CLIMATE CHANGE AND WATER SECURITY

MAJ GEN ANM MUNIRUZZAMAN NDC. PSC.

BIPSS
Towards a Secure World

“Water is the new oil: a resource long squandered and soon to be overwhelmed by insatiable demand. ”

CLIMATE CHANGE: A DISASTROUS BEGINNING

- Climate change is a phenomenon we can no longer deny as its effects have become increasingly evident worldwide. It refers to any significant change in the measures of climate lasting for an extended period of time. In other words, climate change includes major changes in temperature, precipitation, or wind patterns, among other effects, that occur over several decades or longer.
- Climate change may be due to natural external factors, or even a natural internal processes of the Earth's climate system, however, the anthropogenic forcing is leading to an increase in the concentration of greenhouse gases, or combinations of these factors.
- One of the biggest ways a change in climate is felt, is through **a *change in water resources*** : Droughts, floods, sea level rise and extreme weather all put both our ecosystems and us, humans at risk.

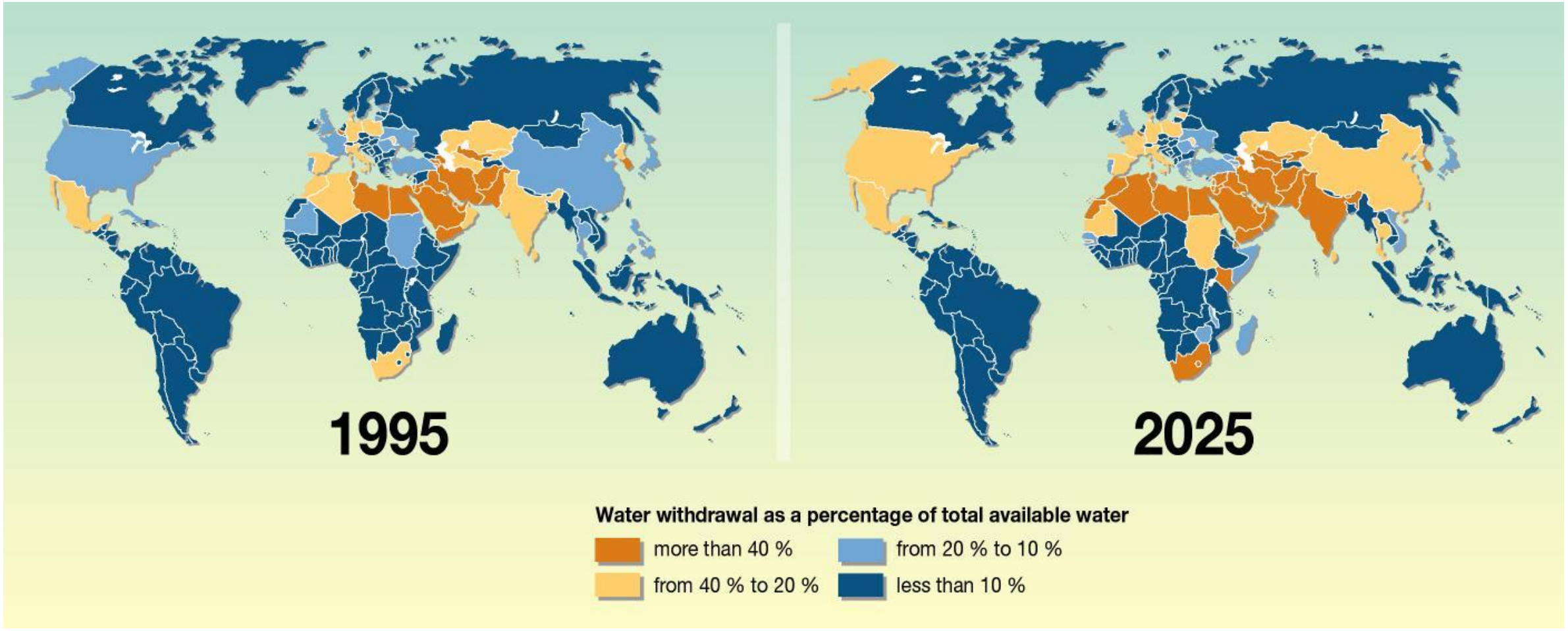
CLIMATE CHANGE: A DISASTROUS BEGINNING

- Known records and climate projections provide abundant evidence that fresh water resources are vulnerable and have the potential to be strongly influenced by climate change, with wide ranging consequences for human societies and to the ecosystem.

