Water-Energy Nexus

Organization of American States

Washington D.C. March, 2015

What is the Water-Energy Nexus?

Organization of American States

- **The interlinked and interdependency between water and energy.**

  - **Energy** generation processes require significant amounts of **water**.
  - **Water** requires **energy** for treatment and transport.

•Choices made in one domain have direct and indirect consequences on the other, positive or negative.

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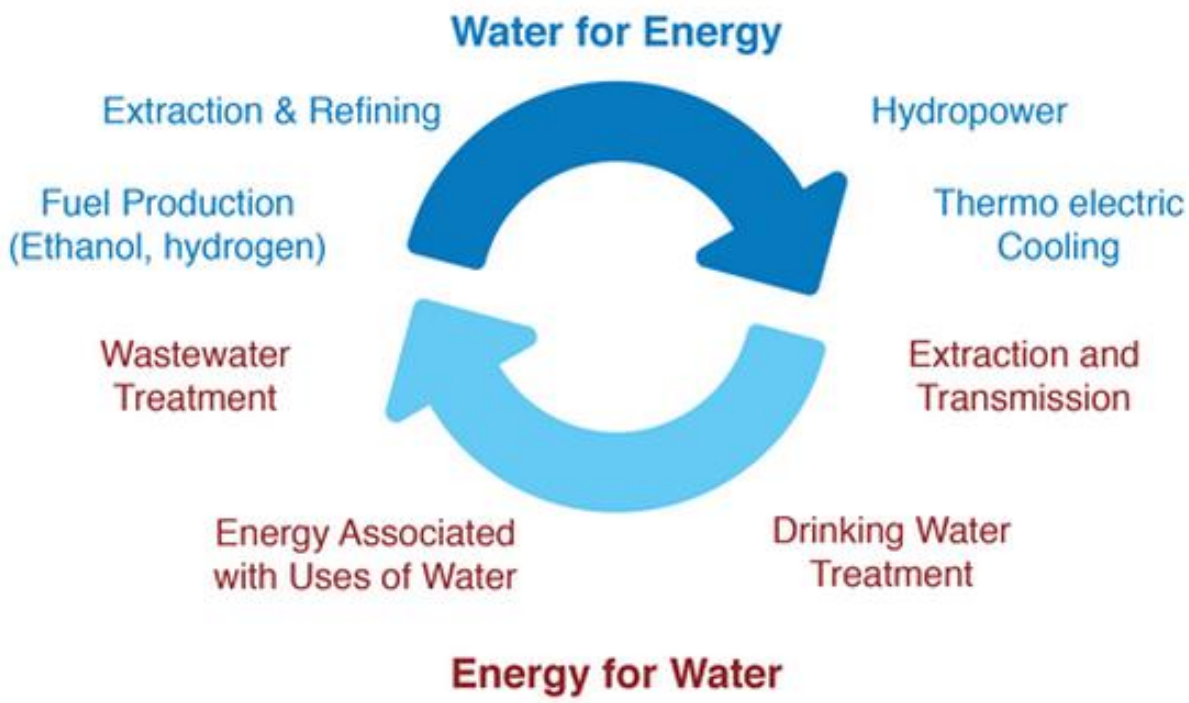

Calandro, T. (2011) The Energy-Water Nexus: An Emerging Risk

What is the Water-Energy Nexus?

Organization of American States

The links and interdependency between water and energy.

Both resources are inextricably linked as almost all energy generation processes require significant amounts of water, and water requires energy for treatment and transport. This relationship is the energy-water nexus.

Addressing the water–energy nexus is vital to drive economic growth and improve human prosperity, particularly in the context of climate change.

Choices made in one domain have direct and indirect consequences on the other, positive or negative. The form of energy production being pursued determines the amount of water required to produce that energy. At the same time, the **availability and allocation of freshwater resources determines how much (or how little) water can be secured for energy production**. Decisions made for water use and management and for energy production can have significant, multifaceted and broad reaching impacts on each other – and these impacts often carry a mix of both positive and negative repercussions. (United Nations, 2014)

Design by Sana Sandler / Courtesy Argonne National Laboratory

Water for Energy

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Water is needed for energy

- Fuel Cycle (extraction and refining)
- Thermoelectric cooling
- Power plant operations
- Transportation
- Biofuels crop
- Hydropower

Design by Sana Sandler / Courtesy Argonne National Laboratory

* The availability and allocation of freshwater determine how much (or how little) water can be secured for energy production.

