ASSESSING WATER SECURITY:
A VITAL STRATEGY TO SUSTAINABLE WATER MANAGEMENT

Dr. Mukand S. Babel
Professor, Water Engineering and Management
Asian Institute of Technology
msbabel@ait.asia

Mukand S Babel
Asian Institute of Technology (AIT)
msbabel@ait.asia
msbabel@gmail.com

Professor, Water Engineering and Management
Chair, Climate Change Asia @ AIT

Director, Executive Board of International Water Resources Association (IWRA)
Board Member, Asian Water Council (AWC)

Research: Hydrologic and Water Resources modeling, Integrated Water Resources Management; Hydrologic Extreme Events, Water Resources and Socio-economic Development; Water Supply and Sanitation, Climate Change Impacts and Adaptation, Water-Energy-Food Nexus

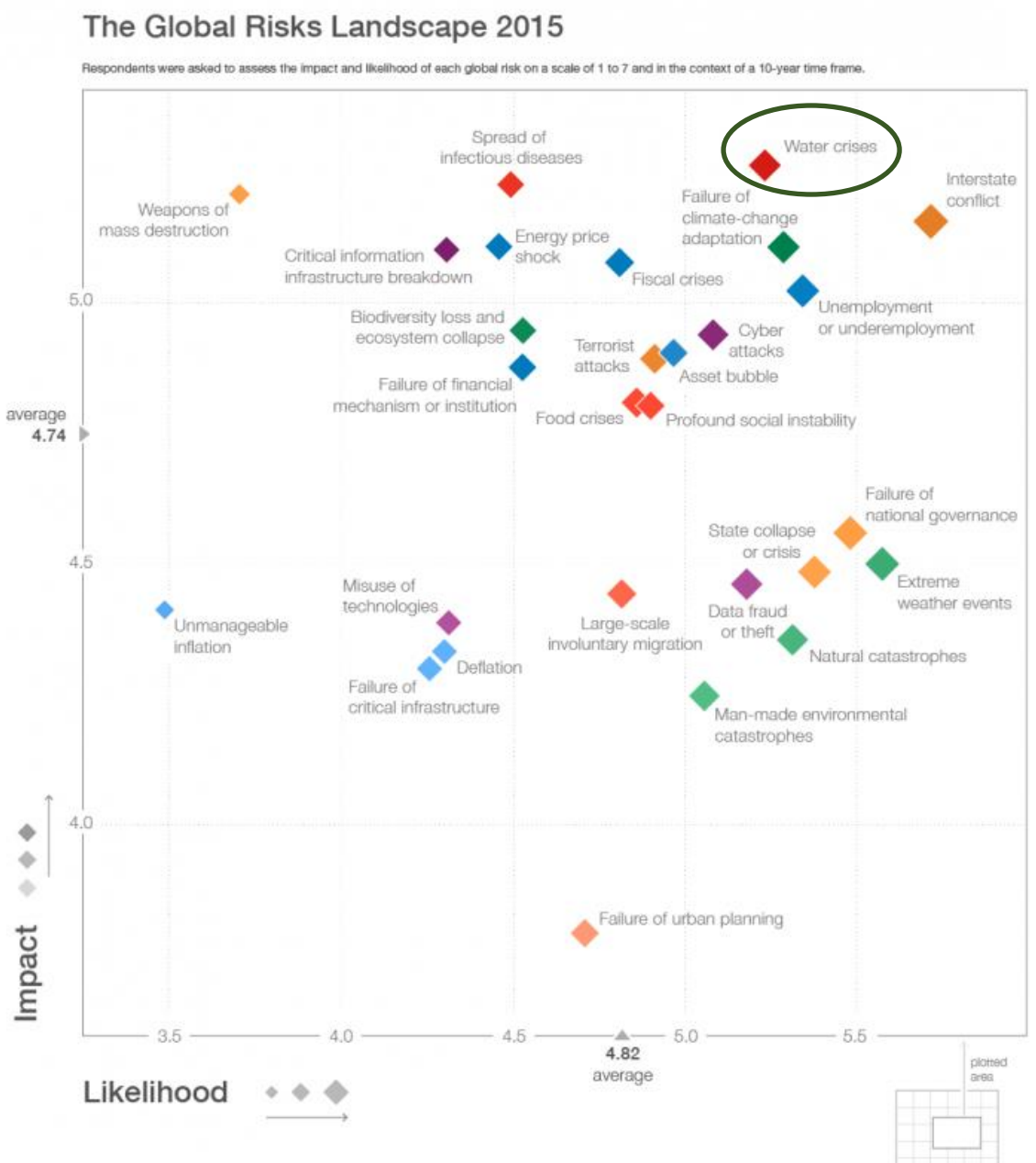
Experience: 32+ years of teaching, research and consulting
Geographical coverage: South and Southeast Asia

Publications: 110+ international journal papers
***h*-index:** 19
No. of citations: 1175

CONTENTS

- Background and Context
- A framework for city-scale assessment of water security
- Application of the framework for Bangkok
- Final reflections

Water security is among the top global issues the world faces



World Economic Forum (2015)

Water security is among the top global issues the world faces

10 biggest problems in the world according to the EU (2011)

10. Don't know

9. Proliferation of nuclear weapons

8. Armed conflict

7. Spread of infectious iseases

6. Population growth

5. Availability of energy

4. International terrorism

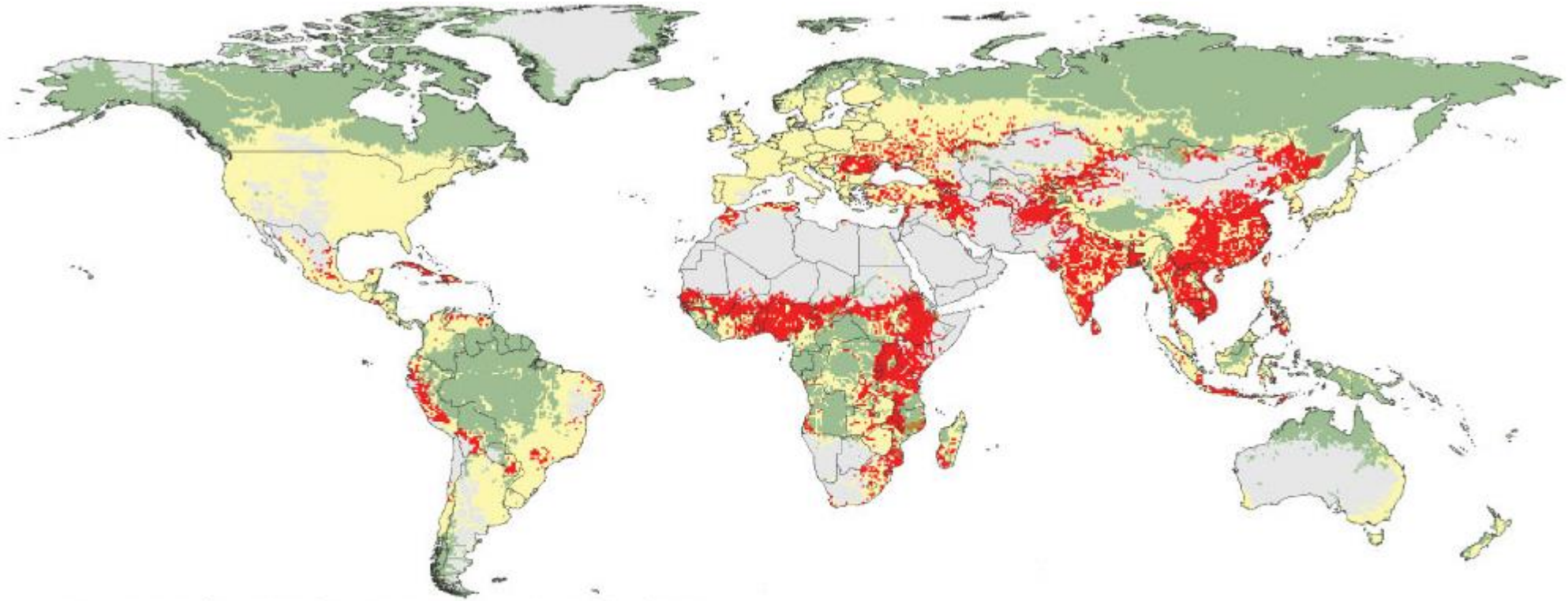
3. Economic situation

2. Climate change

1. Poverty, hunger, drinking water

EU citizens were asked to rank which problem they thought constituted the biggest threat to the world

Water security is among the top global issues the world faces



Vorosmarty et al. (2010)

Water security figures prominently in the global landscape for development

Sustainable Development Goals (SDGs)

SDG 6: Ensure availability and sustainable management of water and sanitation for all

Target 6.1: Universal and equitable access to safe and affordable drinking water for all

Target 6.2: Adequate and equitable sanitation and hygiene for all, and end open defecation,

Target 6.3: Improve water quality by reducing pollution, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally.

