CLIMATE CHANGE ADAPTATION AND INTEGRATED WATER RESOURCES MANAGEMENT

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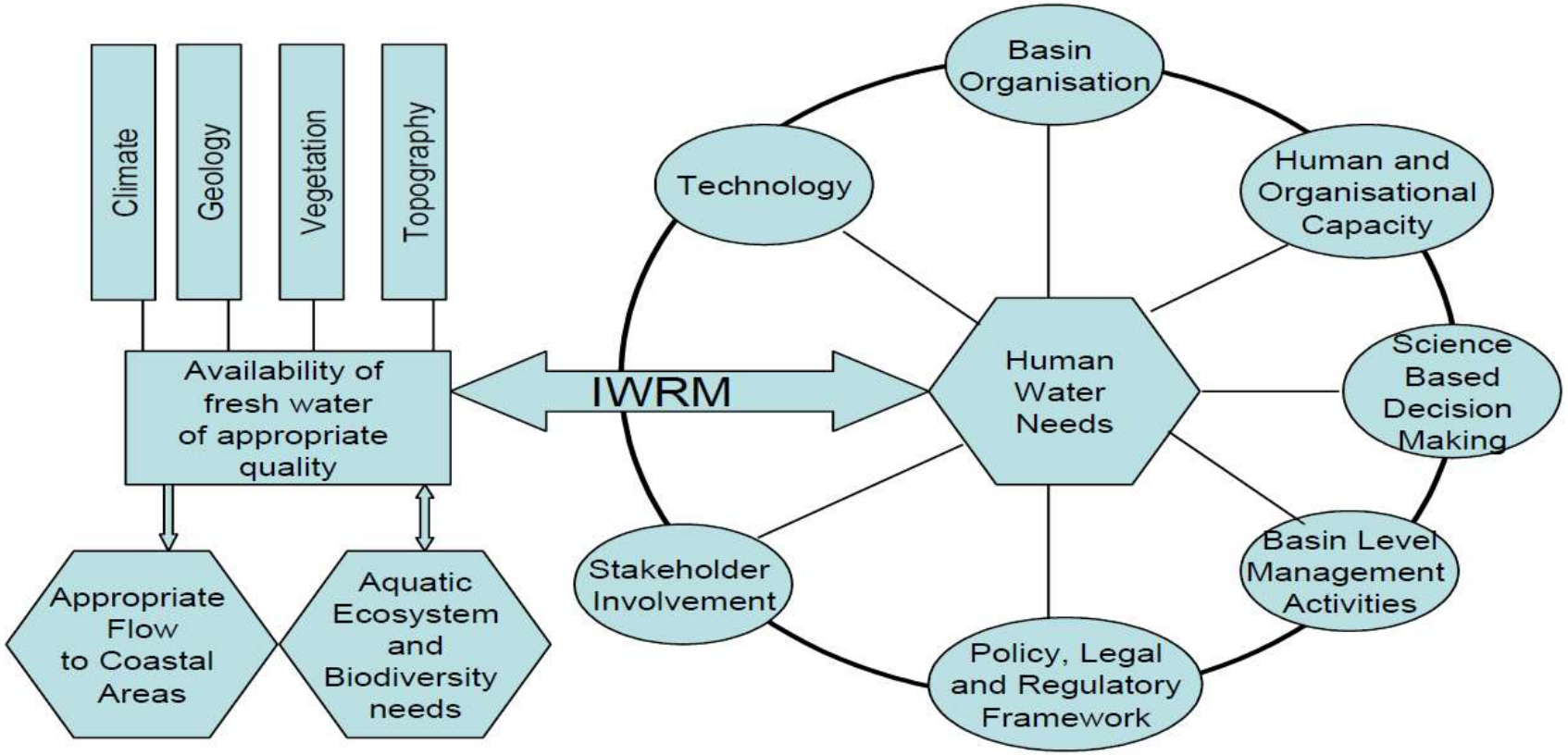
What is IWRM?

