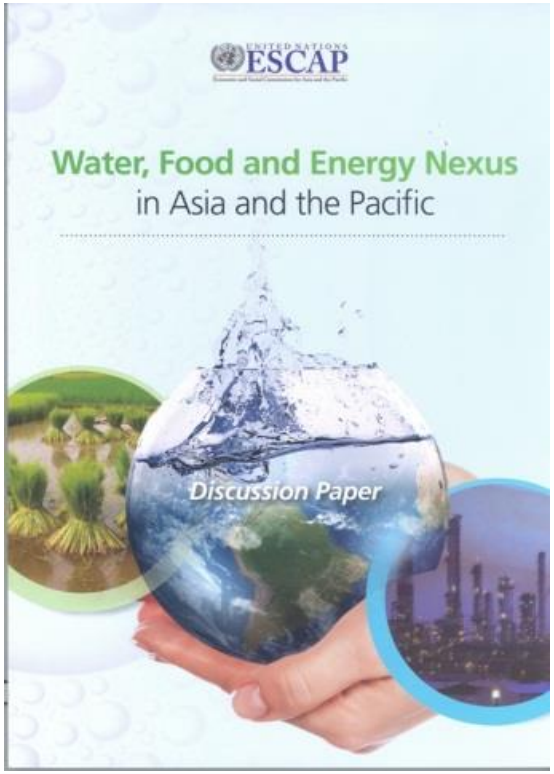
Water-Food-Energy Nexus: Policy Perspectives in Asia and the Pacific

Hongpeng Liu

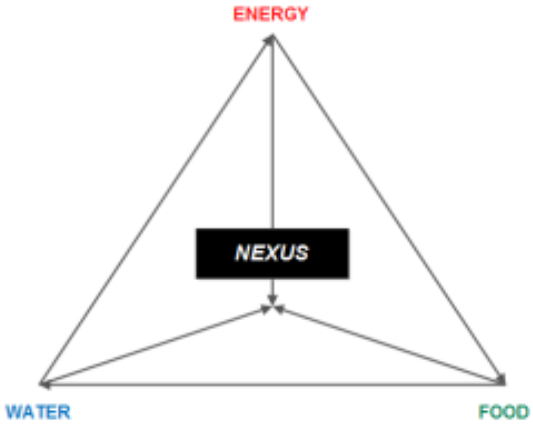
Director, Energy Division, ESCAP

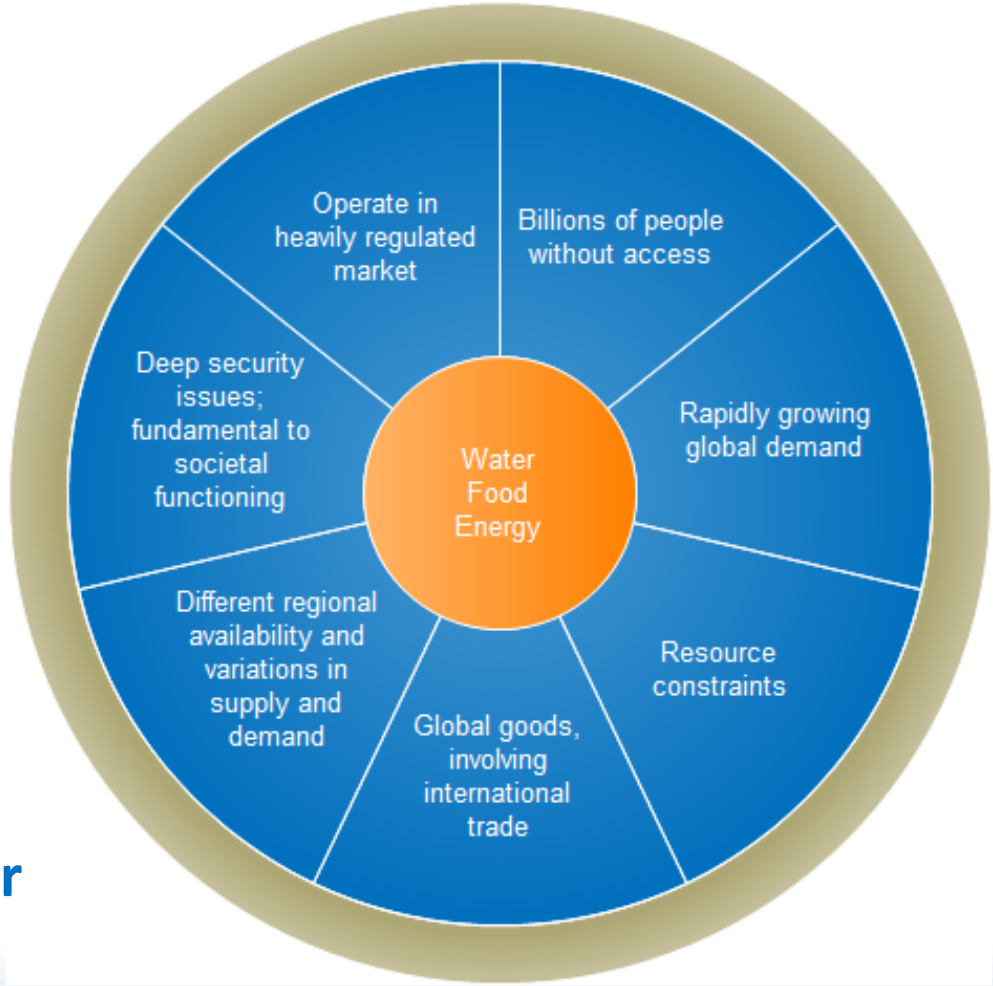
ESCAP Publication 2014



Why water, energy and food resources?

