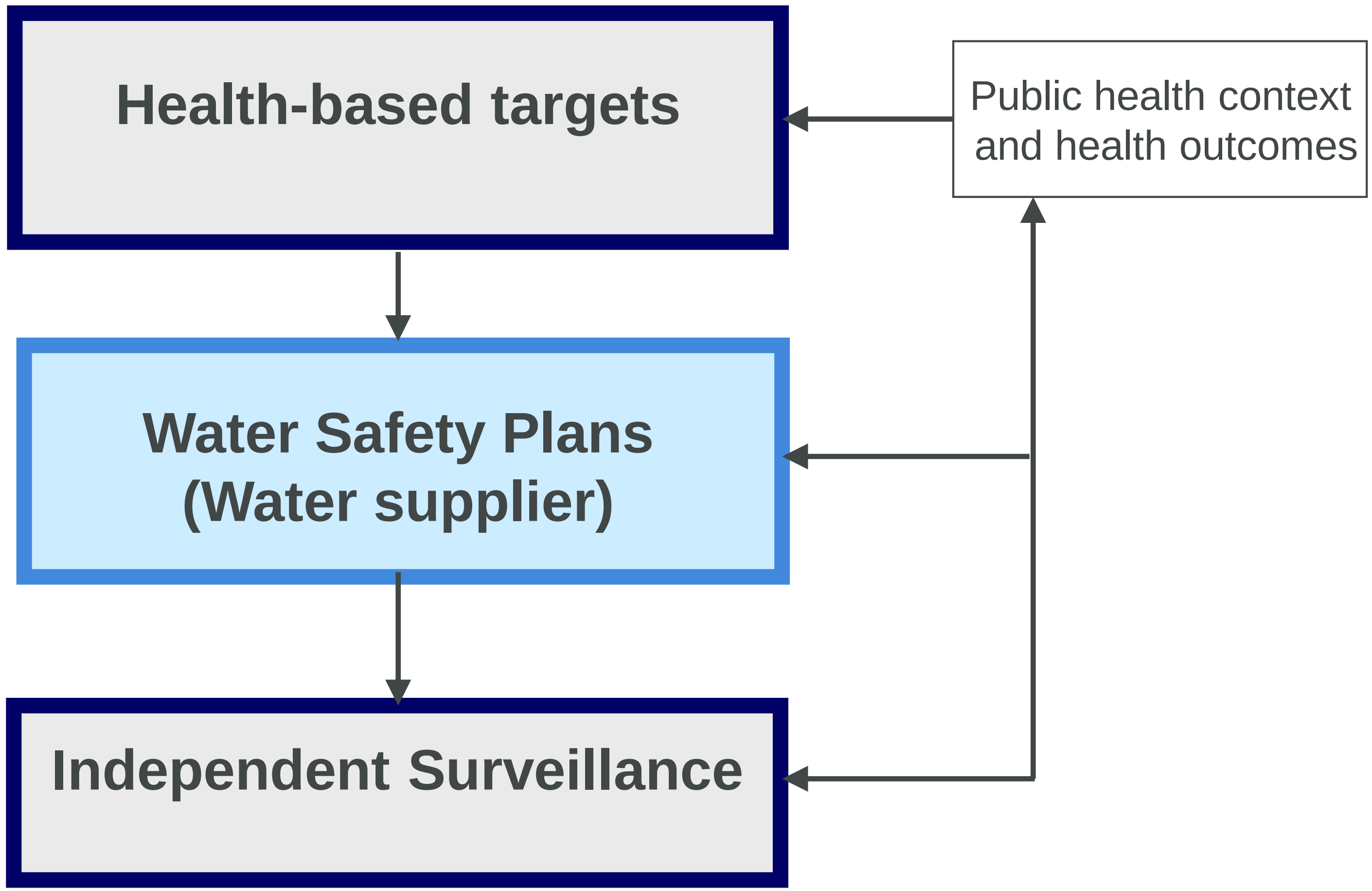
WATER SAFETY PLAN: A comprehensive risk assessment and risk management approach that includes all steps in the water supply from catchment to consumer