- **'A process which promotes the coordinated development and the management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems'. (GWP)**
- **Integrated Water Resources Management (IWRM) taking river basin / sub-basin as a unit should be the main principle for planning, development and management of water resources. (NWP 2012)**
- **A State's need for water resource management varies according to its characteristics –its geography, climate, size, population, political and cultural systems, level of development, and the nature of its water resource problems.**
- **IWRM strives for effective and reliable delivery of water services by coordinating and balancing the various water-using sectors**

Ingredients of IWRM



REQUIREMENTS FOR SETTING UP IWRM REGIME

- Recognition of Constraints and Opportunities
- Assessment of Resources- Temporal and Spatial Availabilities
- Demand assessments- Temporal and Spatial distribution with existing efficiencies
- Disaster potential appreciation and response strategies
- Coordination and collation of Stakeholder aspirations and priorities
- Optimisation of demands with assured efficiency levels
- Resource Mobilisation strategies with understanding of transboundary inter-linkages
- Techno-economic implications and time lines for implementation
- Intervention measures- inventorization and future developments/ augmentations
- Authorization for implementation through statutory processes

RESOURCE MOBILIZATION

- All the results of the analysis of the River Basin Characteristics of the state
- A comprehensive review of the impact of anthropogenic interventions on the status of surface water and ground water, including an estimation of pollution, point as well as diffused, in water uses
- Identification of protected areas, social and cultural flow needs and duration
- Environmental needs
- Ground water and protected aquifers, if any
- A summary survey of existing pricing policies and an economic analysis
- A fair assessment of the effects of existing legislations
- An economic analysis for optimal allocation and the notional cost of deviation from optimal

DEMAND ASSESSMENT

- Present and past Agricultural Water Use including on-farm practices
- Efficiencies achieved through existing farming practices
- Usages arising out of Urban developments and rural consumption requirements
- Needs of aquatic and land flora and fauna for survival
- Energy generation- regulated flows and consumptive flows
- Requirements for social and religious activities
- Possible changes in usage patterns due to effects of economic development/ population growth/ life style improvements/ climatic changes

STAKEHOLDER INVOLVEMENT

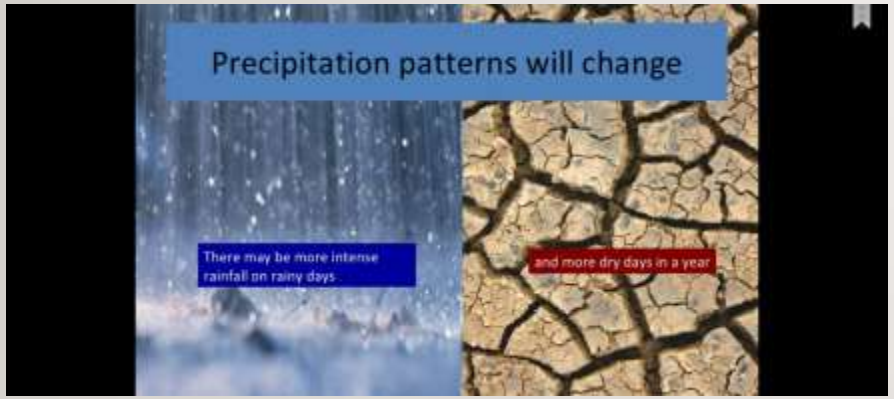
- IWRM formulation can not be considered purely an engineering or scientific exercise
- There are multiple stakeholders having an interest in availability and distribution of water
- Each class is acutely aware of its own requirements and comfort levels. However, they may not be aware of the competing demands and requirements of others.
- Building awareness about the availability and distribution scenario to all the stakeholders is a must. The information should be easy to comprehend and digest.
- Stakeholders should also be made aware about the limitations of resources- water, technologies, finances, timelines for the solutions to emerge on the ground.
- Role of efficiencies in utilization and re-use/re-cycle strategies need be brought out to encourage sharing of the resources in an optimal manner.

CLIMATE CHANGE

- **Global warming is *likely* to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate.**
- **Warming from anthropogenic emissions from the pre-industrial period to the present will persist for centuries to millennia and will continue to cause further long-term changes in the climate system**