CLIMATE CHANGE AND ITS IMPACT ON WATER

How is water related to climate change?	• Water is the primary medium through which climate change influences Earth's ecosystem and thus the livelihood and well-being of all societies.
How does water influence the ecosystem?	• Higher temperatures and changes in extreme weather conditions are projected to affect availability and distribution of rainfall, snowmelt, river flows and groundwater, and further deteriorate water quality and quantity.
How are WE being effected?	• Climate change exacerbates water quality and availability in all regions with an already higher water scarcity: Africa, South Asia, Southwest Asia, the Middle East and the Mediterranean. • Currently 1.1 thousand million people are without access to safe drinking water. (IPCC 4th assessment)

PROJECTED WATER STRESS AROUND THE WORLD

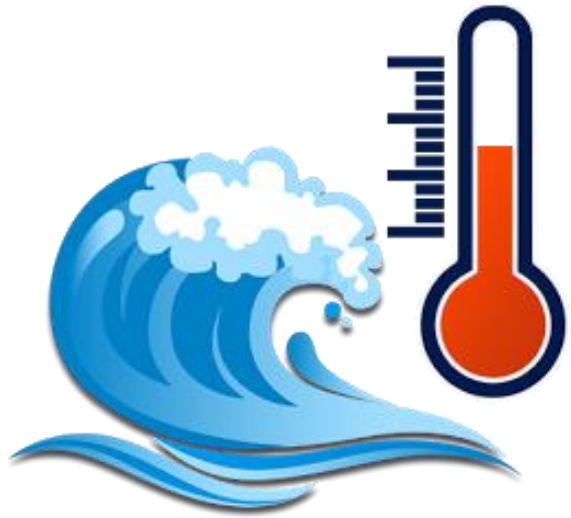


Source: UNEP

OBSERVED CHANGES IN CLIMATE ON WATER

Increase in atmospheric temperature

Reduction in water availability in basins by glaciers that are slowly melting. This leads to an excess and scarcity of freshwater resources, all at the same time.



Increase in surface water temperature

Reductions in dissolved oxygen content of water. Increase in algal blooms, mass coral bleaching events.

OBSERVED CHANGES IN CLIMATE ON WATER

Sea Level Rise

As glaciers and ice cap melt, the sea level rises, causing inundation and salinity intrusion at coastal areas. At the same time, the availability of freshwater also falls.

Shift in Precipitation pattern

Changes in water availability due to changes in precipitation and other phenomenon. While some countries will have excess rainfall, others may have none at all. (e.g groundwater recharge)

OBSERVED CHANGES IN CLIMATE ON WATER

Increased Evapotranspiration

Water availability reduction is seen throughout. Salinisation of water resources And Lower groundwater levels becomes a common phenomenon

More intense and extreme weather events

Increased floods leads to degradation of water quality and introduce several pollutants onto the water. At the same time, droughts effect the water availability and overall quality.

THIRSTING FOR A FUTURE

"Water resources and how they are managed impact almost all aspects of society and the economy, as climate change not only obligates large scale natural impacts, but adds major anthropogenic pressure to nations that are already confronting the issue of sustainable freshwater use."