Target 6.4: Substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals of freshwater to address water scarcity.

Water security figures prominently in the global landscape for development

Sustainable Development Goals (SDGs)

SDG 6: Ensure availability and sustainable management of water and sanitation for all

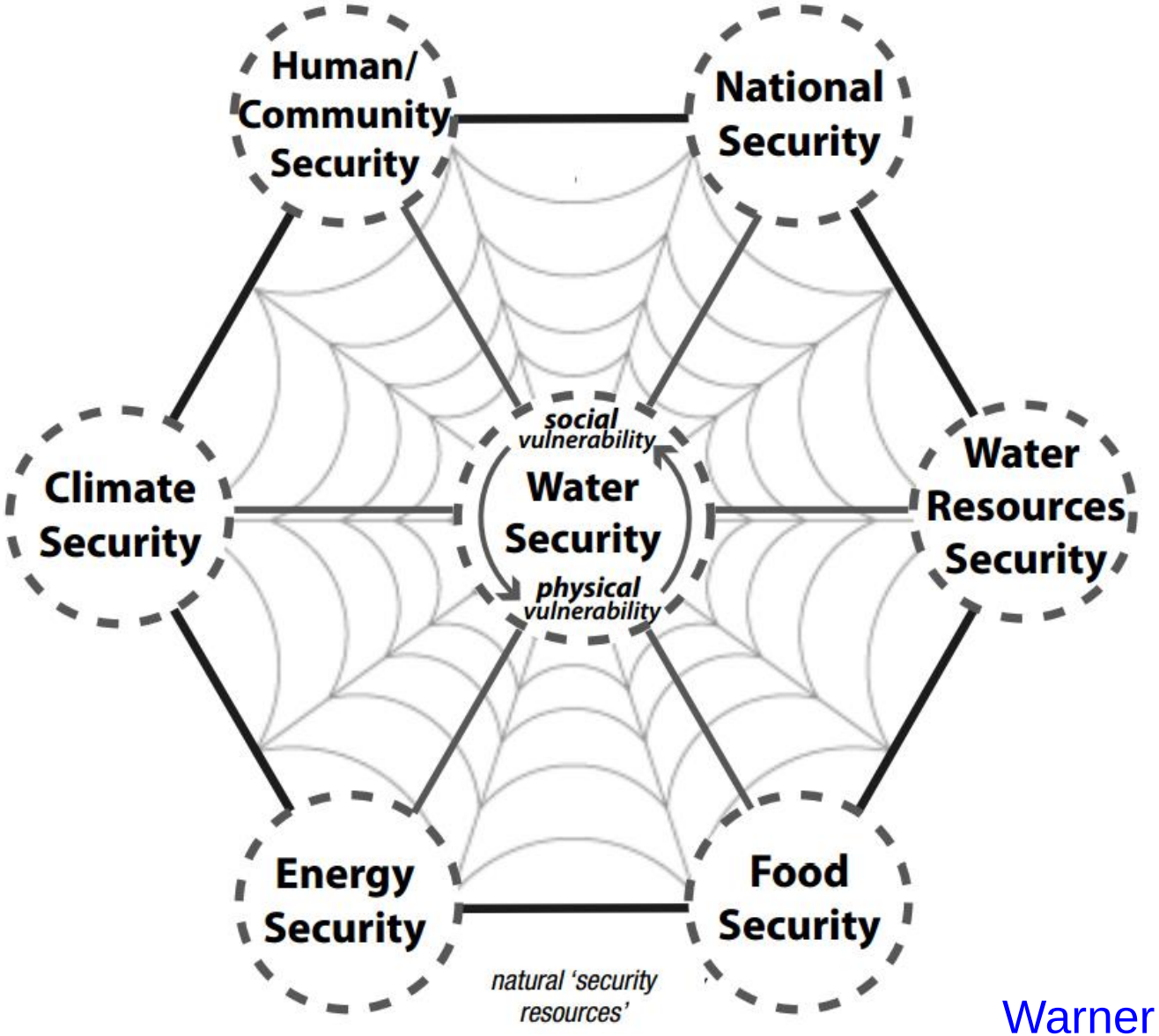
Target 6.5: Implement Integrated Water Resources Management at all levels.

Target 6.6: Protect and restore water-related ecosystems.

Target 6.a: Expand international cooperation and capacity-building support to developing countries in water and sanitation related activities and programs, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies.

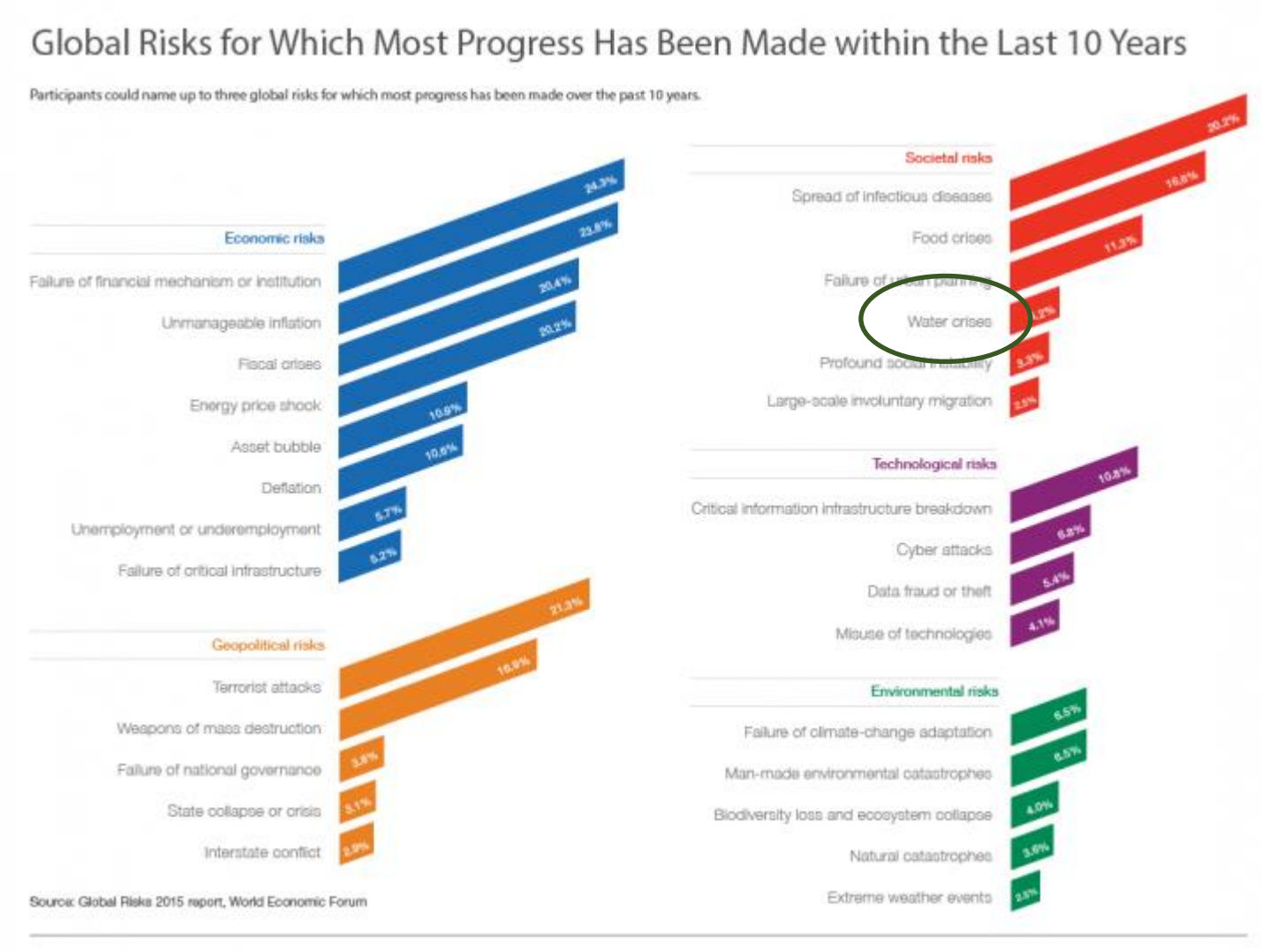
Target 6.b: Support and strengthen the participation of local communities in improving water and sanitation management.