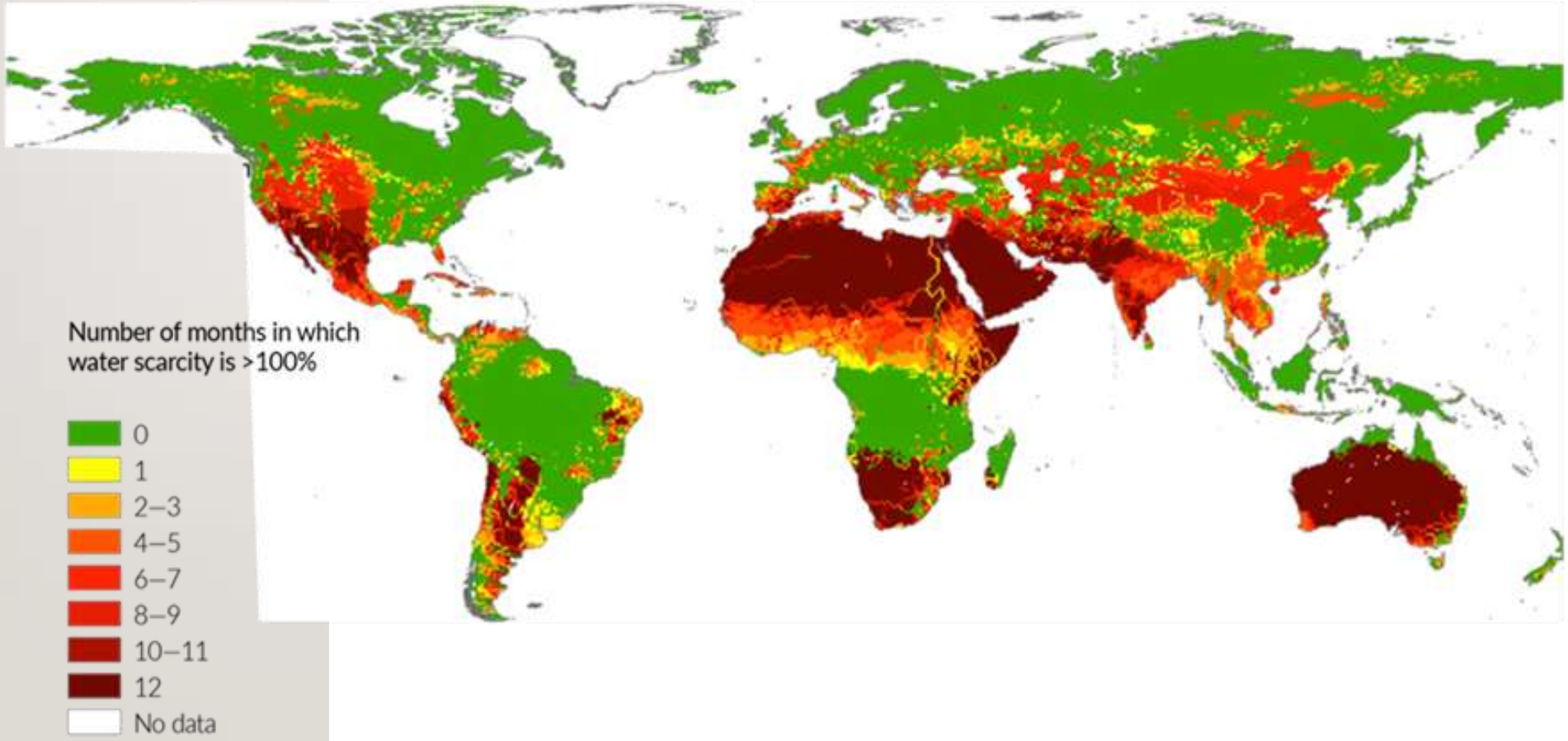
- Risks from droughts and precipitation deficits are projected to be higher at 2°C compared to 1.5°C of global warming in some regions.
- Risks from heavy precipitation events are projected to be higher at 2°C compared to 1.5°C of global warming in several northern hemisphere high-latitude and/or high-elevation regions, eastern Asia and eastern North America.
- Heavy precipitation associated with tropical cyclones is projected to be higher at 2°C compared to 1.5°C global warming (medium confidence). As a consequence of heavy precipitation, the fraction of the global land area affected by flood hazards is projected to be larger at 2°C compared to 1.5°C of global warming.