IPCC Technical Paper 6

CURRENT FRESHWATER VULNERABILITIES AROUND THE WORLD

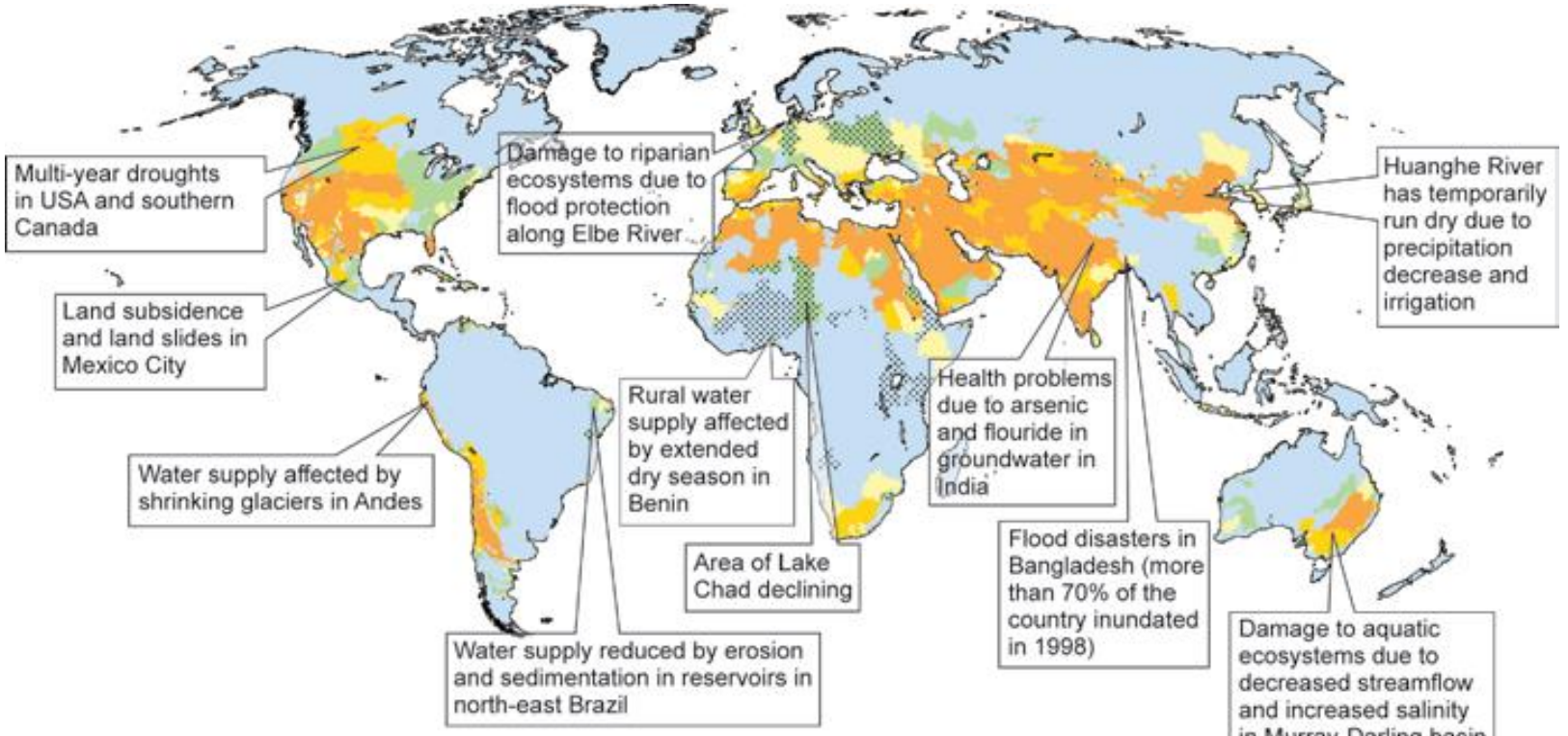
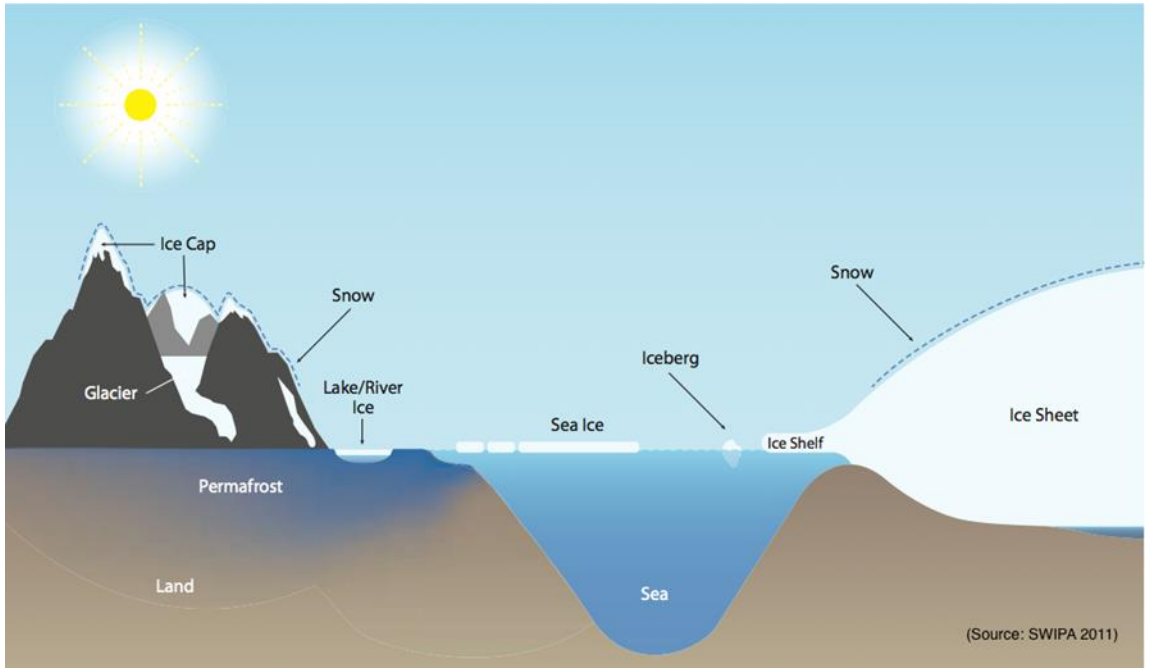


Fig: Examples of current vulnerabilities of freshwater resources and their management around the world