Water security is central to all forms of security



Warner and Johnson (2007)

Despite the problem hardly anything has been done to enhance water security



World Economic Forum (2015)

A possible scenario?

Future water security?

Defining water security: Multiple perspectives

Subject area	Water security focus or definition
Agriculture	• Input to agricultural production and food security
Engineering	• Supply security (percentage of demand satisfied) • Protection against water related hazards (droughts, floods)
Environmental Science	• Access to water functions and services for humans and the environment • Water availability in terms of quality and quantity • Minimizing impacts of hydrological variability
Public health	• Supply security and access to safe water • Prevention and assessment of contamination of water in distribution systems
Policy	• Sustainable development • Protection against water-related hazards
Water Resources	• Water scarcity • Supply security (Demand management) • Green (versus “blue”) water security – the return of flow of vapor.

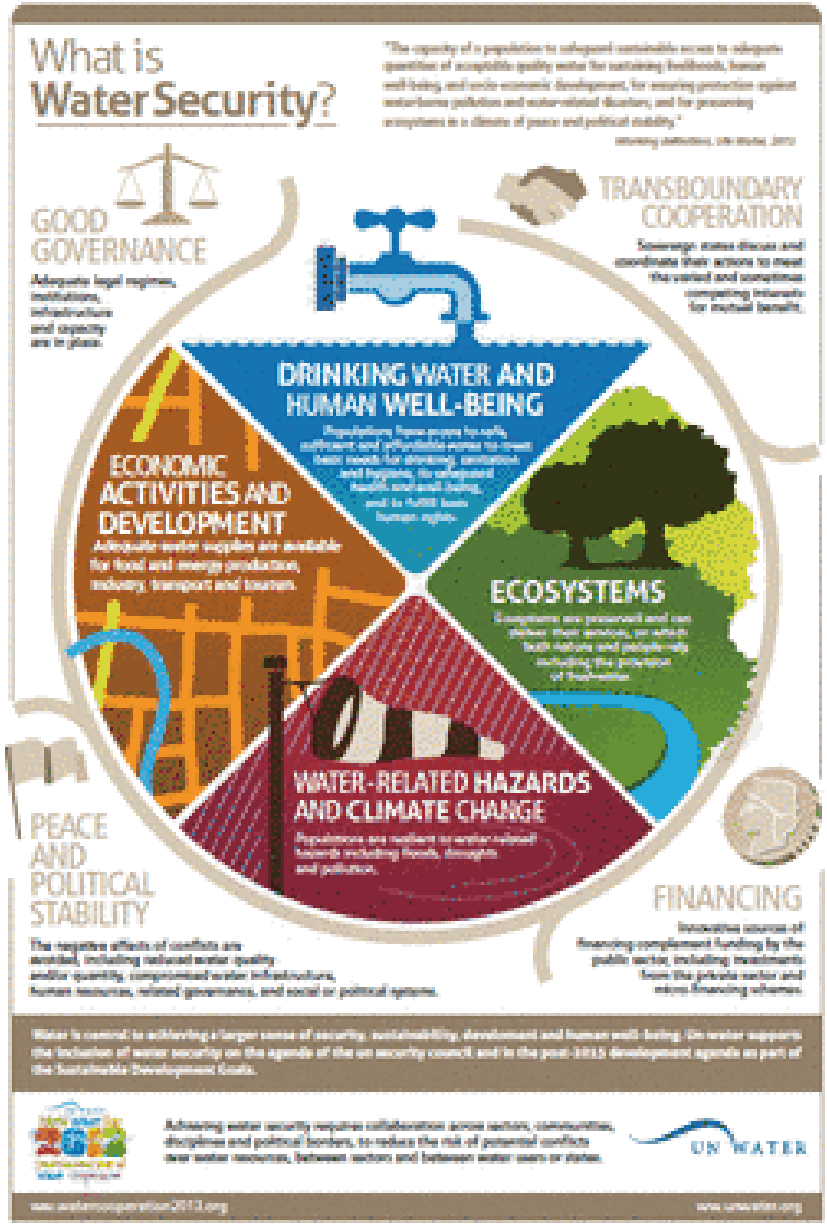
Defining water security: Multiple perspectives

Subject area	Water security focus or definition
Fisheries, Geology/Geoscience, Hydrology	• Hydrologic (groundwater) variability • Security of the entire hydrological cycle
Anthropology, Economics, Geography, History, Law, Management, Political Science	• Drinking water infrastructure security • Input to food production and human health/wellbeing • Armed/violent conflict (motivator for occupation or barrier to cooperation and/or peace) • Minimizing (household) vulnerability to hydrological variability

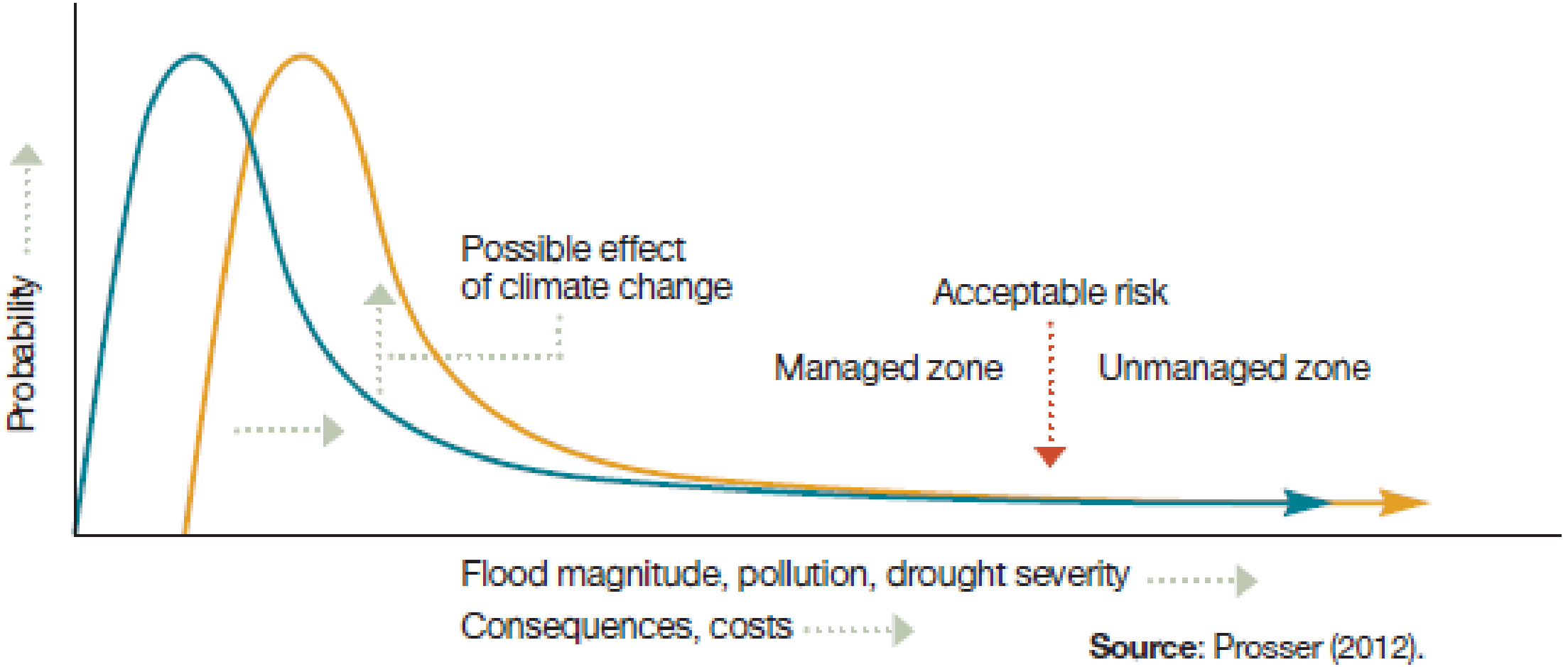
Defining water security: Widely accepted notion

The capacity of a population to safeguard sustainable access to adequate quantities of and acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability

UN-Water (2013)



Water security is about learning to live with an acceptable level of water risk (OECD, 2013)



Source: Prosser (2012).