PRIME EFFECT OF CLIAMTE CHANGE ON WATER RESOURCES



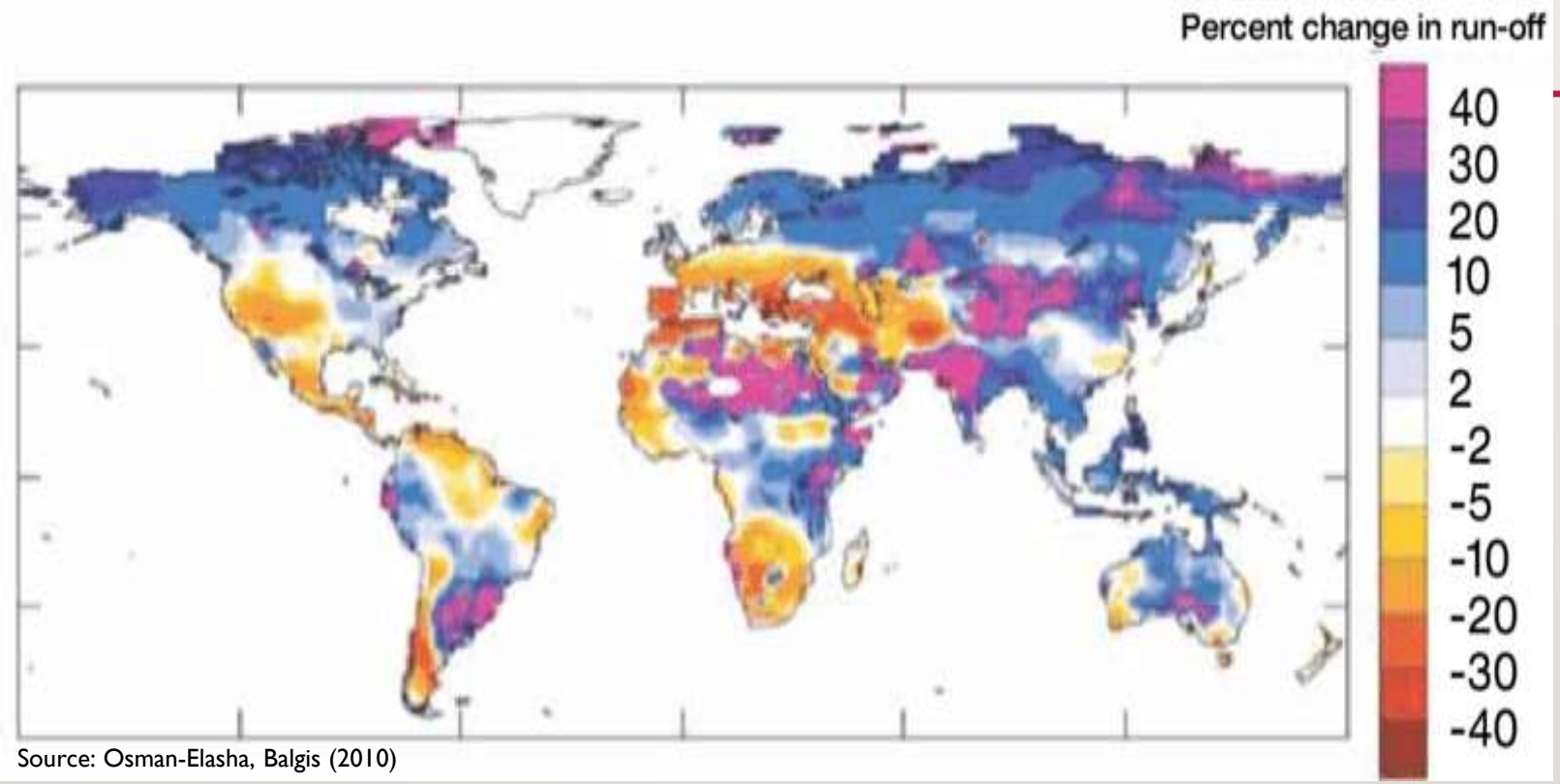
Increasing Water Scarcity

Two thirds of the world's population currently live in areas that experience water scarcity for at least one month a year



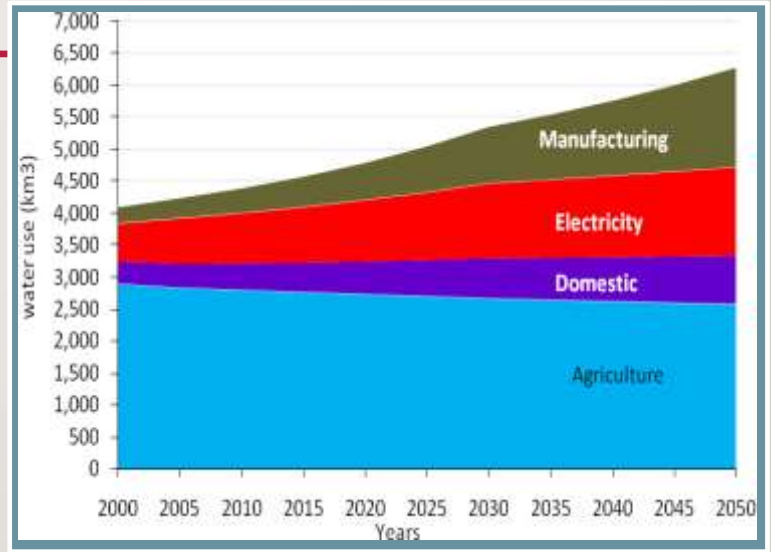
Source: Mekonnen and Hoekstra (2016)

GLOBAL WATER RESOURCES CONSUMPTION



Source: Osman-Elasha, Balgis (2010)

Rising temperatures and changes in run-off patterns will influence the flow of rivers upon which countries in the region depend. Runoff is projected to drop by 20-30% in the MENA region.