PROJECTED CHANGES IN CLIMATE AS THEY RELATE TO WATER

- Snow land and ice
- The cryosphere (consisting of snow, ice and frozen ground) on land stores about 75% of the world's freshwater. In the climate system, the cryosphere and its changes are intricately linked to the surface energy budget, the water cycle and sea-level change. More than one-sixth of the world's population lives in glacier or snowmelt-fed river basins (Stern, 2007)

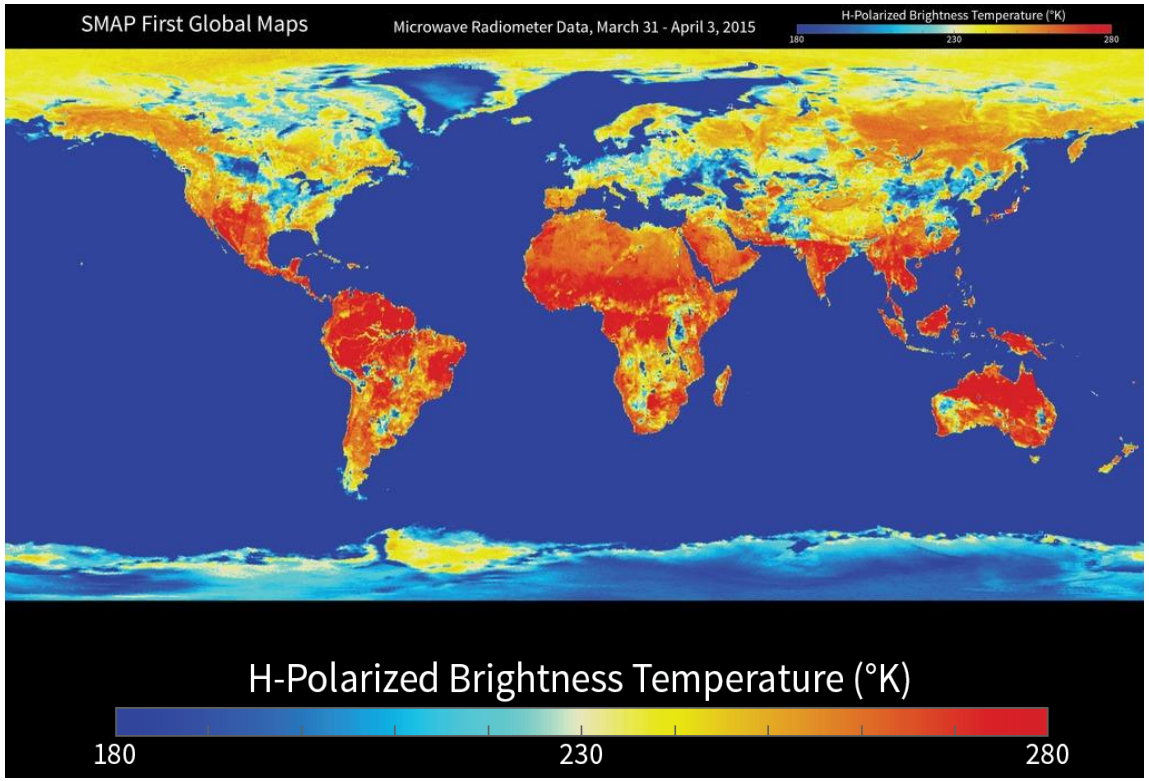


PROJECTED CHANGES IN CLIMATE AS THEY RELATE TO WATER

- Rising Sea Level
- Rising sea level potentially affects coastal regions, but attribution is not always clear. Global increases in extreme high water levels since 1975 are related to both mean sea-level rise and large-scale inter-decadal climate variability (Woodworth and Blackman, 2004).