Example of a water security assessment

Project title: "Developing an operational water security index, and its application in selected diverse regions of Asia"

Funded by: APN for Global Change Research

Project duration: 2014 – 2017

Project partners:

Asian Institute of Technology

Central University of Rajasthan

Thuyloi University

Study areas:

Chao Phraya River Basin, Thailand

Banas River Basin, India

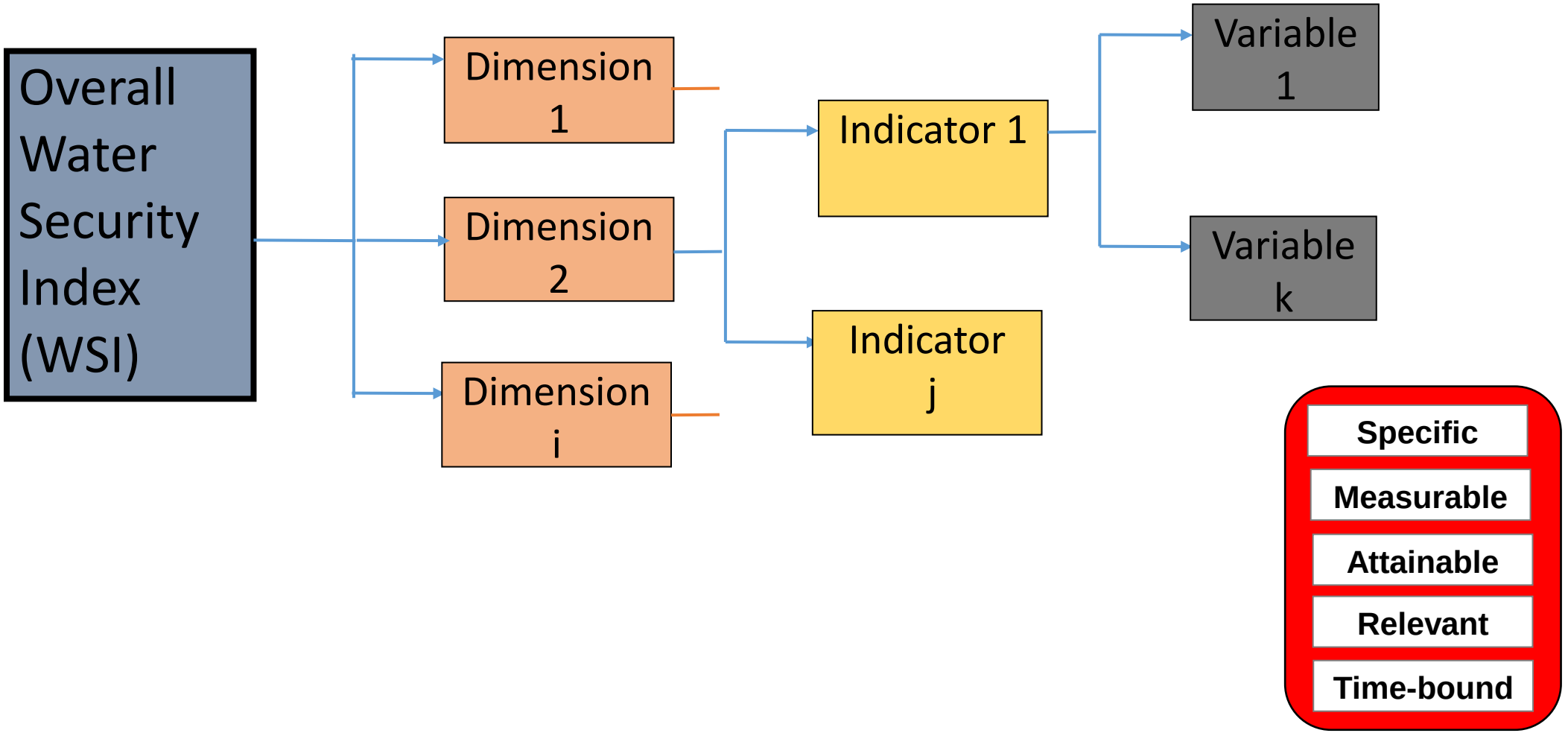
Red River Basin, Vietnam

Previous efforts for water security assessments

Indicator/Index	Source	Spatial scale
Water Stress Indicator	Falkenmark et al. (1989)	Country
Vulnerability of Water Systems	Gleick (1990)	Basin
Water Resources Vulnerability Index	Raskin (1997)	Country
Indicators of Water Scarcity	Heap et al. (1998)	Country, region
Water Security	GWP (2000)	Country
Index of Water scarcity	OECD (2001)	Country, Region
Water Poverty Index	Sullivan (2002)	Country
Index of Watershed Indicators	US EPA (2002)	Basin
Water Security	Zeitoun (2011)	Country
Water Security Index	ADB (2013)	Country

Example of a water security assessment

Generalized framework



Need for city-scale assessments

- 54% of the world's population live in cities. This figure is likely to increase to 66% by 2050 (UN DESA, 2014).
- Cities are the smallest unit at which water security enhancement interventions take place.
- Important from the perspective of operationalization of water security.
- On-the-ground monitoring of the state of water security is possible.

Framework for water security assessment: City-scale analysis

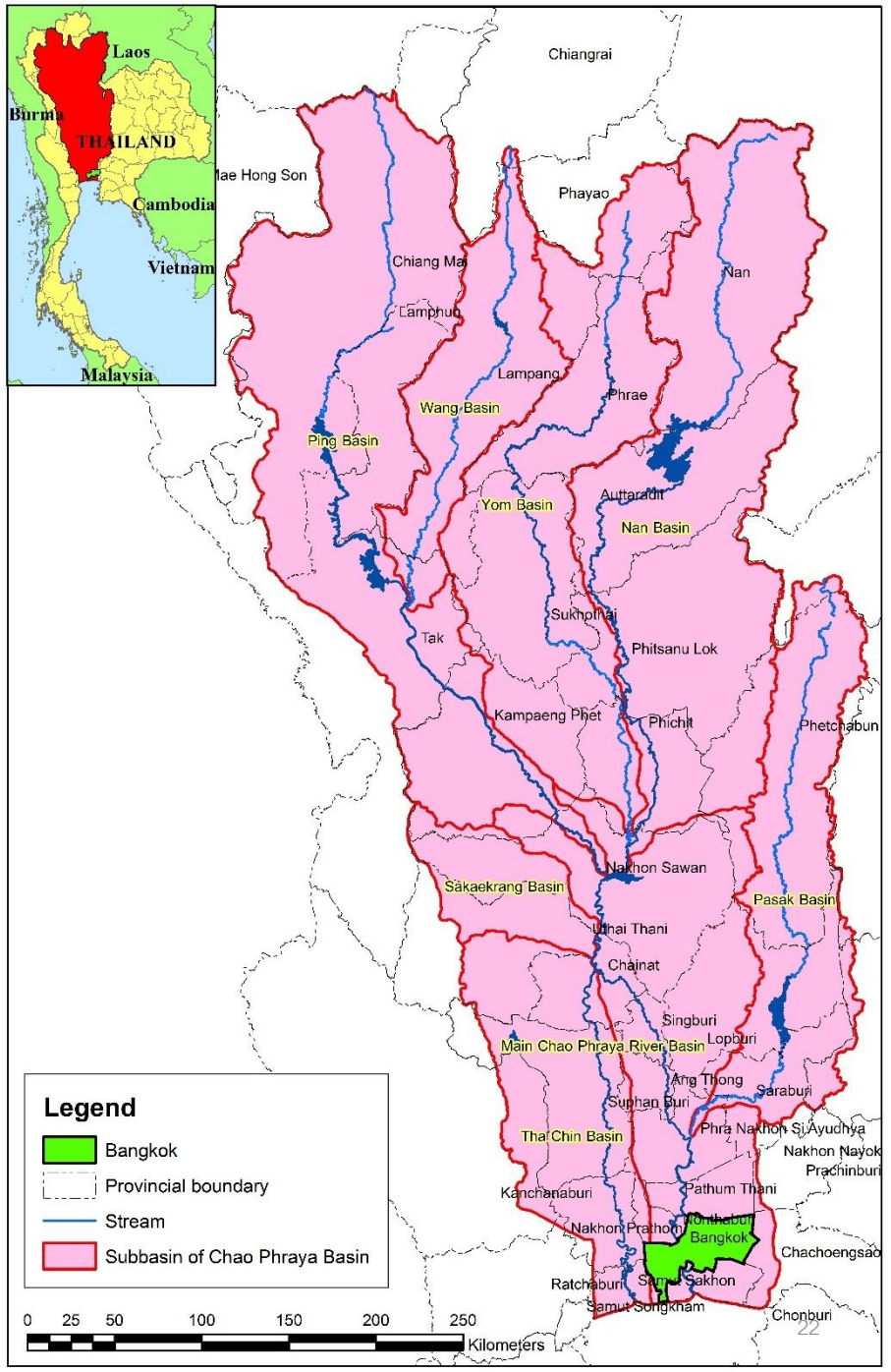
DIMENSION	INDICATOR	WHAT TO MEASURE?
WATER SUPPLY AND SANITATION	Water availability	How much water is available to citizens to carry out their day-to-day activities
	Accessibility	What percentage of the city population has access to clean drinking water?
	Quality of water supplied	Does the water supplied meet the national/international standards?
	Hygiene and sanitation	What is the level and nature of sanitation facilities in the city and what are their impact on human health?
WATER PRODUCTIVITY	Economic value of water	How judiciously is water used in terms of economic benefits?
WATER-RELATED DISASTERS	Resilience against disasters	How well the city is naturally protected against disasters (especially floods)?
	Disaster mitigation interventions	What kind of measures have been taken to mitigate disasters?
WATER ENVIRONMENT	State of natural water sources	What is the current condition of natural water bodies in the city?
	State of pollution	How well are the water bodies in the city protected?
WATER GOVERNANCE	Overall management of the water sector	How well is the water sector managed in the city with respect to various sectors?
	Potential to adapt to future changes	How well equipped is the city to cope up with emerging pressures on water security?
	Citizen support for water security	How supportive are the citizens for water security enhancement?