…unsustainable pressures on these 3 **strategic** resources

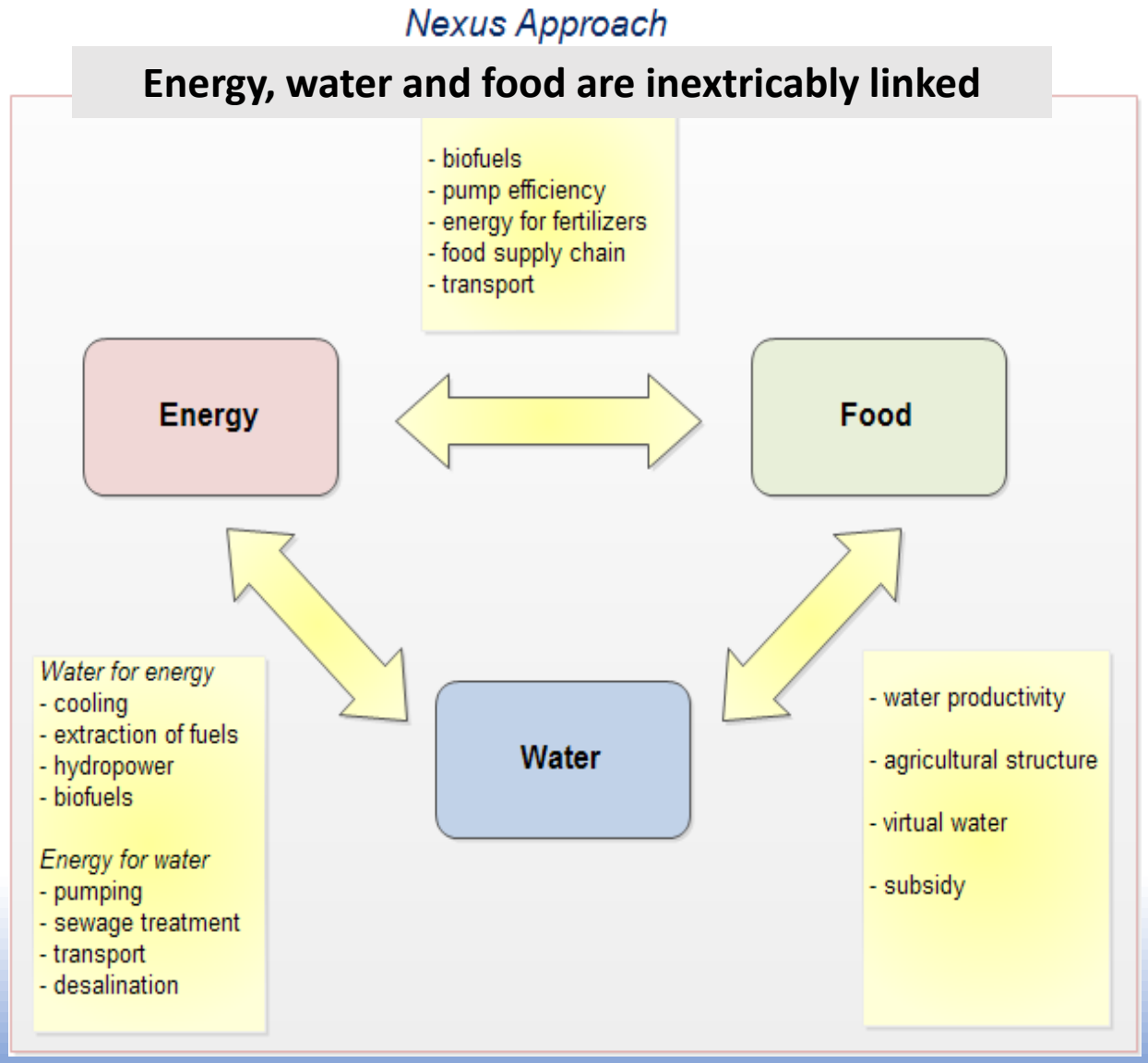




Recognize the consequences of one sector on another to achieve efficiency using systems thinking

Source: Adapted from Bazilian et al 2011

Linking energy, water and food resources



- **Water for energy** currently amounts to about 8% of global **water** withdrawals (45% in industrialized countries, e.g. in Europe).

- **Food production** and supply chain is responsible for around 30% of total global **energy** demand

- **Food production** is the largest user of **water** at the global level, responsible for 80–90% of consumptive blue water use

Oxford Dictionary

- A connection or series of connections linking two or more things
  - A connected group or series
- A central or focal point

Nexus is not an entirely new concept

- Holistic, integrative, and trans-disciplinary thinking
- Mentioned from 1983 (UNU project)
- Bonn Nexus Conference (2011) a breakthrough

The Nexus Approach

Projections for 2050 with 9.2 billion people:

- 70% increase in agricultural demand for food by 2050

- 40% energy demand increase by 2050

- But by 2030: confronting water supply shortage of ~ 40%

Recognizes interconnectedness of water, energy and food across space and time with objectives to:

- **Improve water, energy and food security**
- **Address externality across sectors, and decision-making with the nexus approach**
- **Support transition to sustainability**

Energy needs Water

- 90% of power generation worldwide is water-intensive.
- There is an increasing risk of conflict between power generation, other water users and environmental considerations.
- Energy production accounts for roughly 15% of all water withdrawals, or roughly 75% of all industrial water withdrawals.
- Thermal power generation accounts for roughly 80% of global electricity production and is responsible for roughly one half of all water withdrawals in The United States and in several European countries.
- Hydroelectricity, which can also require abundant water supplies, accounts for about 15% of global electricity production.

Source: *http://www.unwater.org/topics/water-and-energy/en/*

Water required for energy production by different processes

Water consumed to produce 1 MWh of electricity:[16]

Wind turbines	0 m^3/MWh
Solar	0 m^3/MWh
Natural gas	0.2 m^3/MWh
Coal	0.7-3.0 m^3/MWh
Nuclear	0.9-3.3 m^3/MWh
Oil/petroleum	0.1-6.5 m^3/MWh
Hydropower (from evaporation)	17.0 m^3/MWh
First generation biofuels*	32.3-360.0 m^3/MWh

** The amount of water consumed does not indicate whether the crop is irrigated or rainfed. The water intensity of biofuel feedstocks depends on the feedstock used and where and how it is grown. Irrigated crops are much more water intensive than non-irrigated ones. The higher numbers shown represent crops that are irrigated, while the lower numbers represent non-irrigated crops.*

Virtual water content of selected products

Plant-based product	Water requirement	Animal-based product	Water requirement
Wheat	1,150	Beef	15,977
Rice	2,656	Pork	5,906
Maize	450	Poultry	2,828
Potato	160	Eggs	4,657
Soybean	2,300	Milk	865

- Takes 1 liter of water to grow one calorie Meat, on average, requires about 10 times the water required per calorie from plants

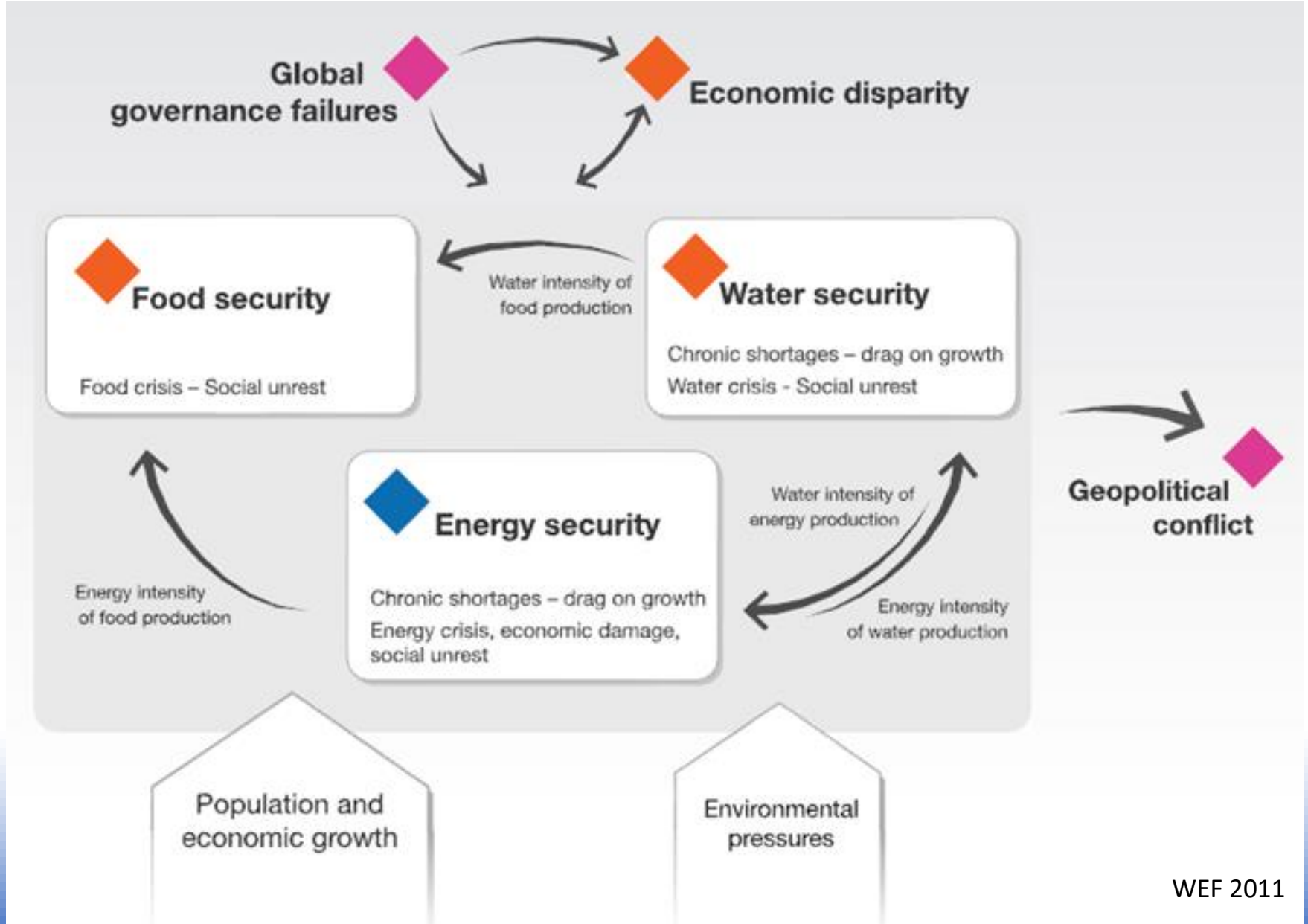
- On average human beings need to drink between 2 and 4 liters of fluids a day but consume 2,000 to 5,000 through the water used in producing their food

Water needs energy

- About 8% of the global energy generation is used for pumping, treating and transporting water.
- Water, being dense, requires much energy to move it. Water transport and distribution are energy intensive processes. Reallocating water through uses and places might increase the value per drop but increase the use of energy.
- Drinking water for municipal systems typically requires extensive treatment and once it becomes wastewater it requires treating again before it can be discharged to the environment.