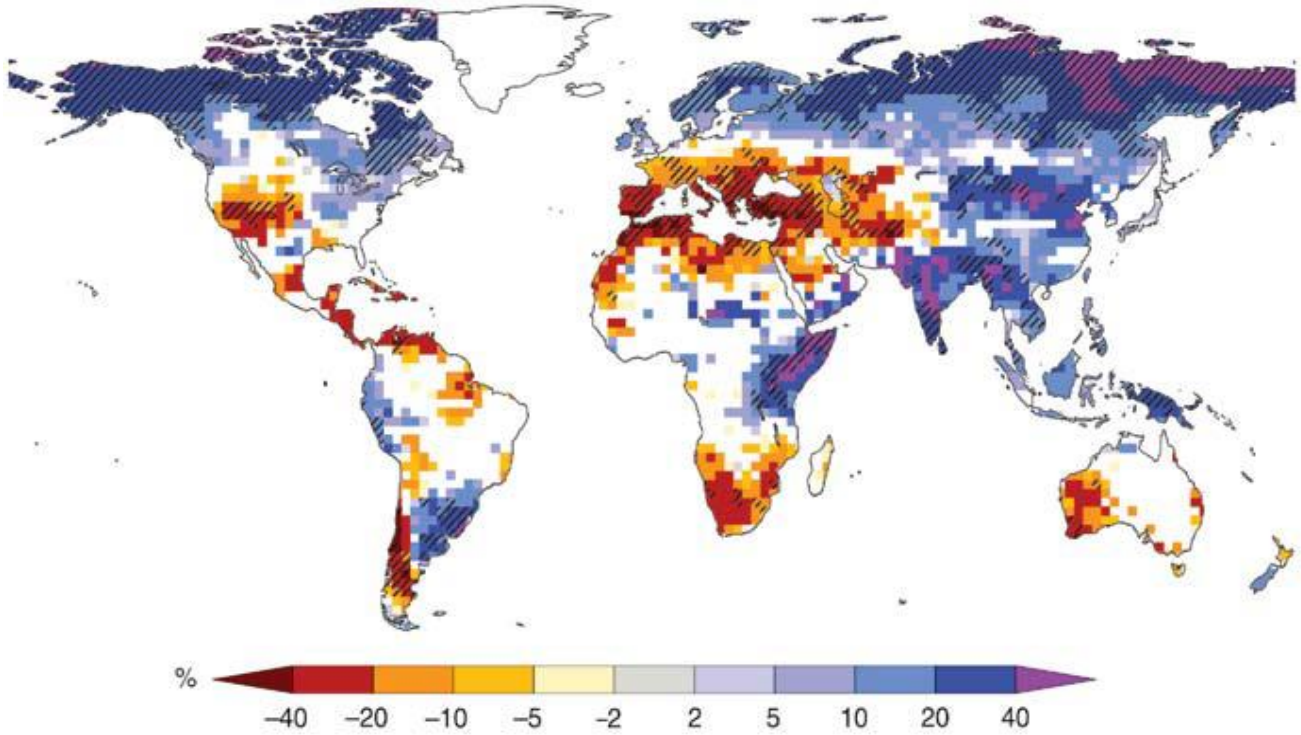
PROJECTED CHANGES IN CLIMATE AS THEY RELATE TO WATER

- Soil moisture
- Projections of annual mean soil moisture content commonly show decreases in the subtropics and the Mediterranean region, but there are increases in East Africa, central Asia and some other regions with increased precipitation. Decreases also occur at high latitudes, where snow cover will diminish.



PROJECTED CHANGES IN CLIMATE AS THEY RELATE TO WATER

- Runoffs and Water discharge
- Changes in river flows, as well as lake and wetland levels, due to climate change depend primarily on changes in the volume and timing of precipitation and, crucially, whether precipitation falls as snow or rain.
- Runoff is notably reduced in southern Europe and increased in south-east Asia and in high latitudes. the effects of CO2 enrichment may lead to reduced evaporation, and hence either greater increases or smaller decreases in the volume of runoff.



CLIMATE CHANGE AND WATER RESOURCES: IMPACTS AND RESPONSES

- **Observed effects due to changes in the cryosphere:** Effects of changes in the cryosphere have been documented with evidence that they are, in general, a response to the reduction of snow and ice masses due to enhanced warming.
- Mountain glaciers and ice caps, ice sheets and ice shelves: The enhanced melting leads at first to increased river runoff and discharge peaks, while in the longer time-frame (decadal to century scale), glacier runoff is expected to decrease
- Snow cover and frozen ground: Due to less extended snow cover both in space and time, spring peak river flows have been occurring 1–2 weeks earlier during the last 65 years in North America and northern Eurasia

CLIMATE CHANGE AND WATER RESOURCES: IMPACTS AND RESPONSES

- **Hydrology and water resources :**
- Changes in surface and groundwater systems: Groundwater levels around the world show a decreasing trend over the last few decades [WGII 3.2,10.4.2], but this is generally due to groundwater pumping surpassing groundwater recharge rates, and not ALWAYS due to a climate related decrease in groundwater recharge. **However**, in regions, such as south-western Australia, where increased groundwater withdrawals have been caused not only by increased water demand but also because of a climate-related decrease in recharge from surface water supplies (Government of Western Australia, 2003).
- Water quality: Water ecosystems have shown changes in species composition, organism abundance, productivity and phenological shifts. [WGII 1.3.4] Also due to warming, many lakes have exhibited prolonged stratification with decreases in surface layer nutrient concentration [WGII 1.3.2], and prolonged depletion of oxygen in deeper layers. [WGII Box 4.1] Due to strong anthropogenic impacts not related to climate change, there is no evidence for consistent climate-related trends in other water quality parameters (e.g., salinity, pathogens or nutrients) in lakes, rivers and groundwater.