Example of multiple potential variables to measure a particular indicator

DIMENSION	INDICATOR	WHAT TO MEASURE?	POTENTIAL VARIABLES
WATER SUPPLY AND SANITATION	Water availability	How much water is available to citizens to carry out their day-to-day activities	1. Per capita water use 2. Number of people using improved water sources 3. Investment in water supply facilities
	Accessibility	What percentage of the city population has access to clean drinking water?	1. Population access to piped water supply 2. Service area coverage for piped water supply 3. Average distance traveled to fetch water from improved water sources
	Quality of water supplied	Does the water supplied meet the national/international standards?	1. Customer satisfaction with water quality 2. Type of water treatment employed 3. Coliform count of supplied water 4. Residual chlorine content 5. Turbidity of water 6. pH of supplied water
	Hygiene and sanitation	What is the level and nature of sanitation facilities in the city and what are their impact on human health?	1. Number of people using improved sanitation facilities 2. Water-borne disease factor 3. Investment in sanitation facilities

Water security assessment for Bangkok

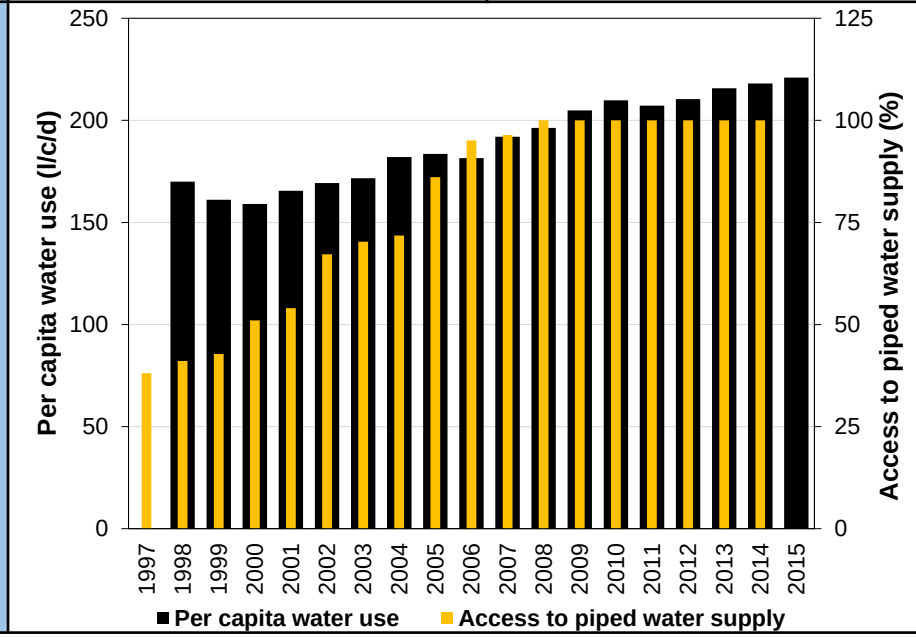
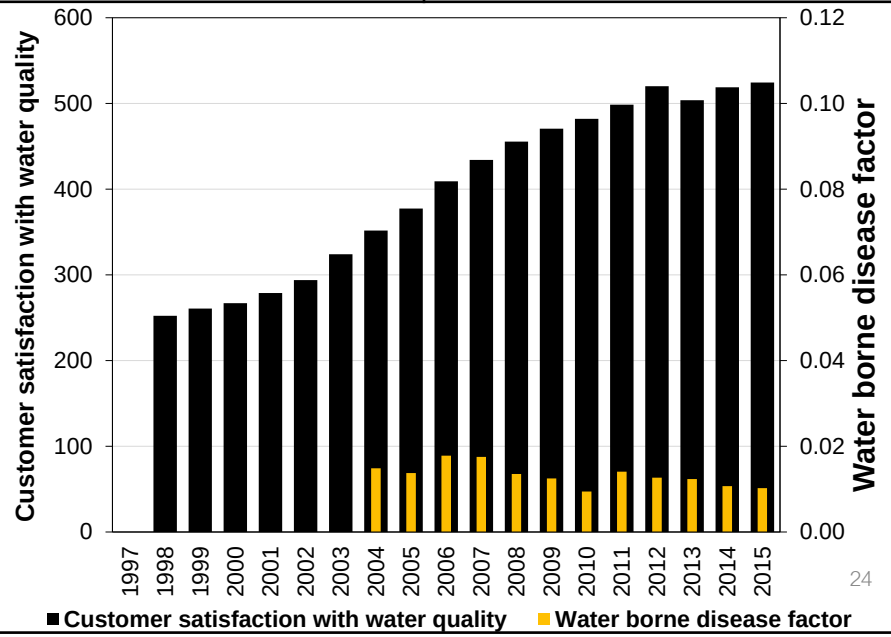
Characteristic	Bangkok
Population (10^6) (2015)	5.69
Area (km^2)	1,119
Per capita GPP (Baht) (2014)	481,118
Coverage	50 districts
Annual rainfall (mm) (2015)	1619



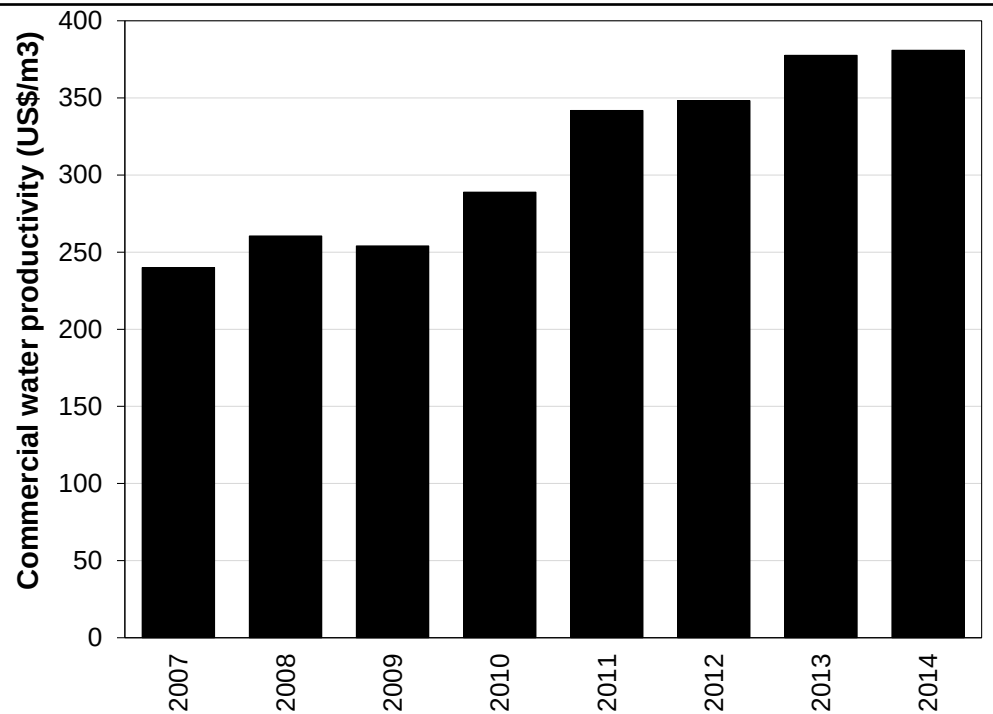
Water security assessment for Bangkok

DIMENSION	INDICATOR	VARIABLE
WATER SUPPLY AND SANITATION	Water availability	Per capita water use
	Accessibility	Access to piped water supply
	Quality of water supplied	Customer satisfaction with water quality
	Hygiene and sanitation	Water-borne diseases factor
WATER PRODUCTIVITY	Economic value of water	Non-agricultural water productivity
WATER-RELATED DISASTERS	Resilience against disasters	Coping potential factor
	Disaster mitigation interventions	Drainage factor
WATER ENVIRONMENT	State of natural water sources	Surface water quality factor
	State of pollution	Wastewater discharge factor
WATER GOVERNANCE	Overall management of the water sector	Institutional factor
	Potential to adapt to future changes	Adaptability factor
	Citizen support for water security	Public consciousness factor