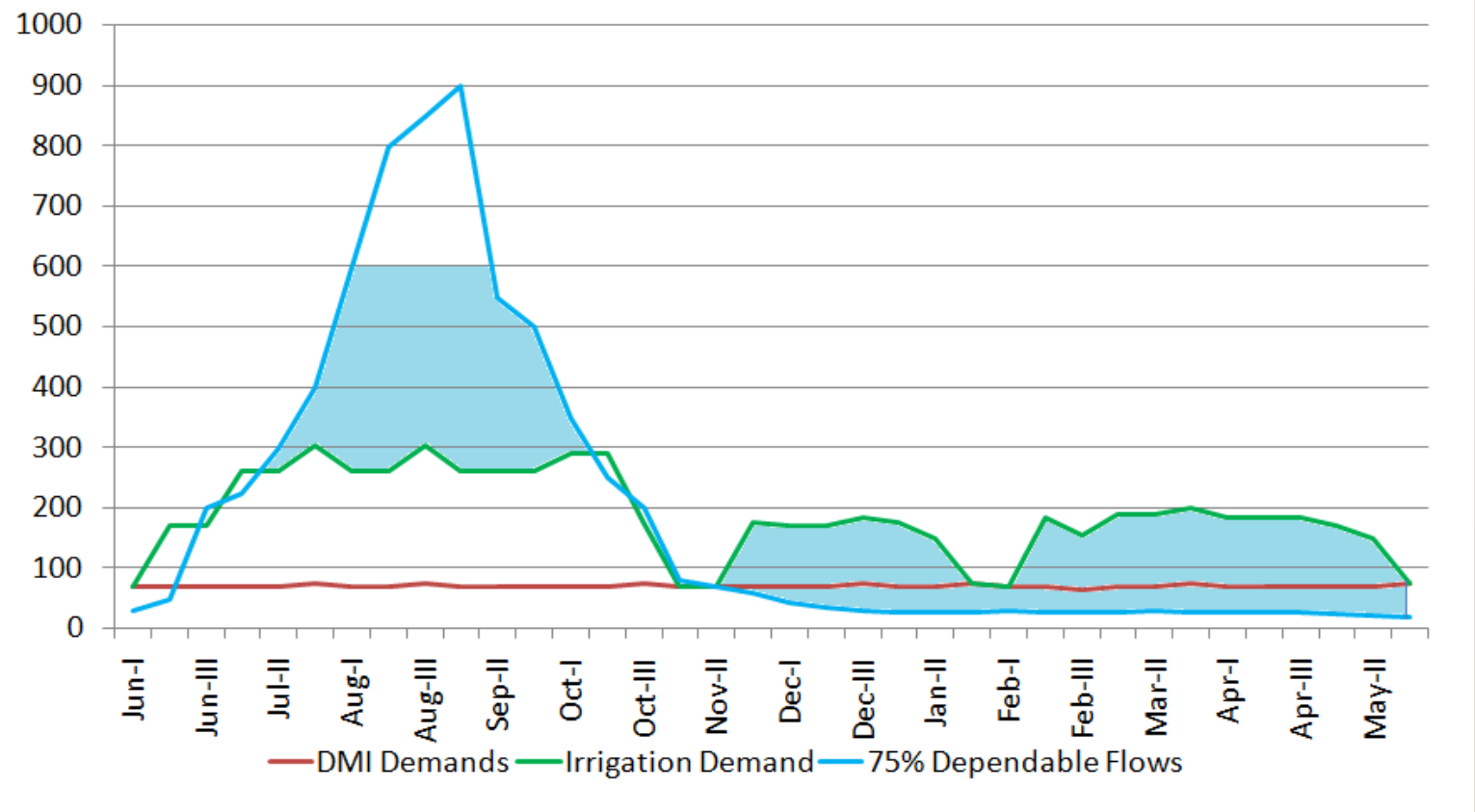
Source: ICID, FAO

Future Projections suggest higher demand for water resources from other sectors, thereby declining the availability of water for agricultural activities