CLIMATE CHANGE AND WATER RESOURCES: IMPACTS AND RESPONSES

- Floods and droughts: A variety of climatic and non-climatic processes influence flood processes, resulting in river floods, flash floods, urban floods, sewer floods, glacial lake outburst floods and coastal floods. Globally, the number of great inland flood catastrophes during the last 10 years (1996–2005) is twice as large, per decade.
- Droughts seem to be determined largely by changes in sea surface temperatures, especially in the tropics, through associated changes in the atmospheric circulation and precipitation. In the western USA, diminishing snow pack and subsequent reductions in soil moisture also appear to be factors. In Australia and Europe, direct links to global warming have been inferred through the extreme nature of high temperatures and heatwaves accompanying recent droughts. [WGI 3.ES, 3.3.4]

THIRSTING FOR A FUTURE: CLIMATE CHANGE AND FRESHWATER RESOURCES

DID YOU KNOW?

More than 1/6 of the worlds population is dependent on water from glacier melt and seasonal snow packs. That's almost 1.6 billion of the population!

- As climate change leads to an increase of the average annual temperature, there will be an initial increase in annual water flows due to the rapid melting of the glaciers. However, it will be followed by a decrease in the flows due to a decrease in the water volume stored in glaciers and snow packs.
- This will result in initial floods and eventually long drought in the regions that are dependent on melting of glaciers for their water supply.
- In addition, rapid melting of glaciers can lead to the formation of glacial melt-water lakes, which may pose a serious threat of GLOFs (Glacial Lake Outburst Floods).

THIRSTING FOR A FUTURE: CLIMATE CHANGE AND FRESHWATER RESOURCES

- Semi-arid and arid areas are particularly vulnerable to the impacts of climate change on fresh water, as the rainfall and river water availability are distributed over just a few months.
- Efforts to offset declining surface water availability will be hampered by the fact that groundwater recharge is likely to decrease considerably in some already water-stressed region

CLIMATE CHANGE: DEMAND AND AVAILABILITY OF FRESHWATER RESOURCES

Increased melting of glaciers and subsequent sea level rise will lead to salinization of ground water and salt intrusion of estuaries, resulting in a decrease in freshwater availability for humans and for ecosystems in coastal areas.

20% of the worlds population living in river basins will be affected by flood hazards by the 2080s due to global warming (IPCC, 2007).

Higher sea surface temperatures, increased precipitation intensity, and longer periods of low flows will further intensify many forms of water pollution, which will have adverse impacts on ecosystems, human health, water system reliability, and operating costs.

CLIMATE CHANGE: DEMAND AND AVAILABILITY OF FRESHWATER RESOURCES

Higher temperatures and increased variability of precipitation would lead to increased irrigation water demand, even if the total precipitation during the growing season remains the same.

An increase in household water demand (for example through an increase in garden watering) and industrial water demand, due to climate change, is likely to be rather small. However, there is a possibility of harm due to increasing flood risk.

CONSEQUENCES OF CLIMATE CHANGE AND IMPACTS ON WATER: ALTERING ECOSYSTEMS AND BIODIVERSITY

- Due to the combined effects of temperature and water stress, the extinction of several amphibians and other aquatic species is projected in Costa Rica, Spain and Australia (Pounds et al., 2006). This includes several species of snakes, frogs, crocodiles and turtles.
- As climate change comes rushing in, as many as 137 species are going extinct each day. In southern Africa, unprecedented levels of extinctions in both plant and animal species are envisaged.
- Freshwater aquatic ecosystems appear to have the highest proportion of species threatened with extinction by climate change (Millennium Ecosystem Assessment, 2005b)

CONSEQUENCES OF CLIMATE CHANGE AND IMPACTS ON WATER: ALTERING ECOSYSTEMS AND BIODIVERSITY

- As the global sea temperature rises, we not only witness mass coral bleaching events, This eventually will lead to extinction of several aquatic life that depend solely on the food and shelter from coral reefs.
- Other species such as Polar bears, Penguins and Seals face severe crisis as the already existent food chain is being hampered.