Water security assessment for Bangkok

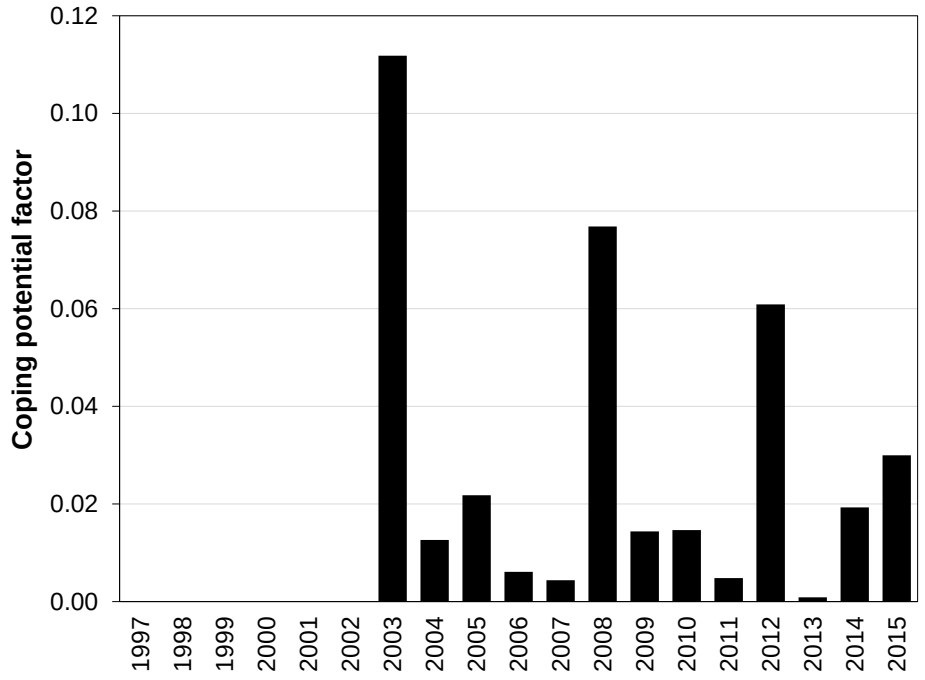
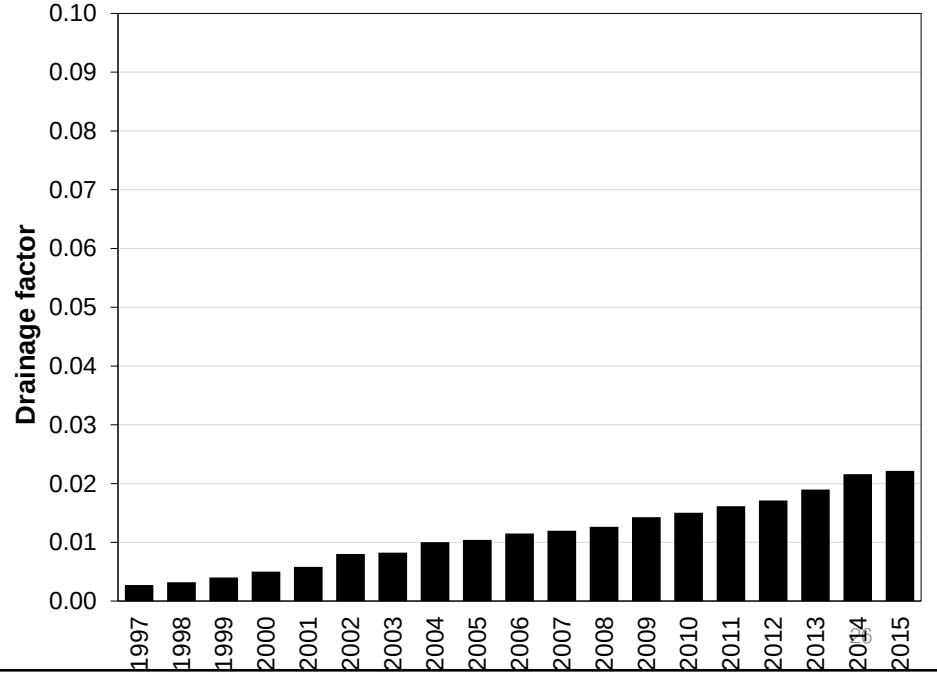
DIMENSION	1. Water supply and sanitation			
INDICATOR	**Water availability**	**Accessibility**	**Quality of water supplied**	**Hygiene and sanitation**
SELECTED VARIABLE	Per capita water use	Access to piped water supply	Customer satisfaction with water quality	Water-borne disease factor
HOW TO MEASURE	Total water consumption /City population	Serviced area /City area	Number of customers/Number of employees in water utility	Hospitalized cases of water-borne diseases /Total hospitalized cases
RESULT				

Water security assessment for Bangkok

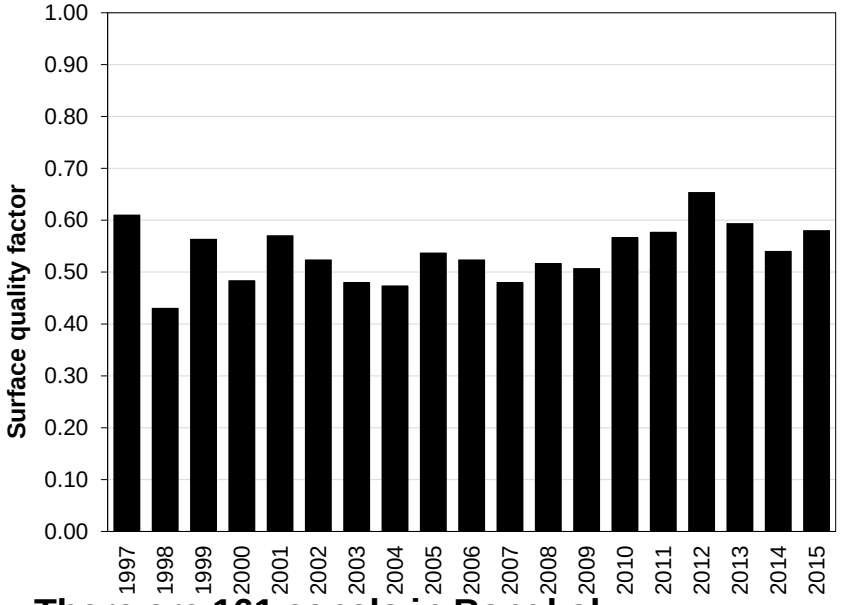
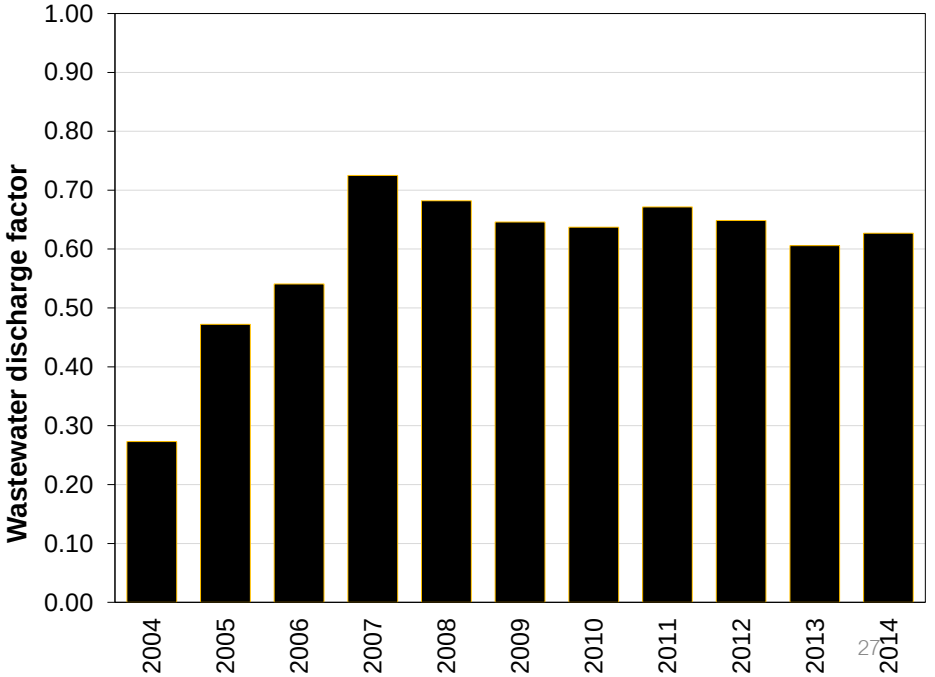
DIMENSION	2. Water productivity
INDICATOR	**Economic value of water**
SELECTED VARIABLE	Commercial water productivity
HOW TO MEASURE	City revenue/City water use(US$/$m^3$)
RESULT	