World Population: a decisive factor

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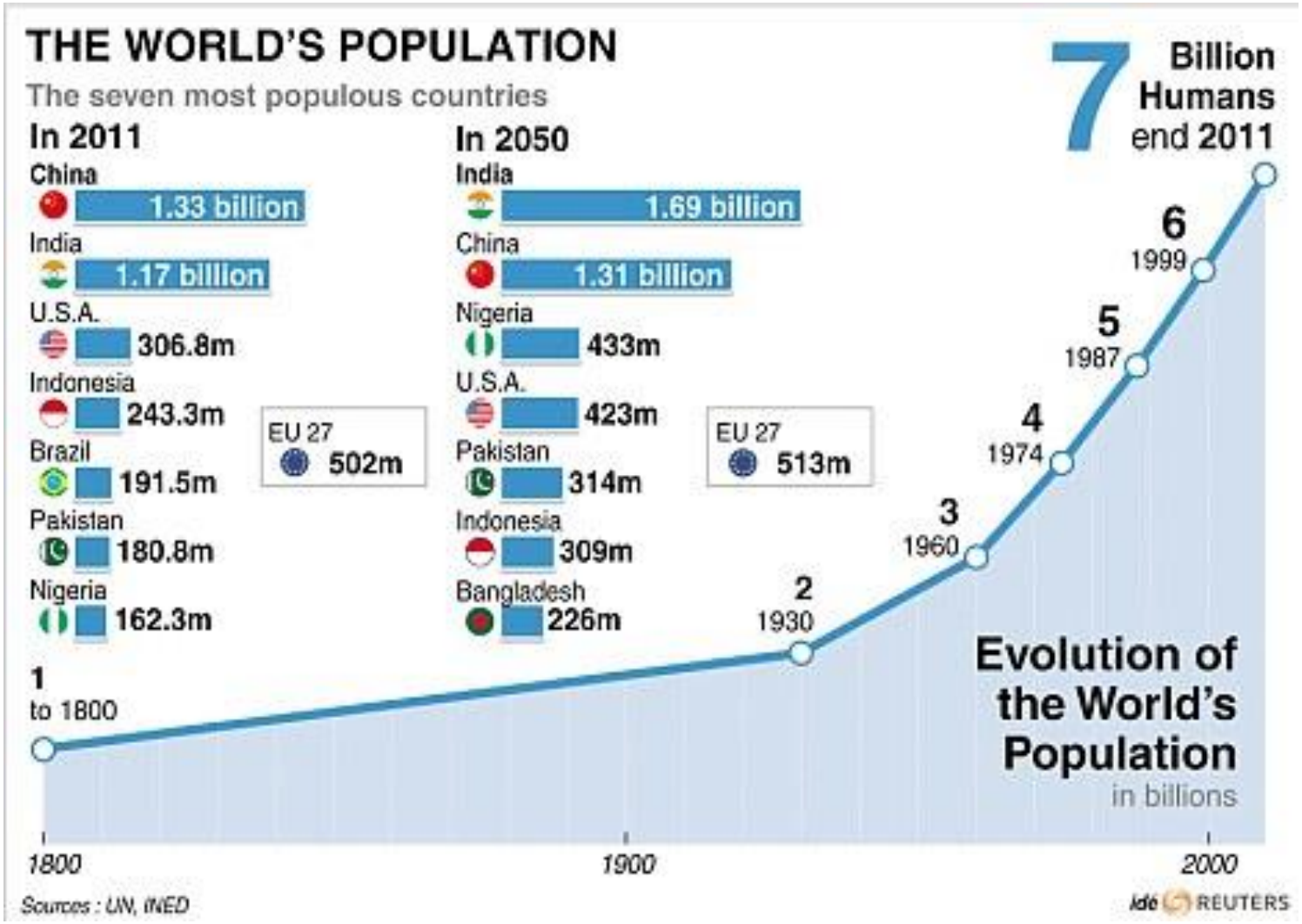

Why W & E nexus is important?