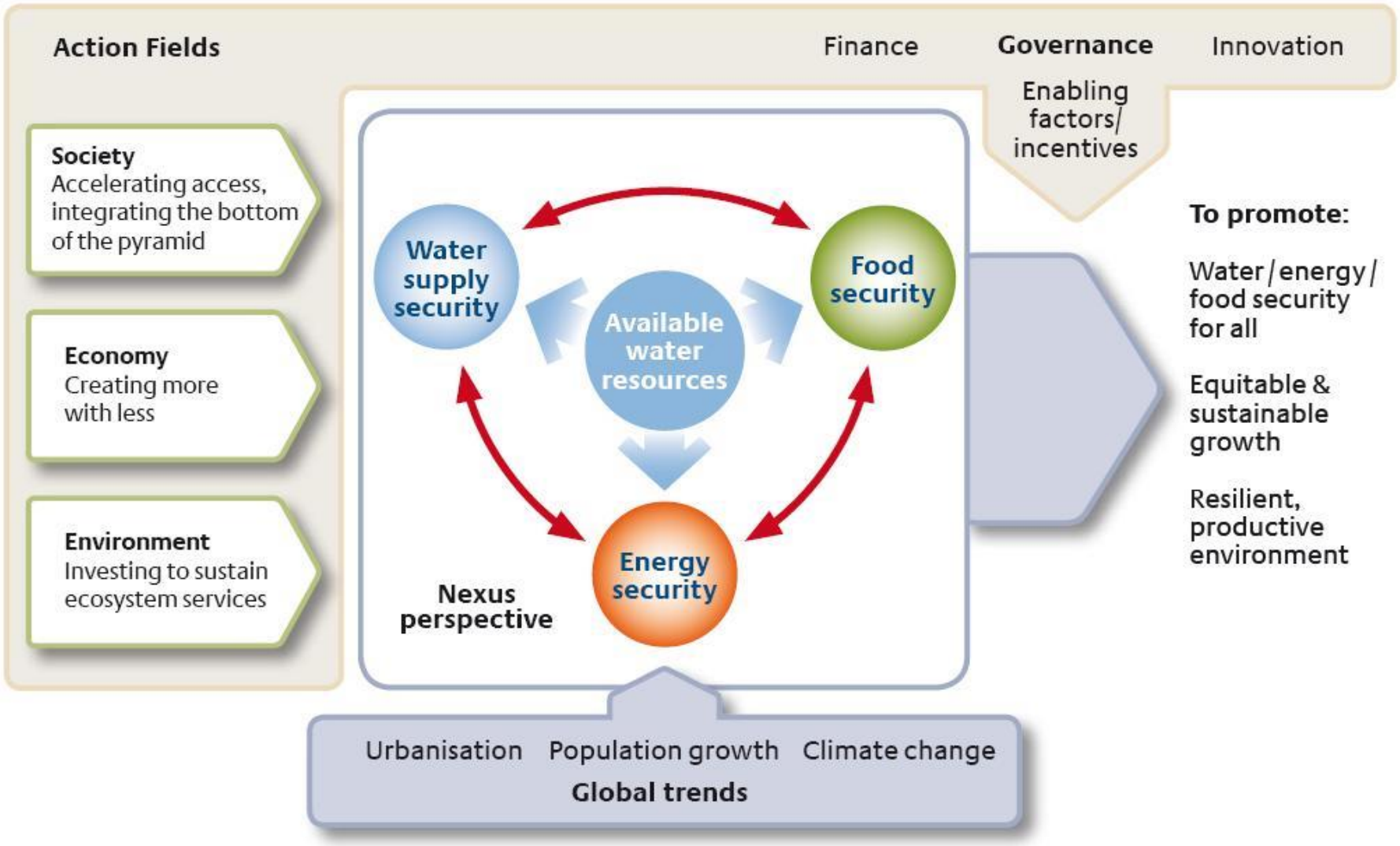
Source: *http://www.unwater.org/topics/water-and-energy/en/*

WEF frameworks



WEF 2011

WEF framework – Bonn 2011



Hoff 2011

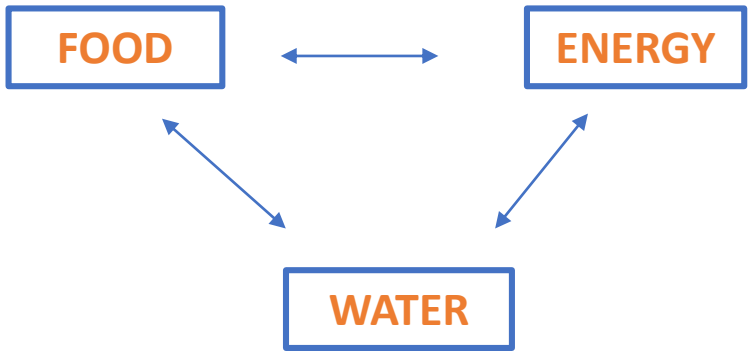
Water-food-energy nexus and its constituent issues

Biofuels:
- Land-use competition

Food supply chain:
- Pump efficiency
- Energy for fertilizers
- Pollution

Irrigation:
- Water productivity
- Agricultural structure
- Water tables
- Overpumping