City revenue is Non-agricultural Gross Provincial Product

Water security assessment for Bangkok

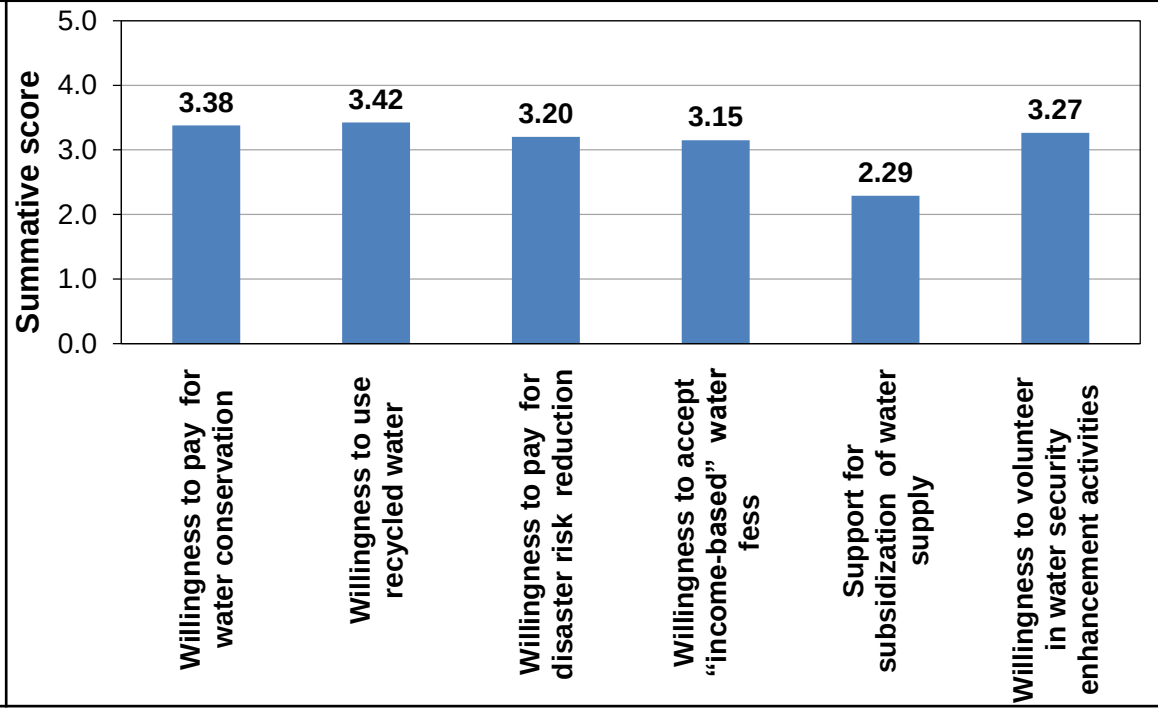
DIMENSION	3. Water-related disasters	
INDICATOR	**Resilience against disasters**	**Disaster mitigation interventions**
SELECTED VARIABLE	Coping potential factor	Drainage factor
HOW TO MEASURE	Investment in disaster response mechanisms/Total city budget	Total open space (green)/Total city area
RESULT		

Water security assessment for Bangkok

DIMENSION	4. Water environment	
INDICATOR	**State of natural water sources**	**State of pollution**
SELECTED VARIABLE	Surface quality factor	Wastewater discharge factor
HOW TO MEASURE	Dissolve Oxygen concentration /Permissible limit (3mg/l)	Amount of treated wastewater /Total wastewater generated
RESULT		

- **There are <u>161 canals</u> in Bangkok**
- **Monitoring points of water quality are <u>282 points</u>**

Water security assessment for Bangkok

DIMENSION	5. Water governance	
INDICATOR	**Overall management of the water sector**	**Citizen support for water security**
SELECTED VARIABLE	Institution factor and Adaptability factor	Public consciousness factor
HOW TO MEASURE	Questionnaire survey	Questionnaire survey
RESULT	Processing	

Average summative Score = 3.12

Scoring
Highly unlikely = 1
Mostly unlikely = 2
Neutral = 3
Likely = 4
Very likely = 5

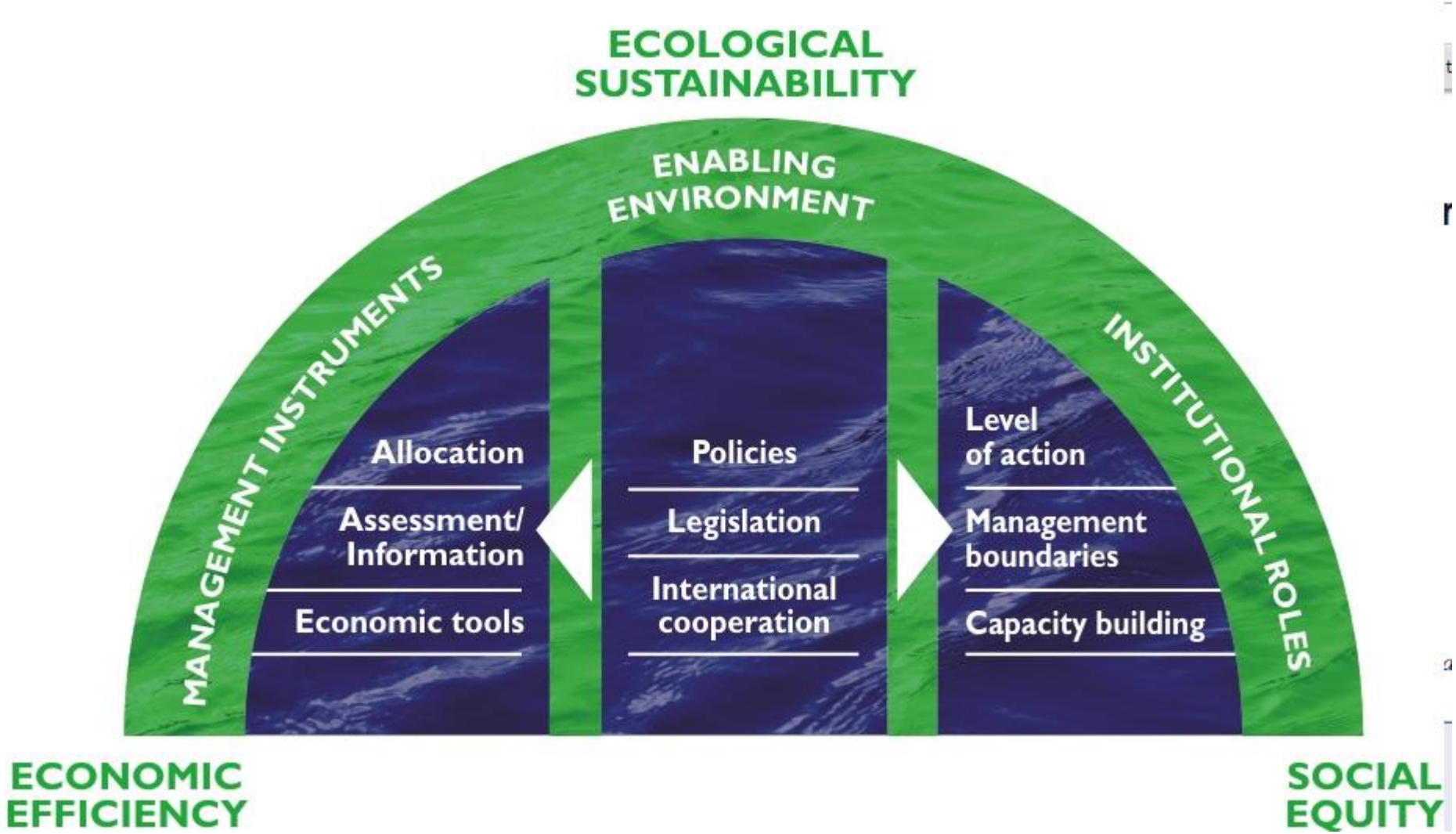
Water security assessment for Bangkok

Questionnaire Survey to assess Institution and Adaptability factors for city-scale analysis

Question	Yes	No
Governance Index		
1. Is public opinion sought when developing water-related plans for Bangkok?		
2. Is there a provision for general public to register their grievances?		
3. Is there an official mechanism to monitor water pollution offences?		
4. Is there a provision to incentivize water conservation and/or water source protection?		
5. Does Bangkok Metropolitan Administration (BMA) consult other water organizations (e.g. MWA, RID) during the development of annual or long-term plans?		
Adaptability index		
1. Does recycling and/or reuse of water take place in Bangkok?		
2. Is there a centralized database for water related information?		
3. Is there an Early Warning System to prevent water-related disasters?		
4. Are future drivers of change (e.g. climate change) taken in consideration when developing long-term BMA master plans?		
5. Is there a mechanism for BMA staff to upgrade water-related knowledge?		