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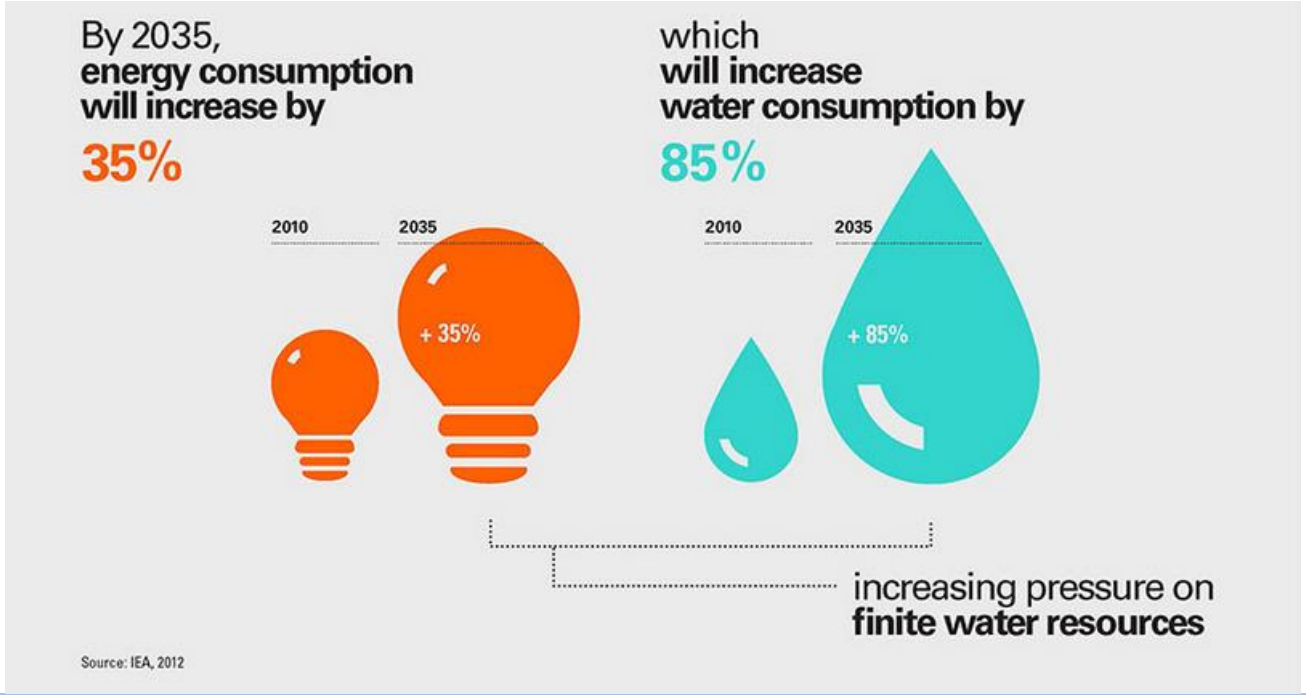
Estimated population growth, if current economical and population patterns remain unchanged:

- 8 billion people by 2035
- 9 billion people by 2050

This means:



World Bank. Thirsty Energy Initiative http://www.worldbank.org/content/dam/Worldbank/Feature%20Story/SDN/Water/Water-Thirsty-Energy-Infographic-FULL-Vertical-900.jpg