Political economy:
- Price volatility
- Virtual water
- Subsidies
- Biofuels

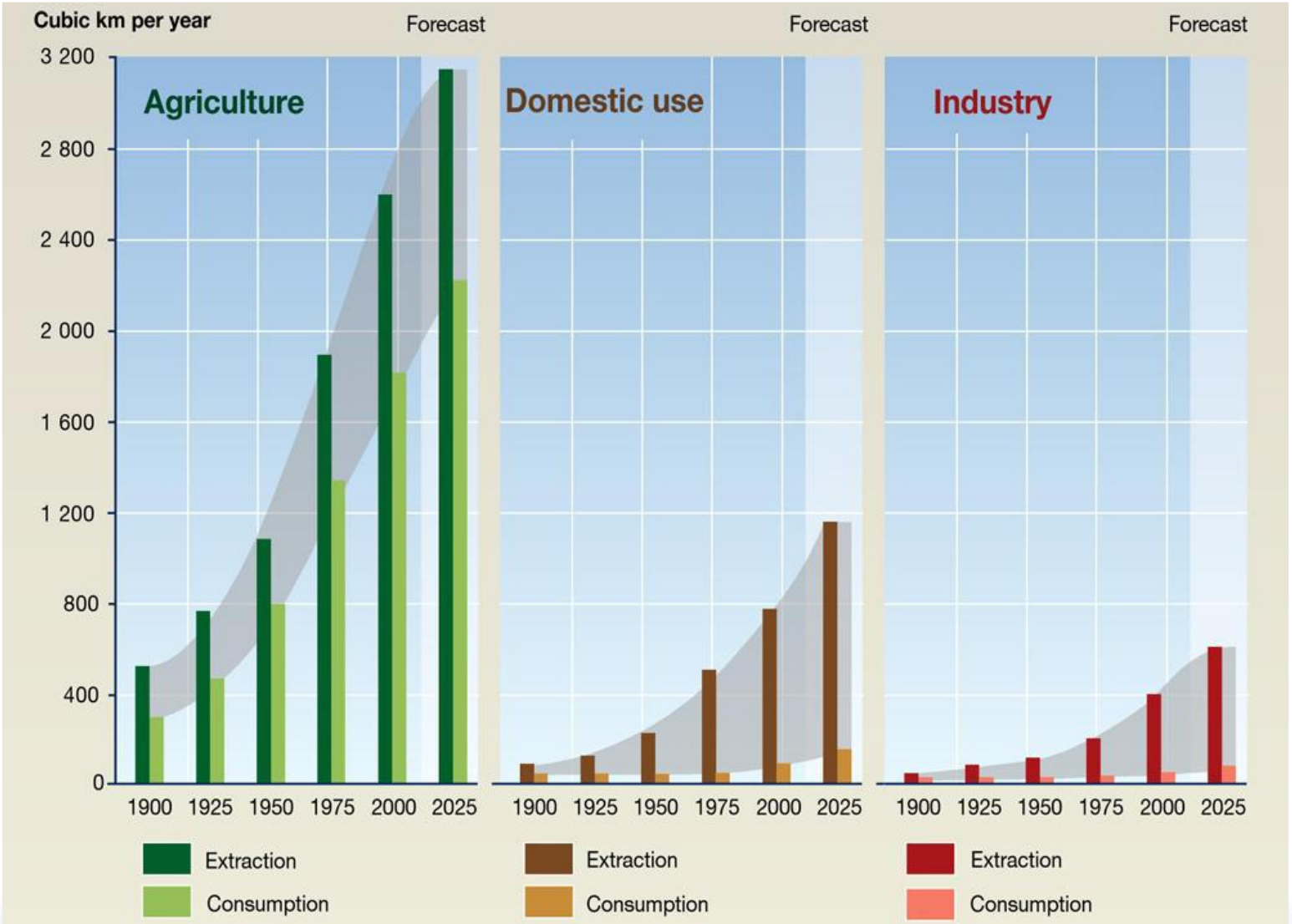


Water for energy:
- Cooling
- Extraction of fuels
- Hydropower
- Biofuels
- Social impact

Energy for water:
- Pumping
- Sewage treatment
- Transport
- Desalination

Source: ESCAP 2012

Trends in global water demand



- 635 million people lack access to safe water and 1.9 billion lack access to effective sanitation
- Up to 3.4 billion people could be living in water-stressed areas of Asia by 2050.

- Require over US$ 130b investments

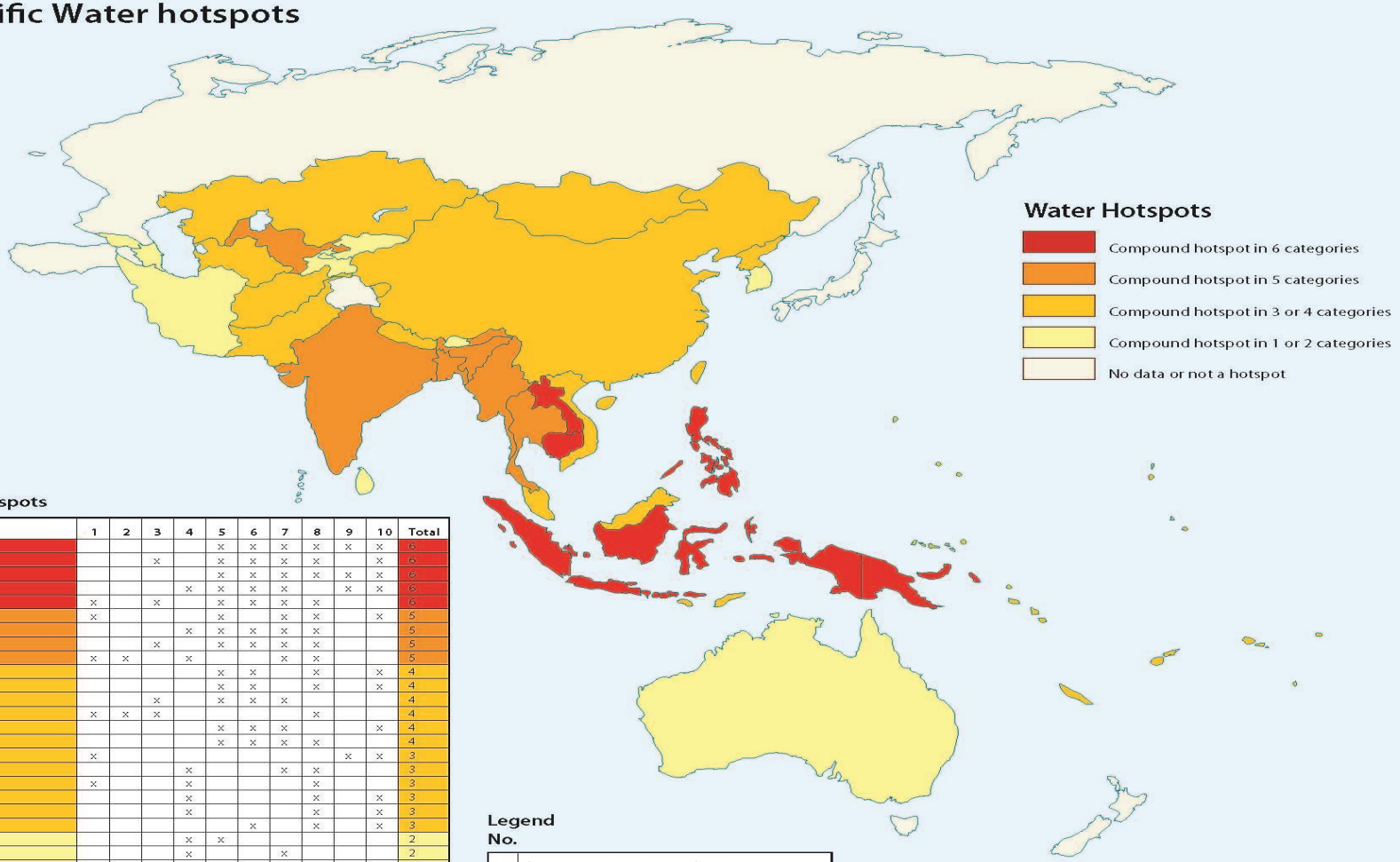
- Hotspots: countries or areas or ecosystems with overlapping challenges of poor access to water and sanitation, deteriorating water quality, limited water availability and increased exposure to climate change and water-related disasters
- Asia and the Pacific is the global hotspot for water insecurity.
  - Afghanistan, China, India, Singapore and Pakistan will have the lowest per capita water availability

- China, India, Indonesia, South Korea and Vietnam, are all in or close to being in conditions of water stress

- The exceptions are few: Bhutan, Brunei, Myanmar, Cambodia, Laos, Malaysia and Papua New Guinea

Water security in Asia and the Pacific

Asia Pacific Water hotspots



Compound Hotspots

	1	2	3	4	5	6	7	8	9	10	Total
Cambodia					×	×	×	×	×	×	6
Indonesia			×		×	×	×	×		×	6
Lao PDR					×	×	×	×	×	×	6
Papua New Guinea				×	×	×	×		×	×	6
Philippines	×		×		×	×	×	×			6
India	×				×		×	×		×	5
Myanmar				×	×	×	×	×			5
Thailand			×		×	×	×	×			5
Uzbekistan	×	×		×			×	×			5
Bangladesh					×	×		×		×	4
China					×	×		×		×	4
Malaysia			×		×	×	×				4
Pakistan	×	×	×					×			4
Timor Leste					×	×	×			×	4
Viet Nam					×	×	×	×			4
Afghanistan	×								×	×	3
Kazakhstan				×			×	×			3
Maldives	×			×				×			3
Mongolia				×				×		×	3
Nepal				×				×		×	3
Pacific Islands						×		×		×	3
DPRK				×	×						2
Kyrgyzstan				×			×				2
Tajikistan				×			×				2
Turkmenistan				×			×				2
Australia							×				1
Azerbaijan				×							1
Bhutan				×							1
Georgia				×							1
Iran								×			1
Republic of Korea					×						1
Sri Lanka								×			1
Prevalence (countries affected)	6	2	5	14	15	13	17	19	4	12	