WSPs provide a valuable framework to address anticipated climate change impacts

WHO Framework for Safe Drinking-water



Introduction to WSP Approach

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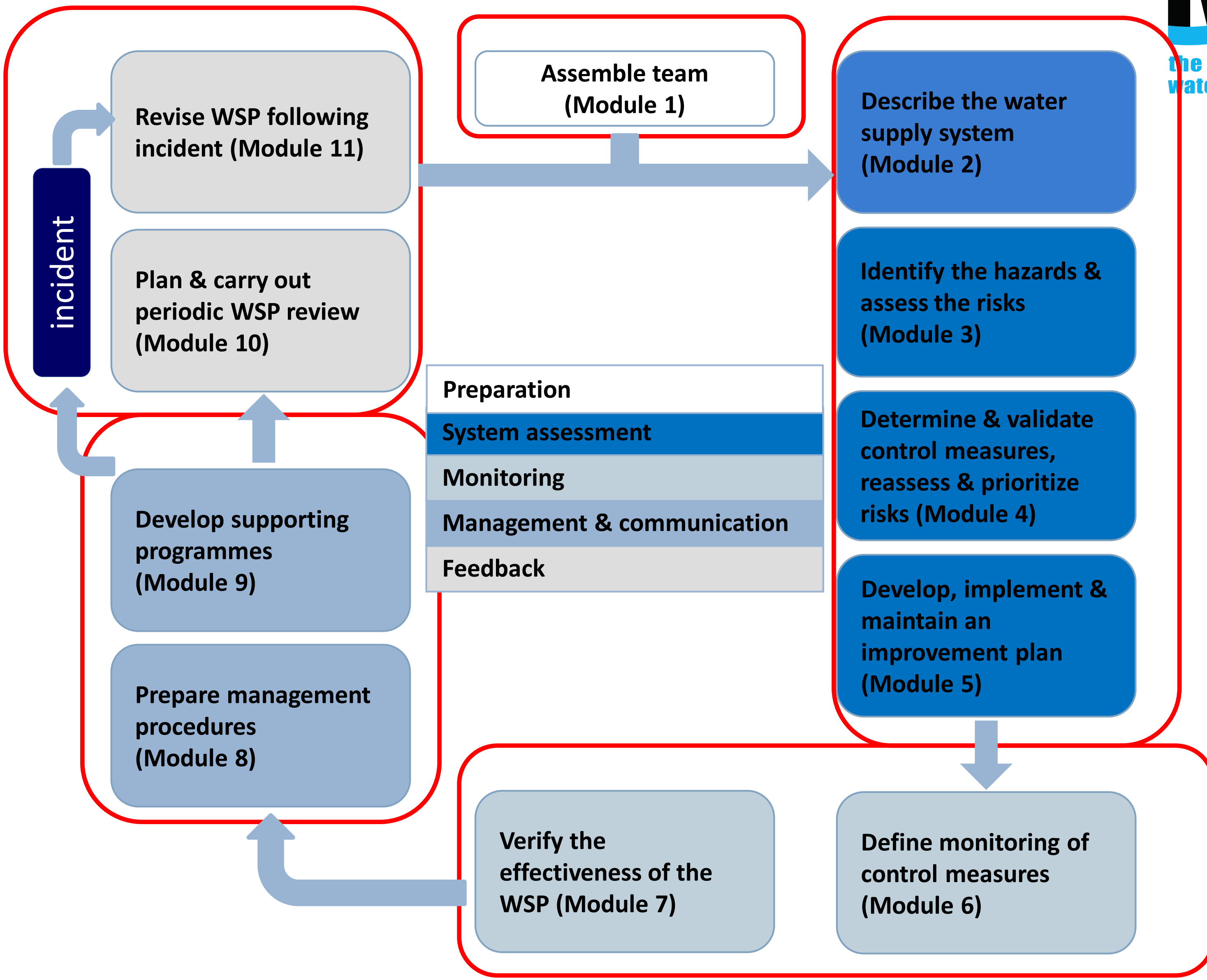
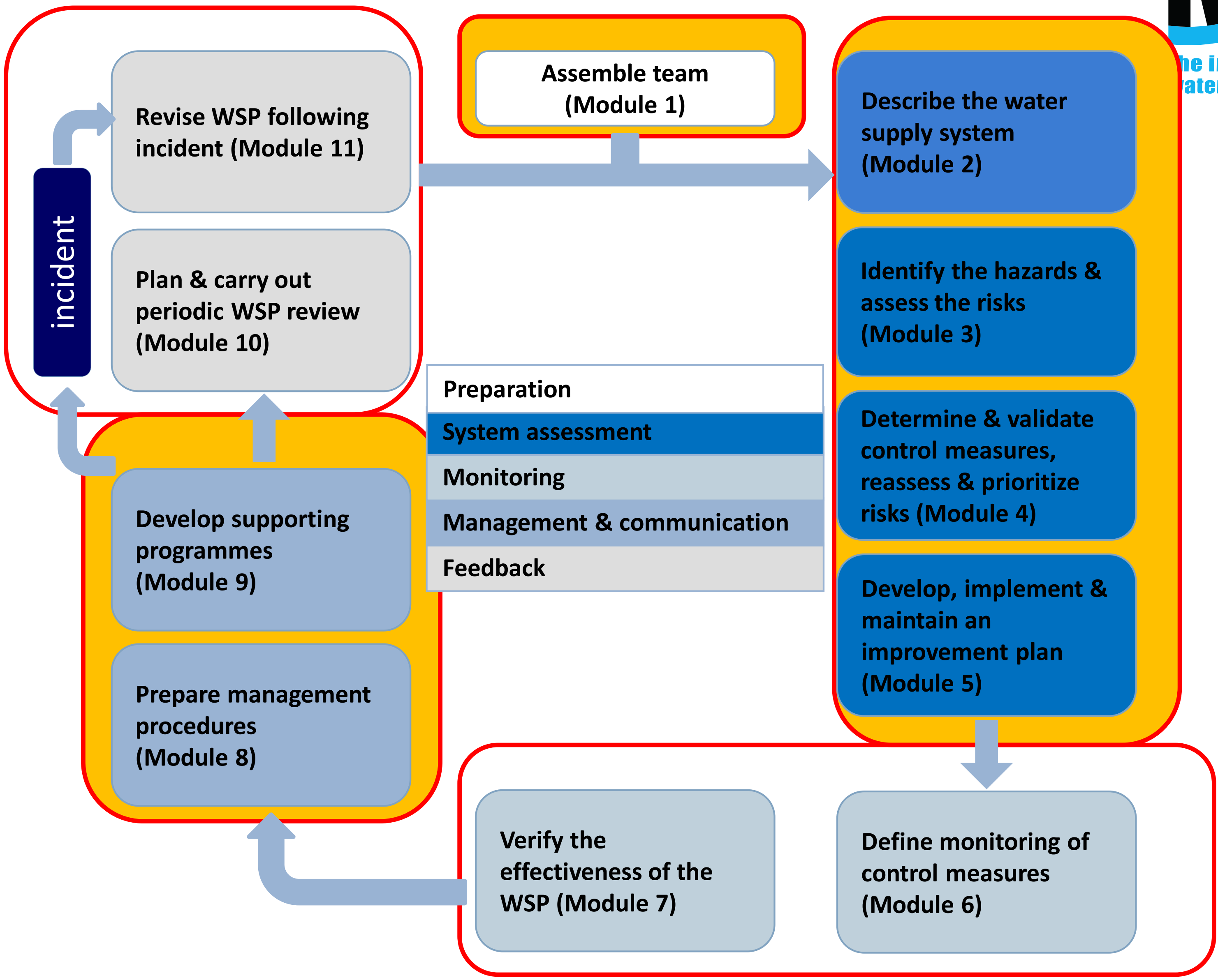
- **Proactive** – prevent contamination; don’t wait for it to happen
- **Holistic** – catchment to consumer management
- **Risk-based** – focus limited resources on highest risks to water safety
- Will **vary in complexity** according to situation
- Objectives:
  - Minimize contamination of source water
  - Reduce or remove contamination by treatment
  - Prevent contamination during storage, distribution and handling