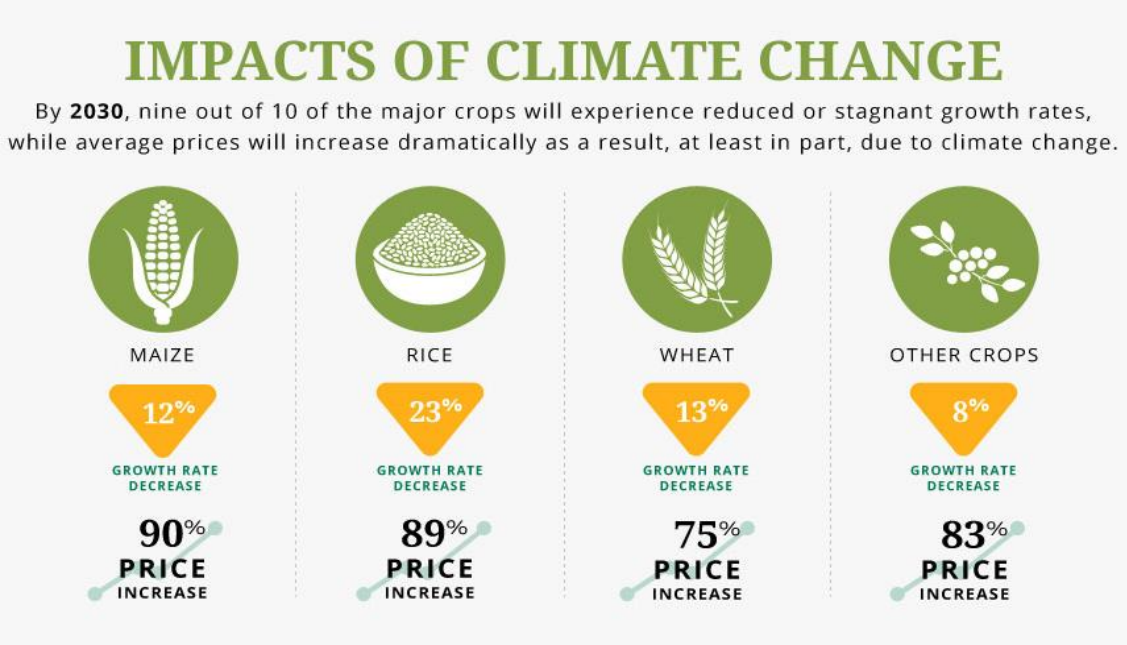
CONSEQUENCES OF CLIMATE CHANGE AND IMPACTS ON WATER: AGRICULTURE AND FOOD SECURITY, LAND USE AND FORESTRY

"The doctor of the future will give no medication, but will interest his patients in the care of the human frame through diet and in the cause and prevention of disease."

— Thomas A. Edison

- Water plays a crucial role in food production regionally and worldwide.
- While too little water leads to vulnerability of production, too much water can also have harmful effects on wheat crop productivity, e.g., by affecting soil properties and by damaging plant growth, by harming or delaying necessary farm operations. Heavy precipitation events, excessive soil moisture and flooding disrupt food production and rural livelihoods worldwide (Rosenzweig et al., 2002).

CONSEQUENCES OF CLIMATE CHANGE AND IMPACTS ON WATER: AGRICULTURE AND FOOD SECURITY, LAND USE AND FORESTRY



Negative impacts of climate change on aquaculture and freshwater fisheries include: stress due to increased temperature and oxygen demand and decreased pH; uncertain future water quality and volume; extreme weather events; increased frequency of disease and toxic events; sea-level rise and conflicts of interest with coastal defence needs; and uncertain supplies of fishmeal.

Source: Farming First

CONSEQUENCES OF CLIMATE CHANGE AND IMPACTS ON WATER: AGRICULTURE AND FOOD SECURITY, LAND USE AND FORESTRY

- Forest ecosystems occupy roughly 4 billion ha of land, and are the ***key determinants*** of water supply, quality and quantity, in both developing and developed countries.
- Nearly 29% of the carbon is stored in trees across the world. Those in the tropics are particularly carbon-rich, accounting for 23% of the world's tree-stored carbon, despite making up just 13% of the world's total forest area.
- In Asia, deforestation may lead to new climate conditions that are unsuitable for successful regeneration of rainforest species (Harding, 1992; Blythe et al., 1994)

CONSEQUENCES OF CLIMATE CHANGE AND IMPACTS ON WATER: AGRICULTURE AND FOOD SECURITY, LAND USE AND FORESTRY

- Tropical developing countries, many of which have poor land and water resources and already face serious food insecurity, may be particularly vulnerable to climate change.
- Rainfall deficits will dramatically reduce both crop yields and livestock numbers in the semi-arid tropics. Food insecurity and loss of livelihood would be further exacerbated by the loss of both cultivated land and coastal fish nurseries as a result of inundation and coastal erosion in low-lying areas.
- Decreased water availability in already water-scarce regions, particularly in the subtropics, has direct negative implications for both food processing and consumption. Conversely, the increased risk of flooding of human settlements in coastal areas from both rising sea levels and increased heavy precipitation may increase food contamination and disease, reducing consumption patterns.

THE QUESTION IS THIS:

Are we in fact witnessing climatic and successive environmental changes with such a magnitude that they may impact the stability and management of coastal areas and international resources such as water and productive land?