CLIMATE CHANGE AND ADAPTATION

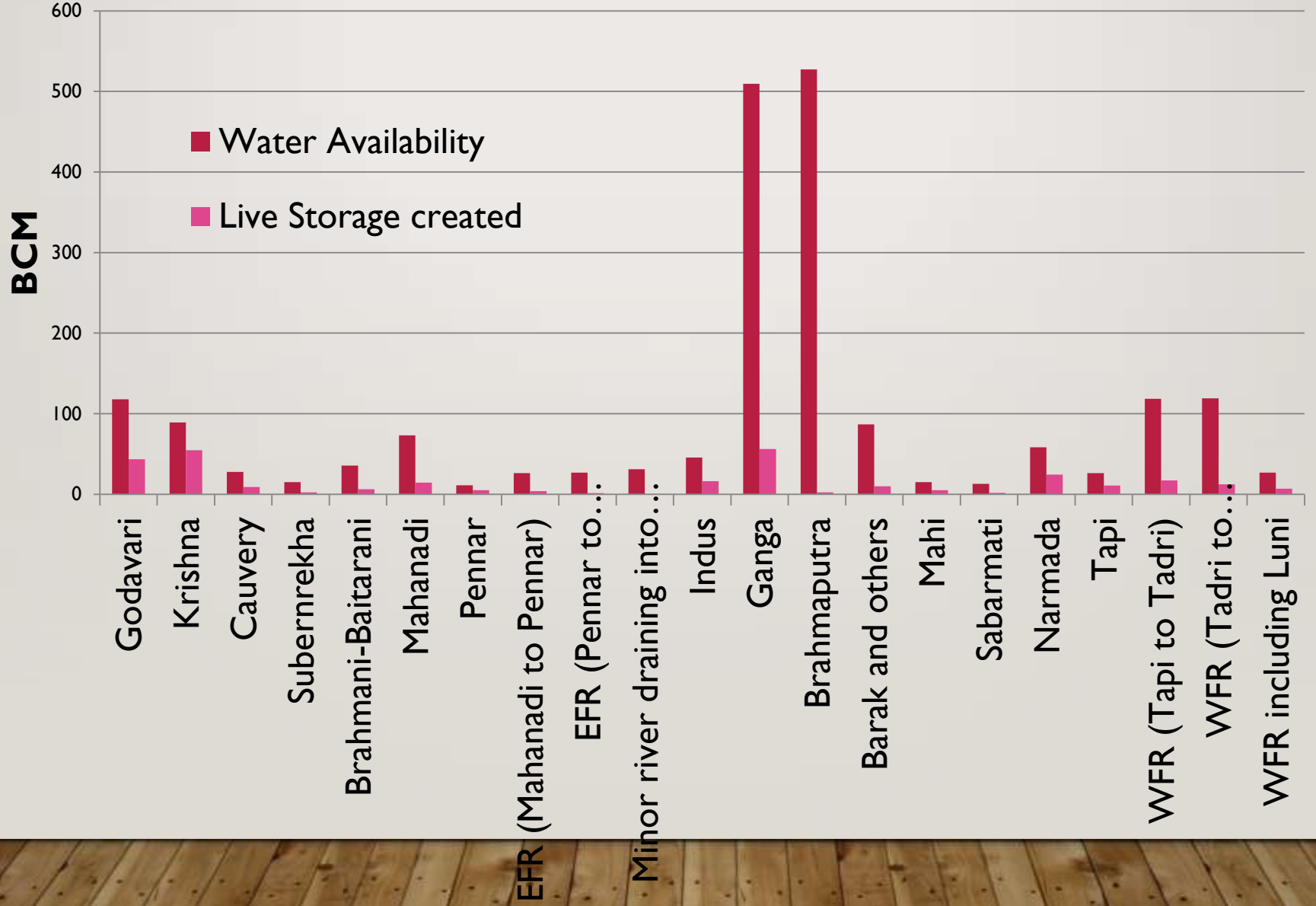
- **Adaptation – adapting to life in a changing climate – involves adjusting to actual or expected future climate.** The goal is to reduce our vulnerability to the harmful effects of climate change (like more intense extreme weather events or food insecurity through changed life cycle of crops and unpredictability of water availability).
- One of the key adaptation strategy is to adaptation to changed hydrological cycle and increased randomness of precipitation
- Most of the developing world is already fighting the water stress and deprivation effects due to climate change

75% Dependable Flows and Consumptive Demands (Typical)



Unless we store monsoon waters, it would be very difficult to manage growing demands of a nation and support 2-3 crops. Environmental demand is also like any other demand and can be released from storage.