Legend

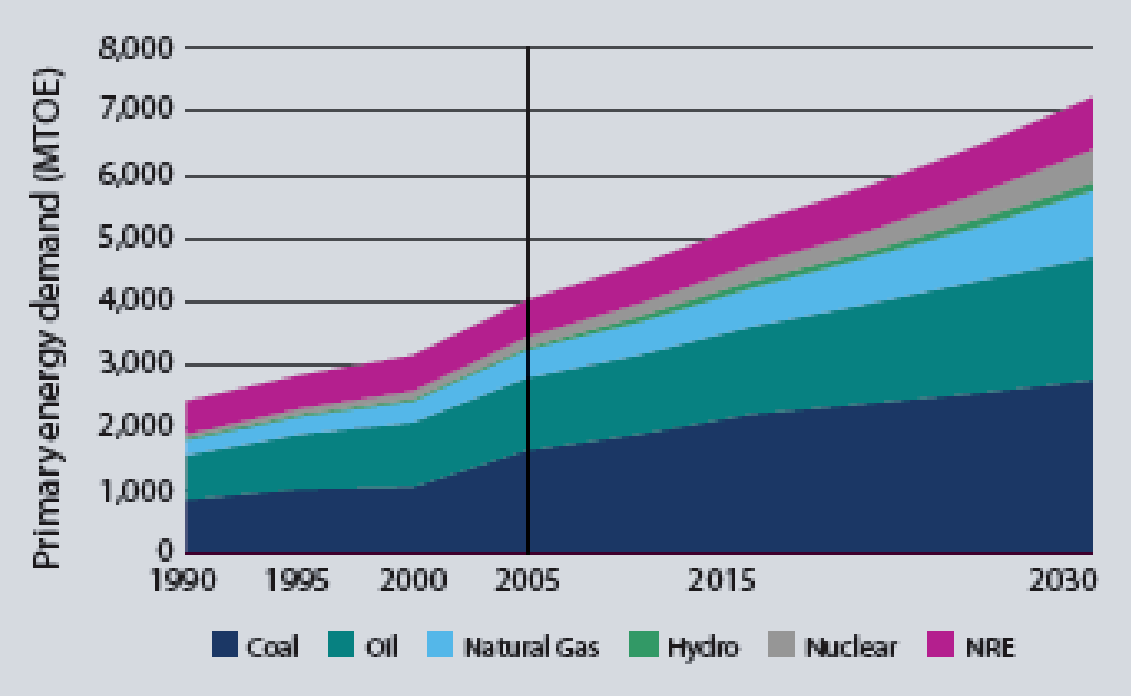
No.	
1	Increasing water scarcity threat
2	High water utilization
3	Deteriorating water quality
4	Poor water quality and low water endowment
5	Flood-prone countries
6	Cyclone-prone countries
7	Drought-prone countries
8	Elevated ecosystem/ Climate change risk
9	Poor access to drinking water
10	Poor access to sanitation

Source: ESCAP 2010

Demand for energy is growing

- Global energy demand is set to grow by 37% by 2040 (IEA)
- The global distribution of energy demand changes more dramatically, with energy use essentially flat in much of Europe, Japan, Korea and North America, and rising consumption concentrated in the rest of Asia (60% of the global total), Africa, the Middle East and Latin America
- By 2030 China will need to expand its power generating capacity by over 1,300 GW (1.5 times the current level of the United States); and India by 400 GW (equal to the current combined total power generation of Japan, South Korea and Australia) (IEA)
- By 2030, global demand for energy and water is expected to grow by 40% and 50%, respectively (UN-Habitat, 2016). Most of this growth will be in cities, which will require new approaches to wastewater management
-

Energy security in Asia and the Pacific

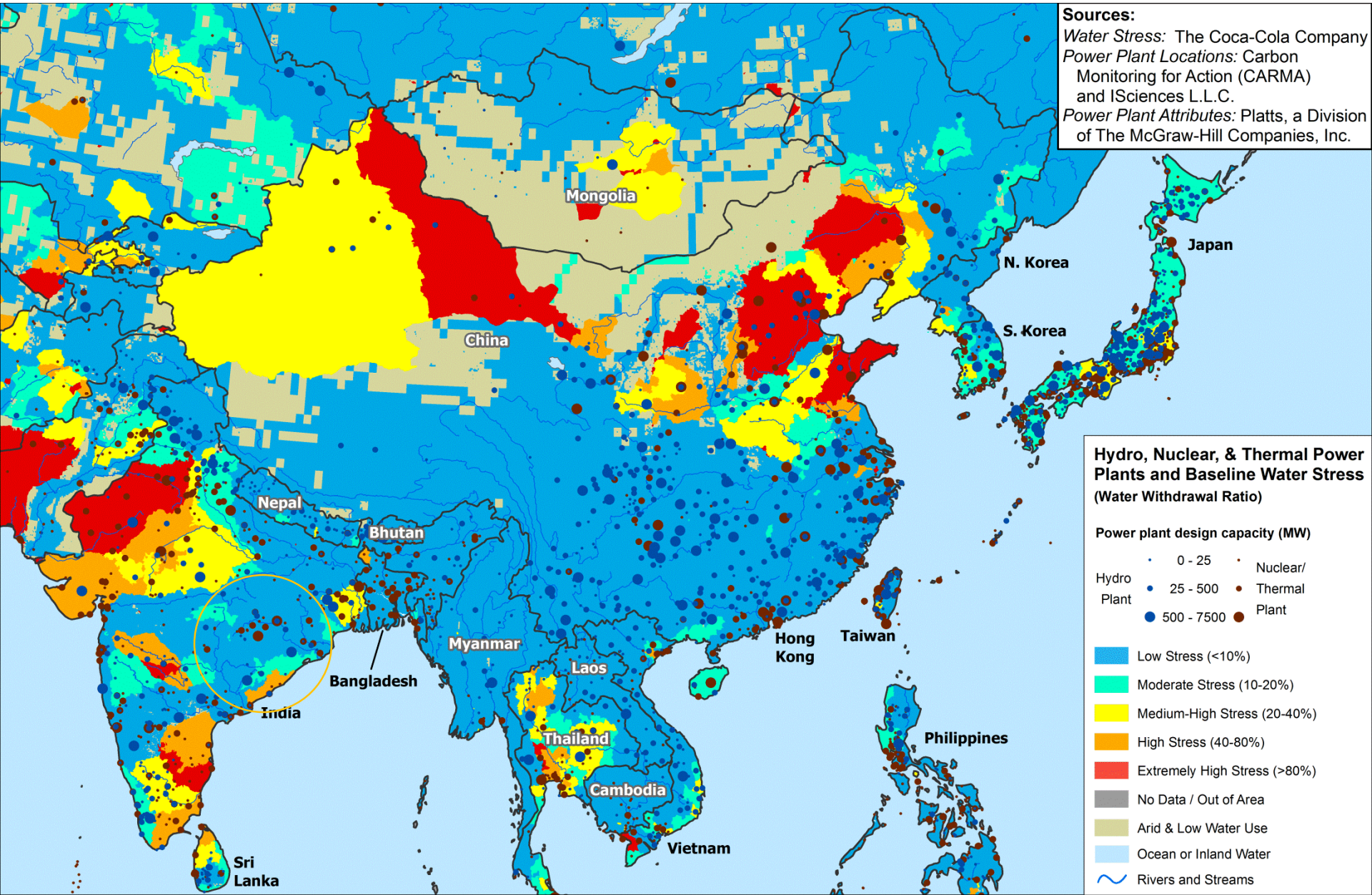


- Growth of energy use in the Asia-Pacific region, particularly in China & India, will have major consequences for geopolitics, financial and energy markets and pollution both regionally and globally

- Growing energy demand in the region is forecast to grow 60 per cent between 2010 - 2035