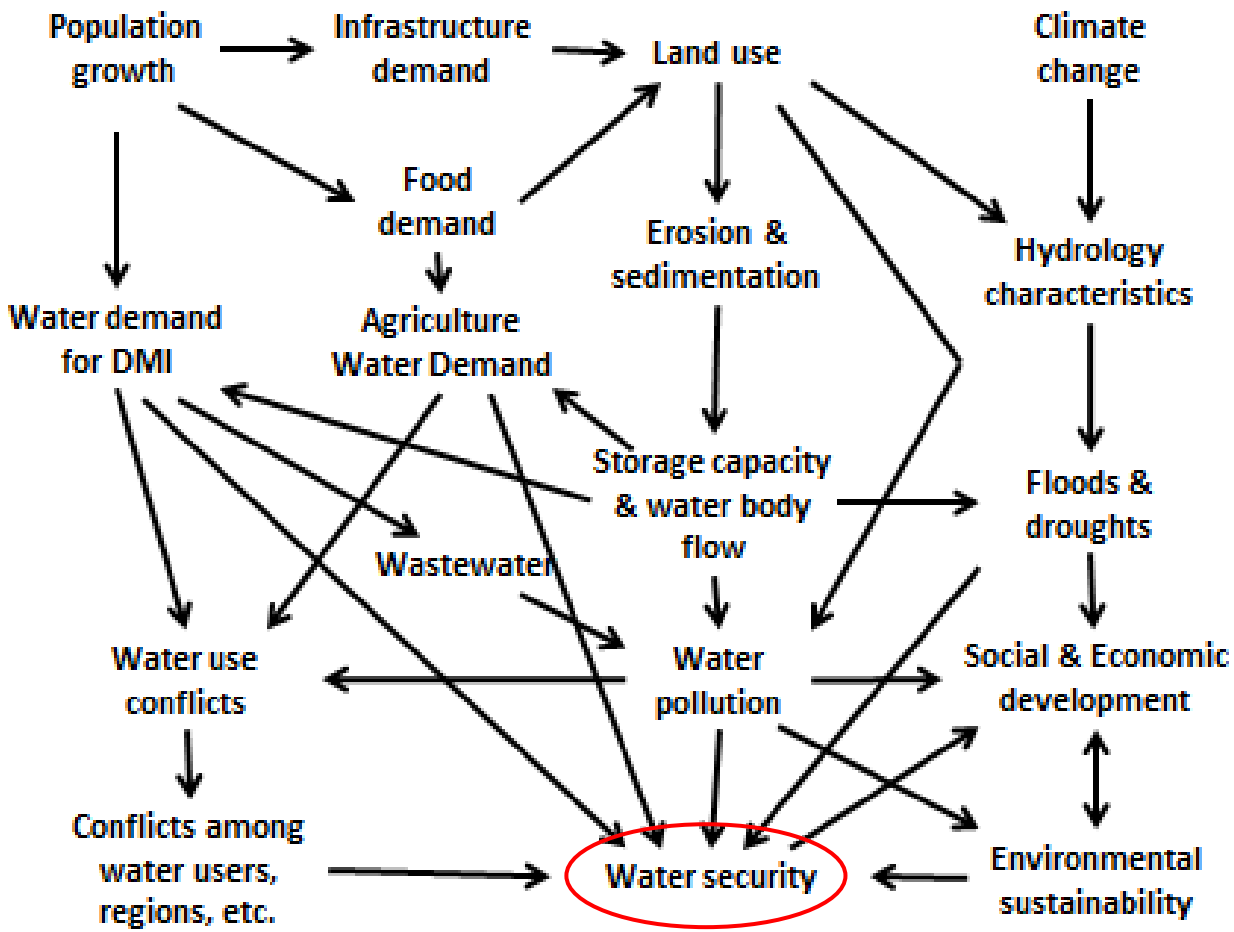
Final Reflections

Achieving water security is a process similar to implementing Integrated Water Resources Management



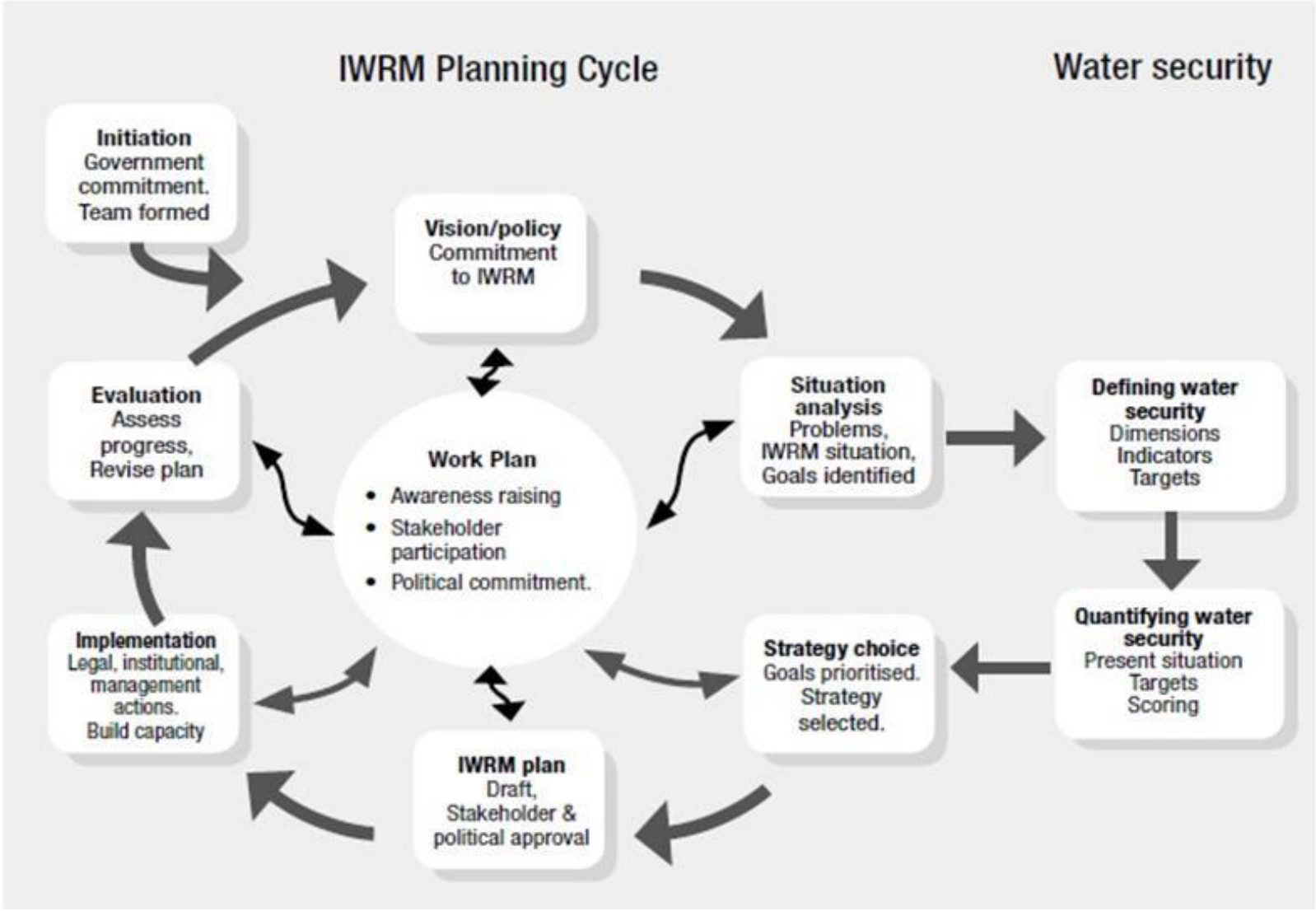
Final Reflections

Dynamics of Water Resources Management Problems in a River Basin Territory



Final Reflections

Factoring Water Security Into The IWRM Planning Cycle (Beek and Arriens, 2014)



Thank you