BASIN WISE WATER AVAILABILITY AND LIVE STORAGE (BCM)



ROLE OF STORAGES IN CLIMATE CHANGE ADAPTATION

- The key to adaptation is to manage the gap between availability and demand patterns
- Within the same cropping pattern, changed evapo-transpiration patterns will demand changes in supply quantum and temporal patterns of supplies
- Increased climate change induced randomness of water availability will require the resilience in storage facilities, which can be provided in form of carry over storages
- Surface storage in form of reservoirs and dams are the only means of storing a significant quantum within a short period of availability
- Ground water storage is having inherent limitation of recharge rates and will have to be backed up by the surface storage to cope with the requirements of recharge

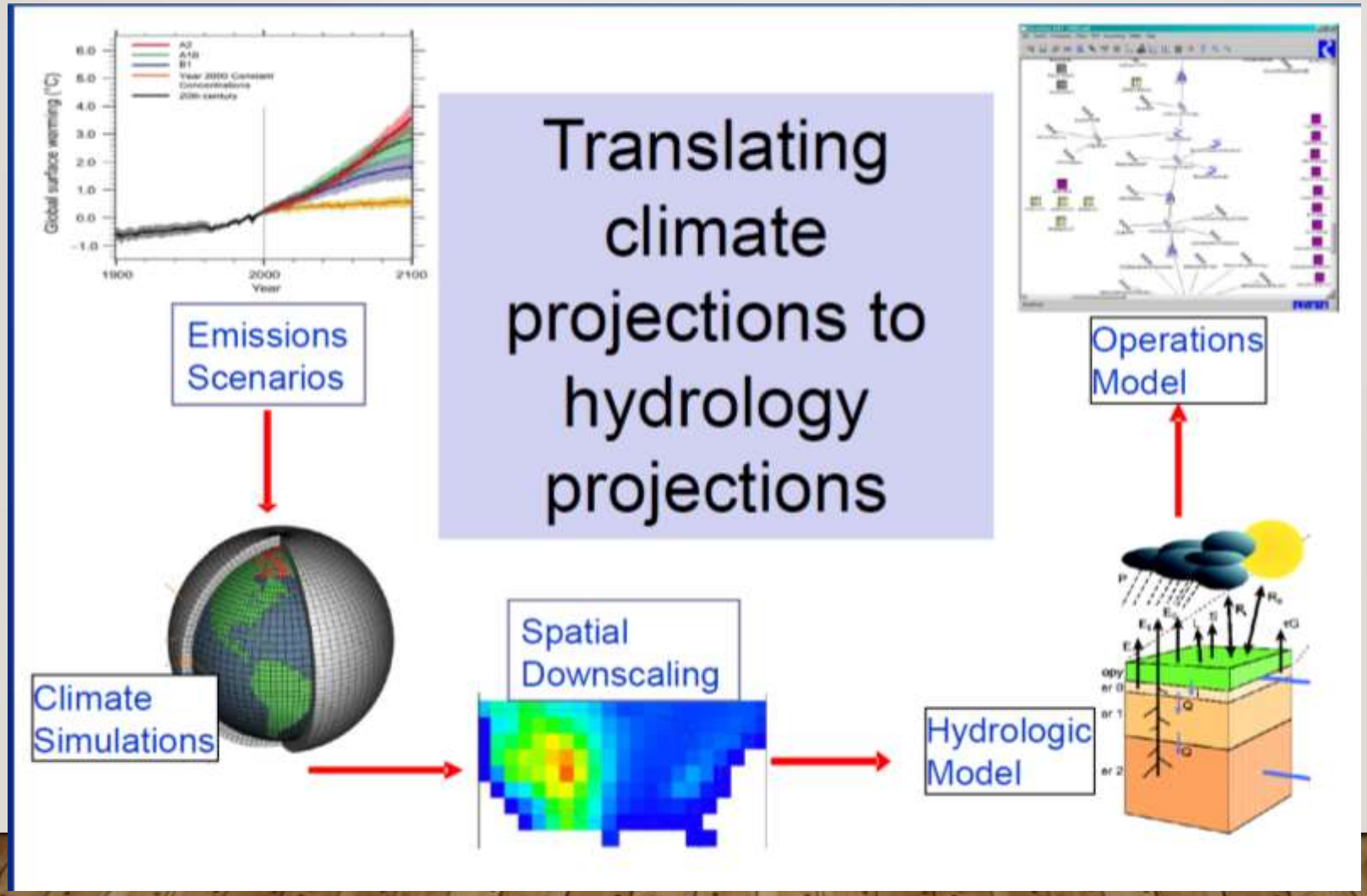
IWRM APPLICATION TOWARDS STORAGE PLANNING

- IWRM methodologies attempt to provide a basin wide view of availability and demands and act as SWOT analysis for finding opportunities and vulnerabilities to match demands and supplies.
- Stakeholder participation ensures the acceptability of the solution in general by involving larger community groups.
- Scale of application of IWRM principles vary on the size of development. Present course of implementation at Micro scale is producing lop-sided results, which are non-optimal when viewed in a larger context.
- IWRM approach delineates a consultative path which is different than the top-down path present in planning processes.

INTEGRATING CLIMATE ADAPTIVE PLANNING IN IWRM STRATEGIES

- Water managers routinely deal with the uncertainty of historical climate variability, but climate change introduces additional uncertainty, difficult to address.
- Water infrastructure especially storages are built to last for ever. They will certainly face the extended effects of climate change and still require to remain relevant.
- For an adaptive planning, a complete view of vulnerabilities in supply and demand side at the basin-global scale is necessary. This view has to be further dovetailed into the nation and trans-boundary views for arriving at the holistic strategy having better chances of adoption.
- Planners and operators of existing infrastructure will have to develop projection scenario for understanding the potential effects and explain them in a consumable manner.
- Solutions will have to span across the diverse fields of demands and supplies assessments. One-sided solutions are not likely to work

KEY TO CLIMATE CHANGE ADAPTATION



STORAGES AS A MEANS FOR ADAPTATION

- With increased variability but simultaneous year-round requirements, storages become the only option.
- Storages planning has to account for long period variability. They will require "carry-over" storage for tiding over long droughts
- The criteria for planning storage has to change from the present one of 75% dependability for agriculture water supply.