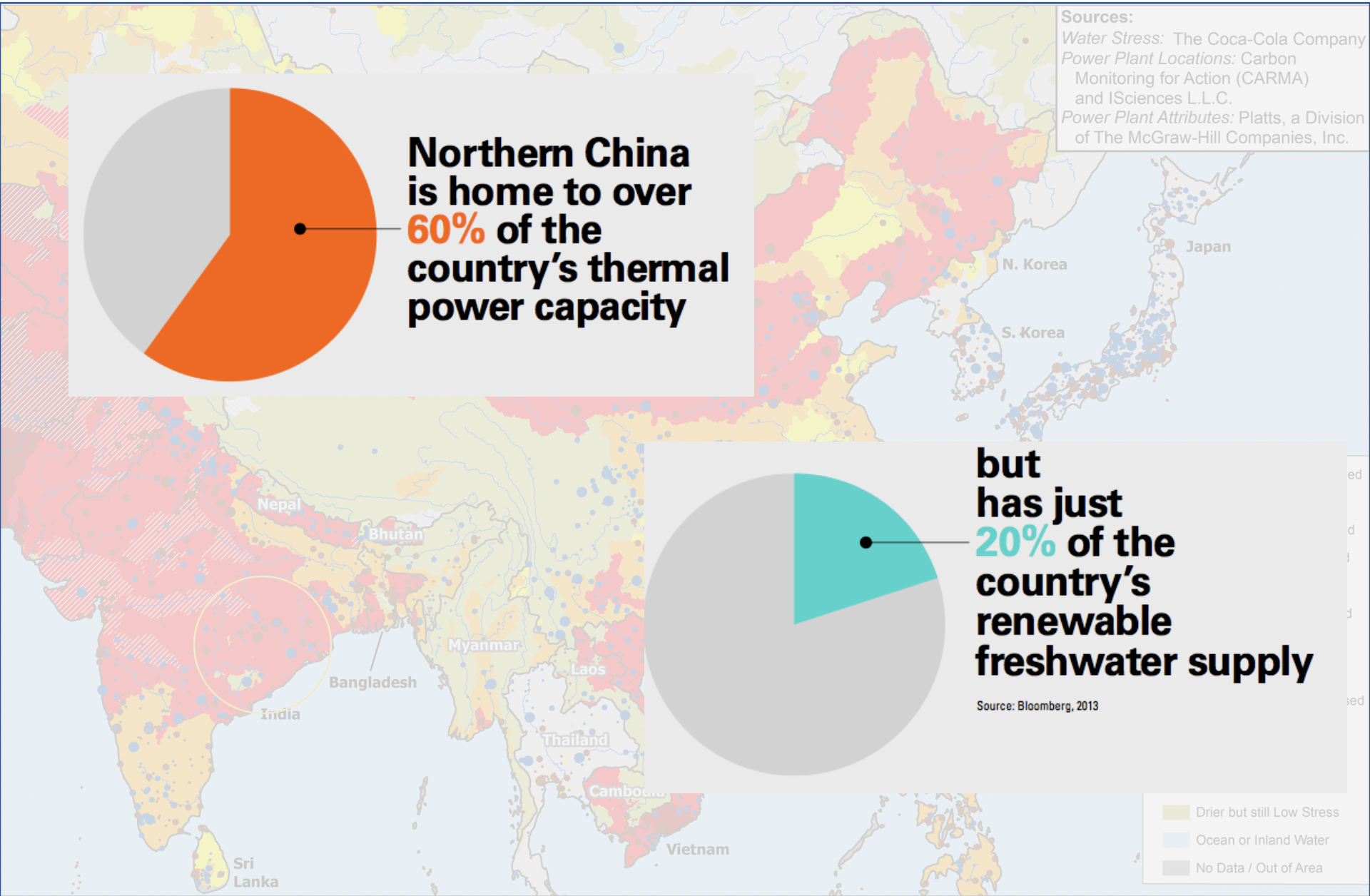
Baseline Water Stress

(and the location of power plants)



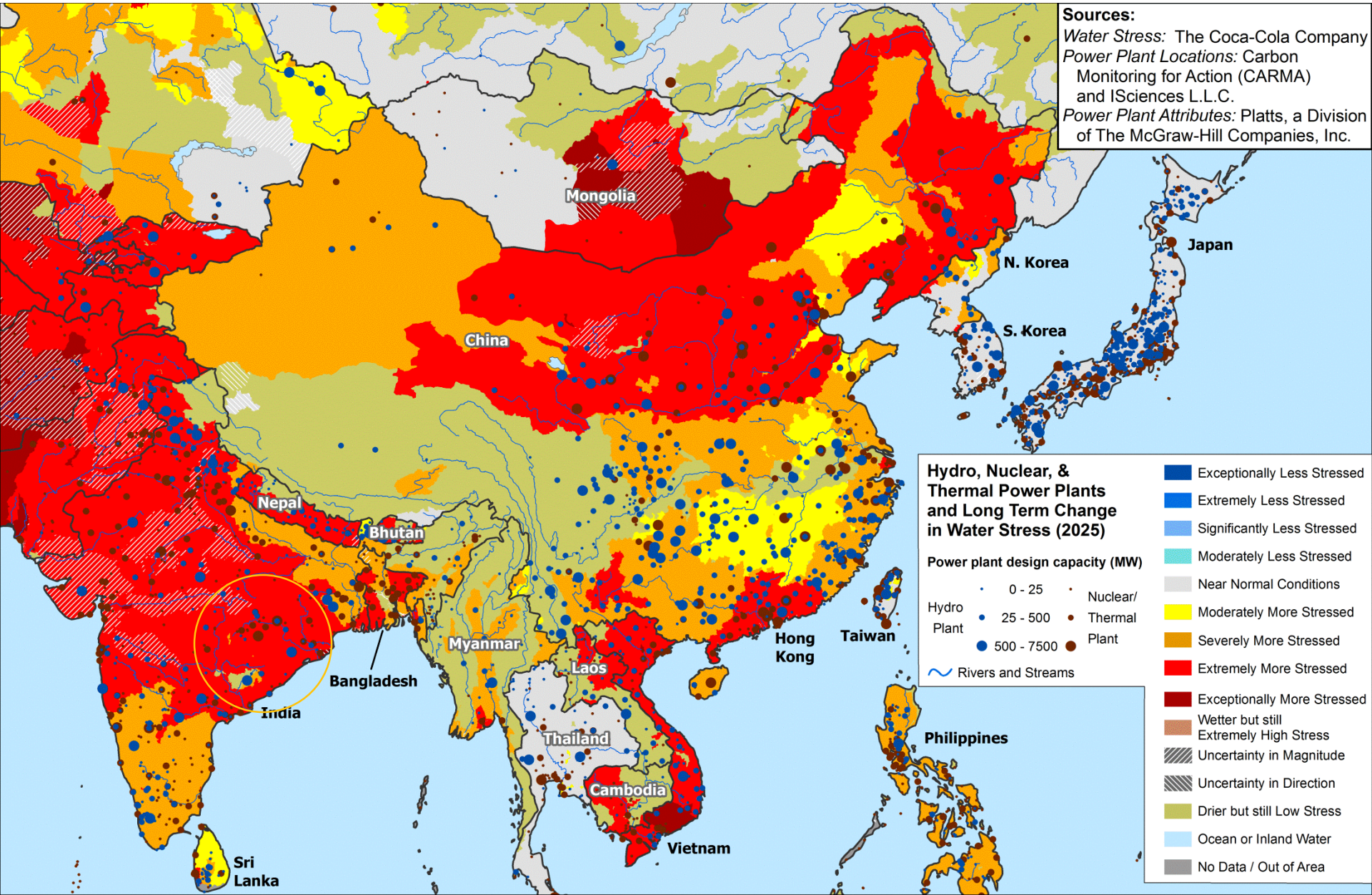
Long Term Water Stress

(and the location of power plants, based on 2025 IPCC Scenario A1B)