Overview of WSP Steps



Key steps where climate change needs to be considered



Climate Resilience through WSPs

- **Objective**: To support the identification and management of climate change associated risks to water supply systems (quality and quantity)

- **Target audience**: Water suppliers/WSP teams

- Applicable for new and existing WSPs

Resilience and Adaptation

Climate resilience of a WSP:

- A WSP that considers climate change in a way that ensures that safe water is supplied to users in enough quantity and which considers the sustainability (i.e. resilience of the system & infrastructure).

Important concepts linked to resilience:

- Capacity to anticipate, respond to, cope with, recover from and adapt to stress and change
- Ability of the system to keep on functioning in a way that it maintain its essential function, identity and structure.

Adaptation and adaptation options – to strengthen resilience of systems. CC terminology, replaced by control measures, for the purpose of this document and ensure understanding from target audience

DRR and IWRM

- Disaster risk reduction (**DRR**) focuses on mitigating exceptional events principally through **improving resilience**
- Integrated Water Resource Management (**IWRM**) **provides a framework for adaptation** to the long-term changes associated with climate change

DRR and IWRM are important contributory approaches to water safety planning.

WSPs can also contribute to DRR and IWRM.

Integration of Climate Change into the WSP Process

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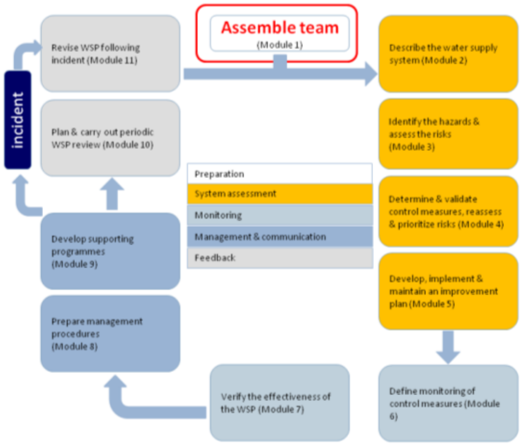
Module 1: Assemble the WSP Team:

- **Consult climate change experts**; do not need to be formal members of the WSP team
- Experts to consult include
  - Climatologists
  - Hydrologist
  - Climate change and water quality linkages
  - Persons with operational experience on different water supply scenarios or disaster management that are being planned for
  - Etc.



As most of the risks posed by climate change will be similar in comparable climatic or ecological zones, this information can be collected for the broader region

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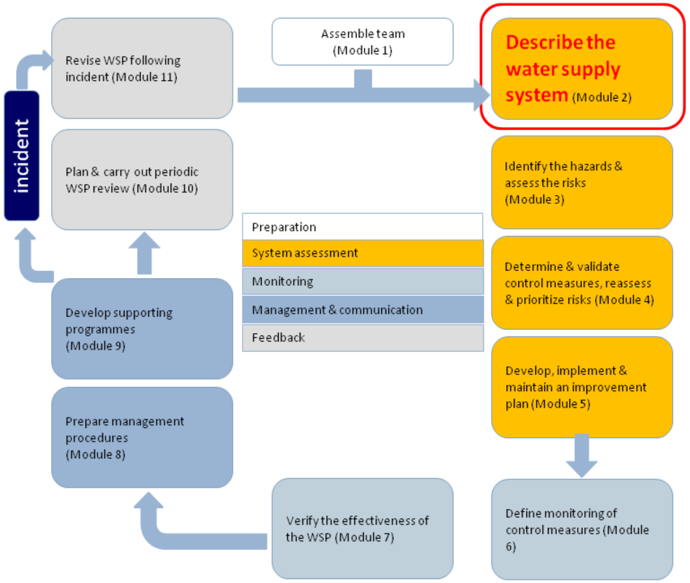
Module 2: Describe the water supply system

- **Scenario analysis: Anticipating future changes** to water supply systems, e.g. changes to cope with seasonal variations due to CC; to be conducted at regional level
  - **Long term planning** for water resource management and water infrastructure, considering other factors that may exacerbate stresses on water resources;
  - **Evaluate outputs from DRR and IWRM** in the context of water quality and availability (e.g. water resources assessments and basin management plans)



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Module 3-5: Hazard identification, risk assessment and improvements

- Assess **current and future hazards and risks** in the context of climate change
- **Vulnerability and adaptation assessments** conducted at the regional level should inform RAs of individual water supply systems

Climate change itself will not change the basic nature of threats to water services but it will change their likelihood and severity, and potentially the geographical range of some threats