- However, the operation rules will have to cater to the water security to the other parts of the basin as well.
- Larger risks in form of floods and earthquakes will have to be catered to and flexibility required for catering to the enhanced risks in future.

SPECIAL CASE FOR EXISTING STORAGES

- The World already has more than 52000 large dams out of which India has more than 5700.
- All these existing dams have been planned using the conventional "steady-state" model of hydro-climate.
- Safety assurance for the enhanced environmental loads associated risks is an important aspect for continued service assurance of the created assets
- Creating carry over storage space in reservoir or off reservoir- policies and planning
- Real time forecasting and operation strategies
- Minimization of evaporative losses of valuable storage

ADAPTATION FOR CONSUMPTIVE USES

- Rationalization of agricultural water management for crops (70% of the consumptive use)
- Cropping pattern optimization with multi-objective process including economics and water use in line with changing agro-climatic environment
- Water Quality and re-use and re-cycle policies for achieving circular economy for water
- Better accounting for water harnessing and consumption
- Predictive technologies to insure against wasteful use and economic losses
- Better management of sedimentation profiles in reservoirs of all sizes

GOVERNANCE PARADIGM CHANGES FOR ADAPTATION

- Under climate change scenario, the internal tensions over sharing water resources will come under increasing strain and earlier consensus may break down.
- Present policy of fixed allocations may have to undergo change to accommodate for increased variabilities and possibilities of long term trends.
- Communities and political units tend to have "rigid fence" approach similar to other resources like money. Barriers will have to be made adjustable.
- Governance mechanisms capable of operating away from political and social grandstanding and determined by mutual appreciation of common minimum requirements will have to come into existence.
- Far more sound and neutral data acquisition regime and its processing will have to be established for a scientific basis of water management
- Devising means for IWRM dialogues to continue and sustain through administrative and facilitation supports through appropriate governments.

SUMMING UP

- Climate change is already upon us. Our storage plans and policies will have to account for the effects.
- Storages- creation and management will be a vital tool for adaptation to the climate change.
- IWRM principles provide a comprehensive tool for orienting the efforts in right direction with consensual approach
- Water governance models will have to account for basin centric IWRM approaches for an equitable and sustainable adaptation strategy

THANK YOU