CONSEQUENCES OF CLIMATE CHANGE AND IMPACTS ON WATER: HUMAN HEALTH

- Human beings are exposed to climate change directly through weather patterns (more intense and frequent extreme events), and indirectly through changes in water, air, food quality and quantity, ecosystems, agriculture, livelihoods and infrastructure.
- Lack of water for hygiene becomes scarce. In return, the burden of several vector borne diseases are seen worldwide. At the same time, the drinking water quality deteriorate due to salinity intrusion, arsenic contamination etc.
- Water scarcity' is associated with multiple adverse health outcomes, including diseases associated with water contaminated with faecal and other hazardous substances (e.g., parasites). Childhood mortality and morbidity due to diarrhea, cholera in low income countries, especially in sub-Saharan Africa,

CONSEQUENCES OF CLIMATE CHANGE AND IMPACTS ON WATER: SETTLEMENTS AND INFRASTRUCTURE

Growing population density in high-risk locations, such as coastal and riverine areas, is very likely to be vulnerable to the water-related impacts of climate change, including flood and storm damages and water quality degradation as a result of saline intrusion.

Infrastructures in low-lying coastal areas is vulnerable to damage from sea-level rise, flooding, hurricanes and other storms. In Poland, estimated damage costs due to a possible rise in sea level of 1 meter by 2100 is US$30 billion, due to impacts on urban areas

Increased street-flooding, flooding of subway systems, and flood and landslide-related damages to bridges, roads and railways are extensively seen.

CONSEQUENCES OF CLIMATE CHANGE AND IMPACTS ON WATER: ECONOMY, INSURANCE, TOURISM, INDUSTRY AND TRANSPORTATION

- Climate and water resources impact on several secondary and tertiary sectors of the economy such as insurance, industry, tourism and transportation. Water-related effects of climate change in these sectors can be positive as well as negative.
- Flooding is responsible for 10% of weather related insurance losses globally. Drought also has an impact: data from the UK show a lagged relationship between the cost of insurance claims.
- In the last 10 years, there have been four cases where the flooding of urban underground rail systems has caused damages of more than €10 million (US$13 million) and numerous cases of lesser damage (Compton et al., 2002).

CONSEQUENCES OF CLIMATE CHANGE AND IMPACTS ON WATER: ECONOMY, INSURANCE, TOURISM, INDUSTRY AND TRANSPORTATION

- Industrial sectors are generally thought to be less vulnerable to the impacts of climate change.
- Warmer climates open up the possibility of extending exotic environments (such as palm trees in western Europe), which could be considered by some tourists as positive but could lead to a amplification of water- and vector-borne diseases.
- Droughts and the extension of arid environments (and the effects of extreme weather events) might discourage tourists, although it is not entirely clear what they consider to be unacceptable.
- Areas dependent on the availability of snow e.g., for winter tourism are among those most vulnerable to global warming.

MAKING OUR VOICES HEARD: BANGLADESH'S OUTLOOK ON CLIMATE CHANGE AND WATER

- Bangladesh has been identified as being highly vulnerable to the effects of climate change.
- With roughly 80% of the landmass made up of fertile alluvial lowland and the major employer being agriculture, current climate change predictions of wetter wet seasons and possible drier dry seasons, depending on the global climate model used (IPCC, 1998), can only exacerbate an already critical water resources situation.
- Bangladesh, water shortages have been attributed to issues such as rapid urbanisation and industrialisation, population growth and inefficient water use, which are all aggravated by changing climate and its adverse impacts on demand, supply and water quality

-Chak Fai Fung1, Francis Farquharson1 &

THE WAY AHEAD

- While adaptation and mitigation may seem to be the best process to reduce climatic impacts on water, it is vital for us to understand future climate projections.
- The change in the number of people expected to be under water stress after the 2050s.
- It should be noted that, using the per capita water availability indicator, climate change would appear to reduce overall water stress at the global level. This is because increases in runoff are concentrated heavily in the most populous parts of the world, mainly in eastern and south-eastern Asia.
- Demand for water is increasing due to world's growing population and countries which suffer the greatest water stress are generally those which lack the political and institutional framework necessary for the adaptation of water and crisis management systems ultimately leading to destabilization and violence.

POLICY RECOMMENDATIONS

- Improve our understanding of the links between both natural and anthropogenically induced climate change, its impacts, and adaptation and mitigation response options.
- Inform policymakers and stakeholders about the implications of climate change response options for water resources, as well as the implications for water resources of various climate change scenarios and climate change response options, including associated synergies and trade-offs.
- Ensembles of a better climate model (Sector Specific mitigation) is required to provide a better water availability in the future.

Towards a Secure World

THANK YOU

10 YEARS of BIPSS

Bangladesh Institute of Peace and Security Studies

/bipss /bdbipss @bipss /bipssbd bipss.org.bd