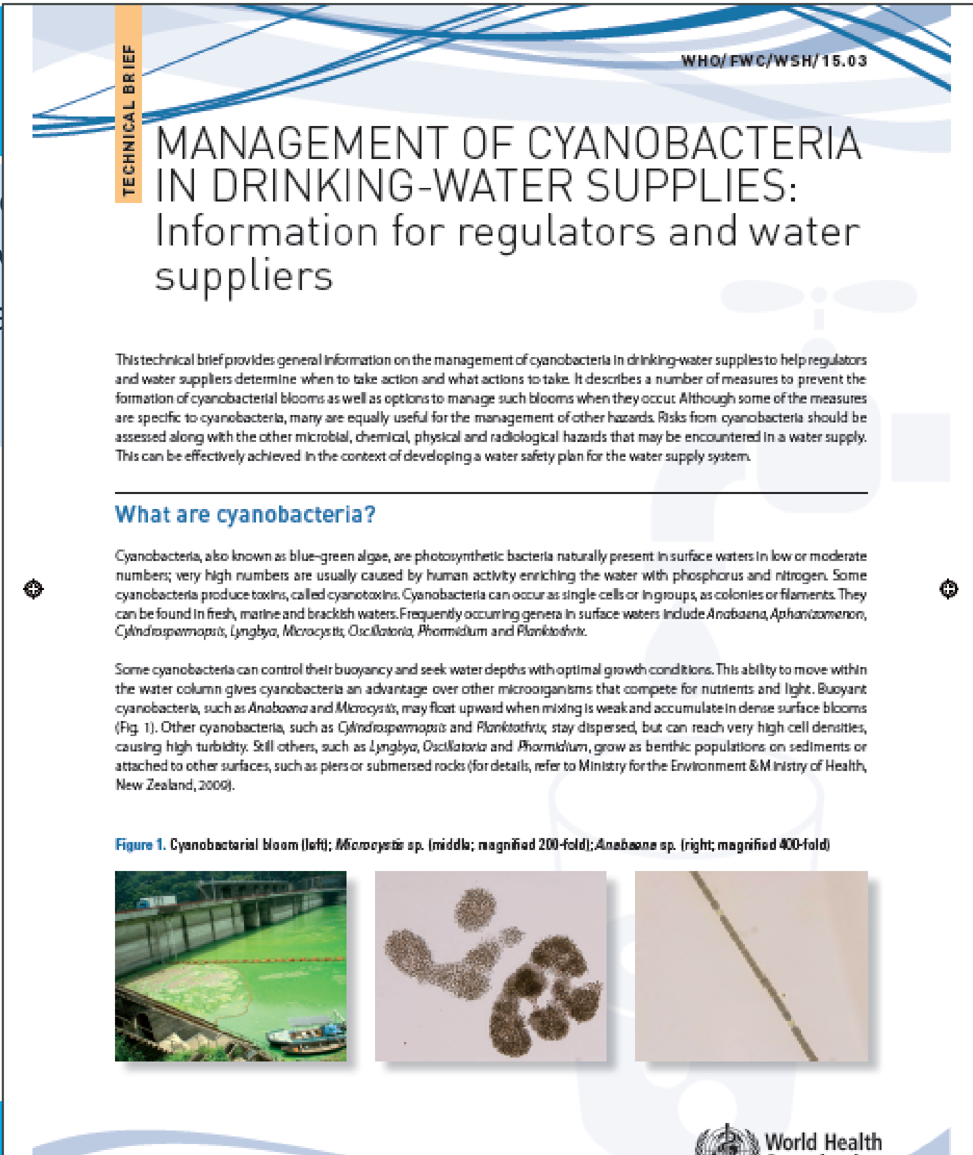
- Consider **resilience/adaptability** for infrastructure **improvements**

Examples of Impacts to Water Quality and Associated Control Measures (Modules 3-5)

	Climate Change Impact	Potential Effect on
2	**Increased temperature**	- Increase in algal bl -Lower dissolved ox - Favouring microbia systems

Example of Potential Control Measure

Use bubble plume mixers, impeller destratifiers or sub-limnetic oxygenation to help minimise stratification and oxidise nutrients, nutrient level control, use of algicides



TECHNICAL BRIEF

WHO/FWC/WSH/15.03

MANAGEMENT OF CYANOBACTERIA IN DRINKING-WATER SUPPLIES:
Information for regulators and water suppliers

This technical brief provides general information on the management of cyanobacteria in drinking-water supplies to help regulators and water suppliers determine when to take action and what actions to take. It describes a number of measures to prevent the formation of cyanobacterial blooms as well as options to manage such blooms when they occur. Although some of the measures are specific to cyanobacteria, many are equally useful for the management of other hazards. Risks from cyanobacteria should be assessed along with the other microbial, chemical, physical and radiological hazards that may be encountered in a water supply. This can be effectively achieved in the context of developing a water safety plan for the water supply system.

What are cyanobacteria?

Cyanobacteria, also known as blue-green algae, are photosynthetic bacteria naturally present in surface waters in low or moderate numbers; very high numbers are usually caused by human activity enriching the water with phosphorus and nitrogen. Some cyanobacteria produce toxins, called cyanotoxins. Cyanobacteria can occur as single cells or in groups, as colonies or filaments. They can be found in fresh, marine and brackish waters. Frequently occurring genera in surface waters include *Anabaena*, *Aphanizomenon*, *Cylindrospermopsis*, *Lyngbya*, *Microcystis*, *Oscillatoria*, *Phormidium* and *Planktothrix*.