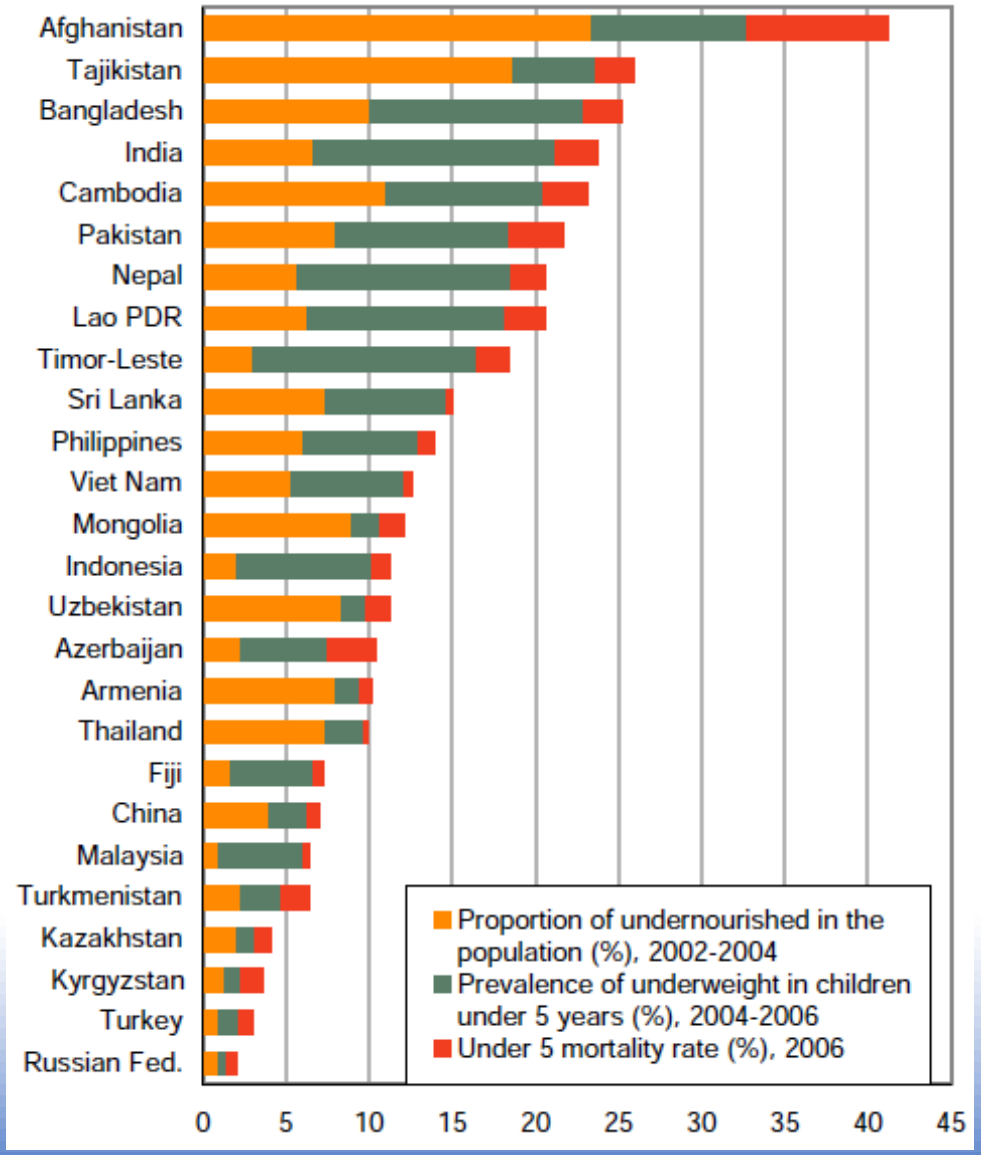


Long Term Water Stress

(and the location of power plants, based on 2025 IPCC Scenario A1B)



Food security in Asia and the Pacific



578 million Asians are undernourished. The global economic crisis and the food crisis in 2006-08, have deprived an additional 100 million people of access to adequate food

Productivity of agriculture – By 2050 South Asia will need to divert up to 57 per cent more water to agriculture

Environmental stress –Salinization induced by irrigation reduces productivity, . Saline soils affecting almost 50 per cent in Turkmenistan

Land-grab – Investments in agricultural and forest lands in many parts of the world have increased significantly

Interlocking effects of Nexus (1)

Biofuels	• Bioethanol in china consumes ~ 4% of total maize production
Hydropower	• Dams along Mekong may impact food security and ecology of Tonle Sap
Thermoelectric & water	• Declining water availability stresses energy sector in China
Irrigation and food security	• Irrigated rice regions with sustainability challenges in Pakistan, China & Australia

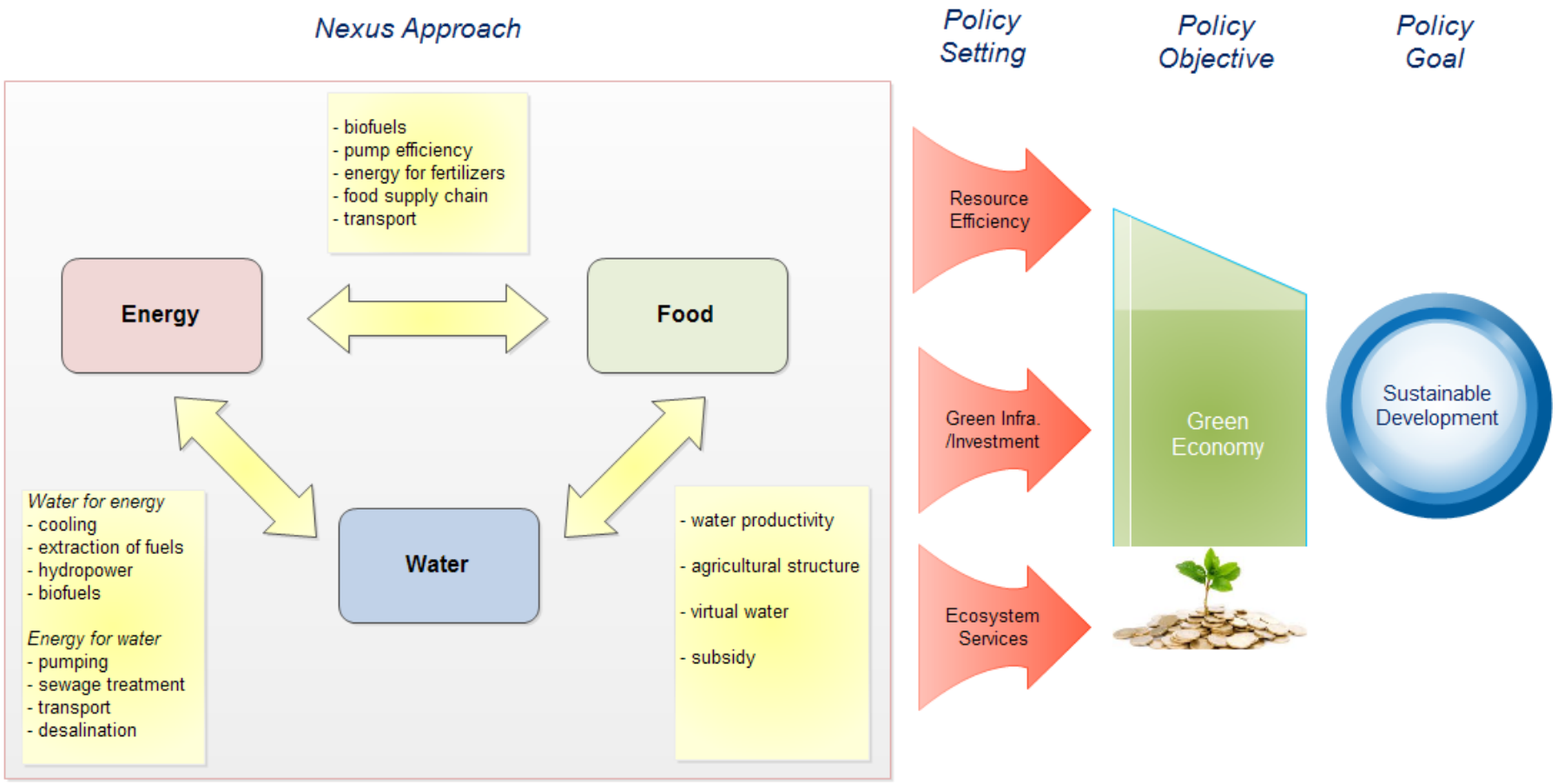
Interlocking effects of Nexus (2)

Irrigation & energy security	• Groundwater irrigation in India exerts pressure on energy security
Food trade & virtual water	• Thailand and India are largest net virtual water exporter
Land and food security	• Increased demand for WEF has increased pressure on land conversion
Water production and energy	• Singapore's aim for water self-sufficiency threatens its energy security

Gaps in the Nexus debate

- Despite close-relationship of WEF resources, their funding, policy-making and oversight are managed as separate issues across the spectrum of policy, planning, design and operation
- **New security convergence - scarcity-conflict thesis is gaining currency, but this time at systemic level (supply-chain; polycentric governance). Need to consider the risks of security narratives on society.**
- Insufficient analysis for some region – the Pacific lags behind
- **WEF frameworks need to consider the environmental dimension more coherently**