Some cyanobacteria can control their buoyancy and seek water depths with optimal growth conditions. This ability to move within the water column gives cyanobacteria an advantage over other microorganisms that compete for nutrients and light. Buoyant cyanobacteria, such as *Anabaena* and *Microcystis*, may float upward when mixing is weak and accumulate in dense surface blooms (Fig. 1). Other cyanobacteria, such as *Cylindrospermopsis* and *Planktothrix*, stay dispersed, but can reach very high cell densities, causing high turbidity. Still others, such as *Lyngbya*, *Oscillatoria* and *Phormidium*, grow as benthic populations on sediments or attached to other surfaces, such as piers or submersed rocks (for details, refer to Ministry for the Environment & Ministry of Health, New Zealand, 2009).

Figure 1. Cyanobacterial bloom (left); *Microcystis* sp. (middle; magnified 200-fold); *Anabaena* sp. (right; magnified 400-fold)

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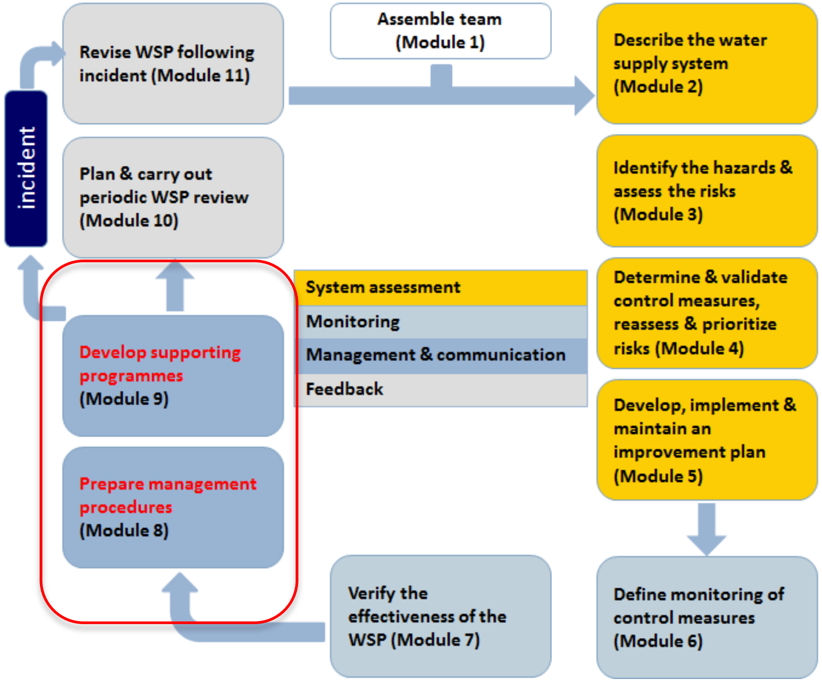
Module 8-9: Management procedures and supporting programmes

- Consider **climate-related emergencies** when developing management procedures
- Need **new supporting programmes** to manage new climate risks
  - E.g Training on awareness of climate change
  - Engagement with relevant agencies to find out latest science and updates on climate risks
  - Training on new technologies and management of new water sources



Future Developments

- Publish WHO guidance document (Q1 2016)
- Continue piloting climate resilient WSPs and review additional technical issues/challenges faced in developing these WSPs.
- Develop guidance to support WASH specific vulnerability and adaptation assessments

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Thank You

Examples of Impacts to Water Quality and Associated Control Measures (Modules 3-5)

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	Climate Change Impact	Potential Effect on Water Sources and Quality
1	**Increased drought duration**	- Longer term adverse impact on water quality - Concentration of hazards increases with low flow - Reduced groundwater recharge, higher concentration of arsenic and fluoride - Increased reliance on alternative water sources which may be more pollutive - In large reservoirs, reduced flow and higher temperature result in lower dissolved oxygen, increased benthic nutrient release, phytoplankton activity

Example of Potential Control Measure
Introduce enhanced treatment e.g. pre-oxidation, ion exchange, chemical adsorption or reverse osmosis Improved catchment management

One of the reverse osmosis trains at Singapore's NEWater Plant
Source: http://www.biwater.com