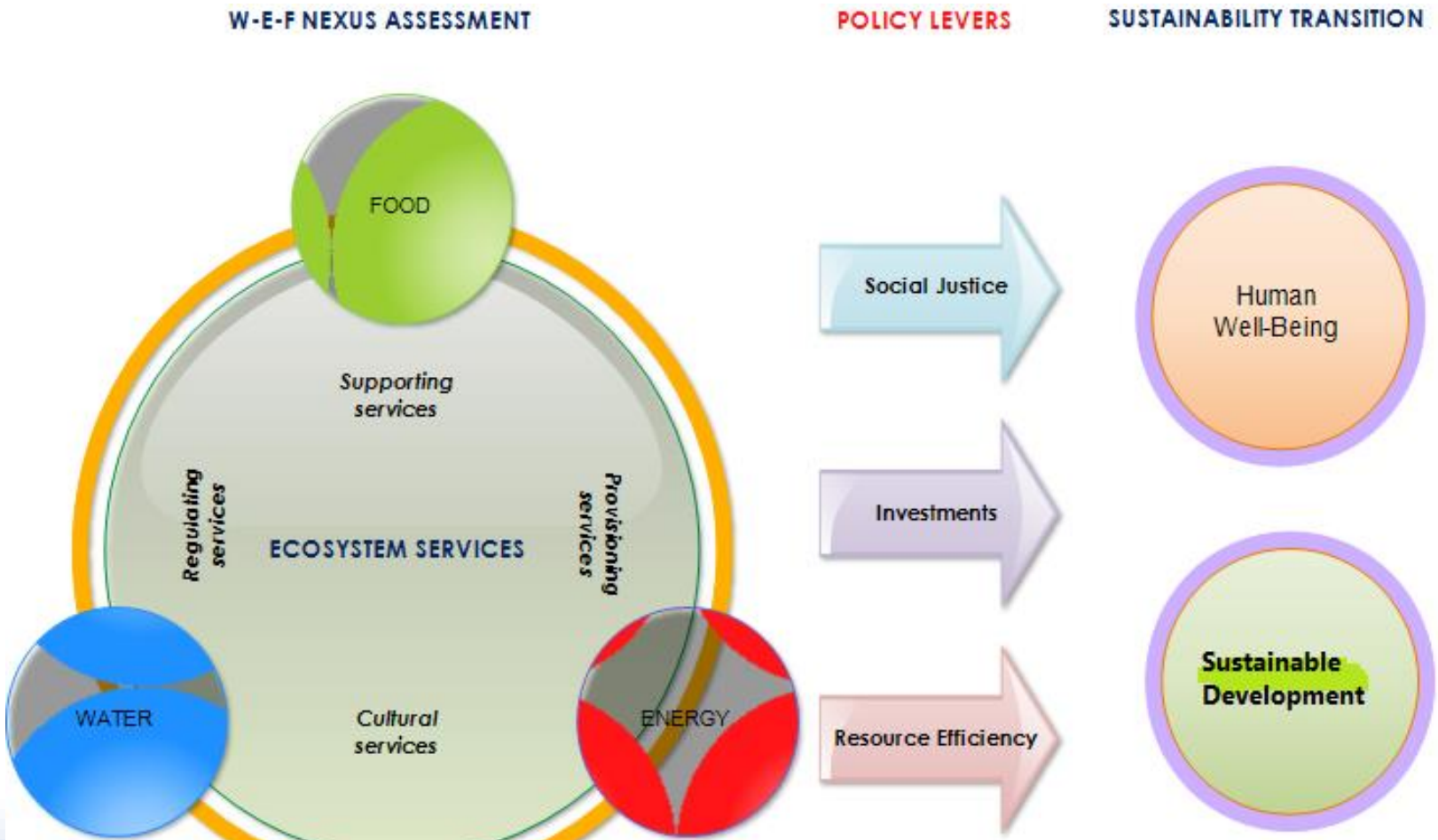
Situating the nexus approach



The Nexus Approach recognizes interconnectedness of water, energy, and food across space and time. Its objectives are:

- **Improve energy, water, and food security**
- **Address externality across sectors, and decision-making at the nexus**
- **Support transition to sustainability**

Suggested framework for Asia Pacific



Re-orientate the governance policy framework with sustainable development goals interlinkages

Policy recommendations (1)

- **Nexus accounting – deepen WEF analysis in A-P**
  - Current approach focuses on input-output analysis; solutions?
  - Three scarcity metrics – **physical** (resource intensity); **monetary** (price & cost dynamics) and **distributive** (implications of social allocations)
  - Policy salience – country-level studies & co-production of nexus knowledge
- **Adopt green economy model towards achieving SDGs**
  - Resource productivity and efficiency
  - Investments in natural capital
  - Social justice

Policy recommendations (2)

- **Re-orientate government policy framework**
  - Policy cycle - 'Socialization' of Nexus ideas
  - Strengthen price signal to ensure productive & efficient use of resources – subsidy and pricing
  - Address supply-and-demand chain – focus on weakest links
  - Align national policy approaches and governance structures with achieving the final objective of sustainability
- **Empower policy process – institutional thinking**
  - Address silo with policy integration
  - Long-term policy – foresight, future studies
  - Apply systems thinking (influence diagram etc)
- **Partnerships for nexus solutions**
  - Involve different actors from the energy, water and agricultural community incl. businesses, government, civil society, academia etc.
  - Requires enabling environment
  - Multi functions
  - Knowledge alliance

❖ Sector-integrated policy approaches

- LAO PEOPLE'S DEMOCRATIC REPUBLIC: 8th Five-Year National Socioeconomic Development Plan (2016–2020)
  - The policy looks into a collaboration with several sectors, such as on forests and water sources protection, which requires collaboration with the agriculture and forestry sector. "Policies on water resources protection and management, food security and energy security, and policies on the development of clean and safe cities, shall be harmonized and closely linked".
- FIJI: Fiji 2020 Agriculture Sector Policy Agenda: "Modernizing Agriculture" 2014-
  - The policy defines water resources, renewable energy, and livestock processing vital components of the national integrated agriculture infrastructure system. The water resources in Fiji then have multiple uses, which include irrigation, energy, fish production, and potable water. It calls for a comprehensive water use plan in Fiji to be included in the proposed Omnibus Agriculture Development Law.
- VANUTATU: Updated National Energy Roadmap (2016-2030)
  - The policy reviews the previous NERM and acts as the national energy policy. Since it was launched, Vanuatu's economy and energy sector have continued to develop. External events, such as Cyclone Pam in early-2015, have also shaped how energy sector policies and priorities are conceived. The NERM focuses on five priorities: accessible energy, affordable energy, secure and reliable energy, sustainable energy, and green growth.

❖ Water-food-energy balance

- ✓ PHILIPPINES: Philippine Development Plan 2017-2022
  - ✓ The mandated biofuels blending will be reviewed with due consideration to the impact on prices, farmer incomes and environmental protection. […].
- ✓ MALAYSIA: Eleventh Malaysia Plan 2016-2020 Anchoring Growth on People
  - ✓ The bio-diesel programme, which will be implemented by the Ministry of Plantation Industries and Commodities, offers the energy sector a sustainable, renewable, and environmentally friendly source of energy, as well as reduces the nation's dependency on imported diesel fuel.
- ✓ Fiji: Fiji 2020 Agriculture Sector Policy Agenda: "Modernizing Agriculture", 2014
  - ✓ The competition between crops for food security and crops for biofuels in using agriculture land must be managed and must not be a hindrance to a positive renewable energy development outlook in Fiji."
- ✓ KIRIBATI: Kiribati National Energy Policy, 2009
  - ✓ Ensure that the limited biomass (inclusive of biofuels) resources are used in an economical, environmental and culturally sustainable manner.

❖ Clean cook fuels, energy efficiency, gender

- MARSHALL ISLANDS: National Energy Policy and Energy Action Plan 2016-
  - The initiatives on promoting energy efficient biomass stoves for cooking in rural areas should be supported, as they consider the impacts of using biomass for cooking on the health of women and children simultaneously saving the environment.[...]
- INDIA: Unnat Chulha Abhiyan (UCA) Programme 2014-
  - [...]develop and deploy improved biomass cook-stoves for providing cleaner cooking energy solutions in rural, semi-urban and urban areas using biomass as fuel for cooking.---To mitigate drudgery of women and children using traditional chulha for cooking.---To mitigate climate change by reducing the black carbon and other emissions resulting from burning biomass for cooking.---
- BANGLADESH: National Strategy for Sustainable Development 2010-2021
  - Disseminate use of environment friendly cooking stoves to rural households which improve women's health by reducing indoor air pollution and save energy and time.---Popularize biogas stove for reducing dependence on fuel wood.