Water Availability vs. Population

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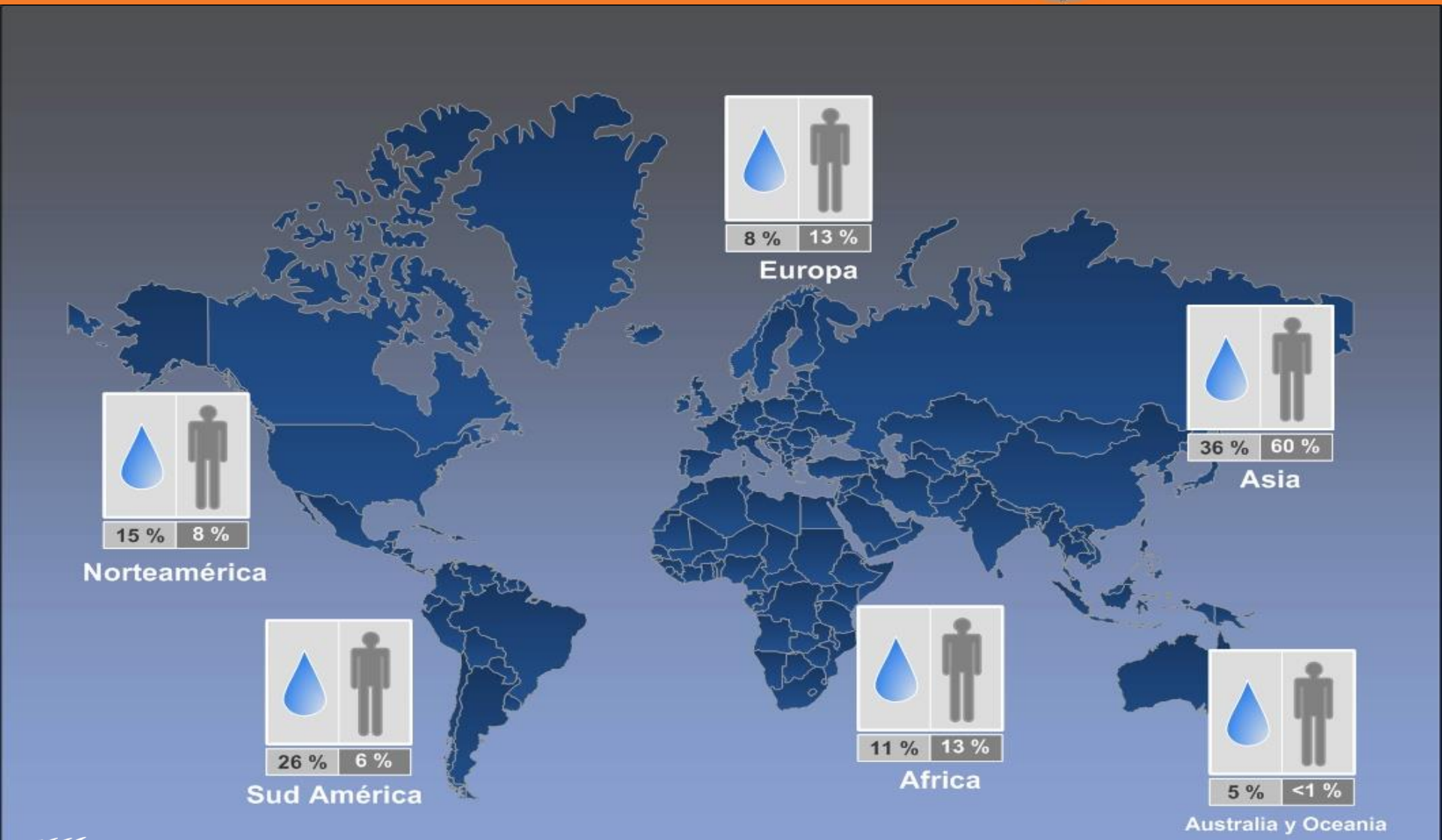
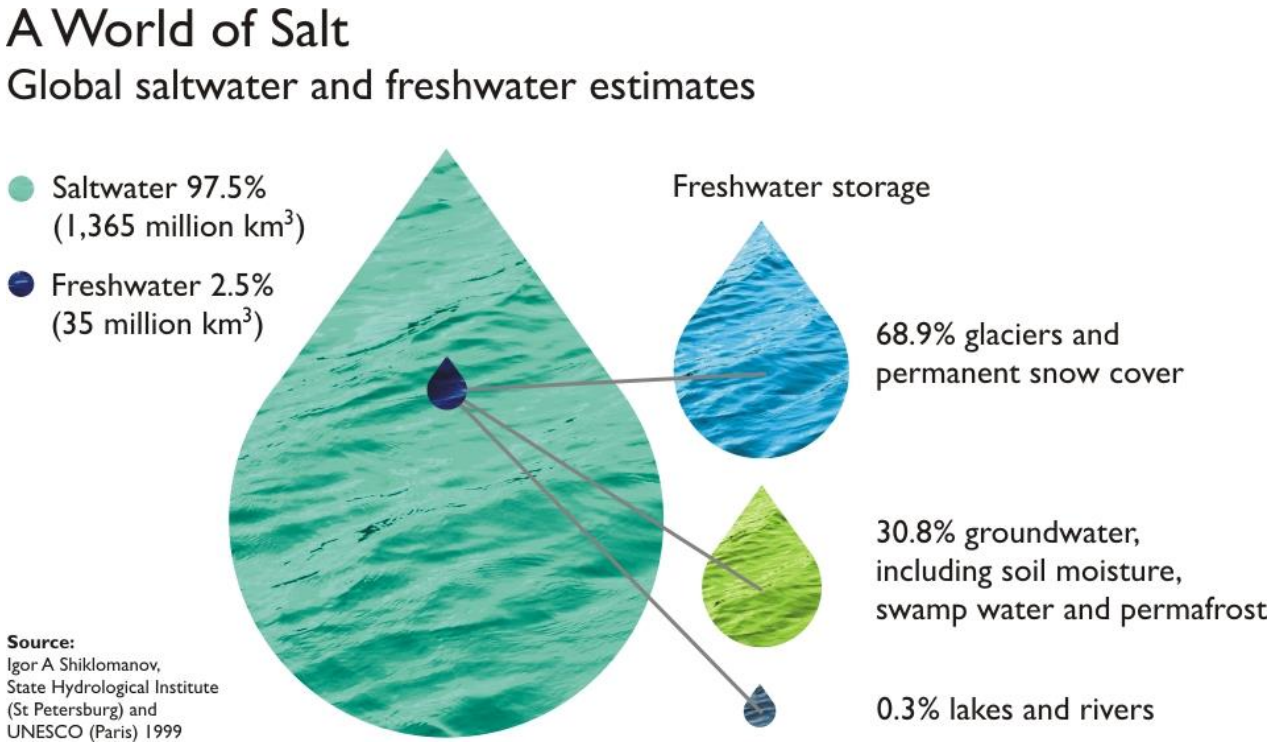


WASA-GN
Water Assessment & Advisory Global Network

Water challenges Worldwide

Organization of American States

Increasing urbanization and economic growth provide significant benefits, but also pose a range of challenges especially for water quantity and quality:

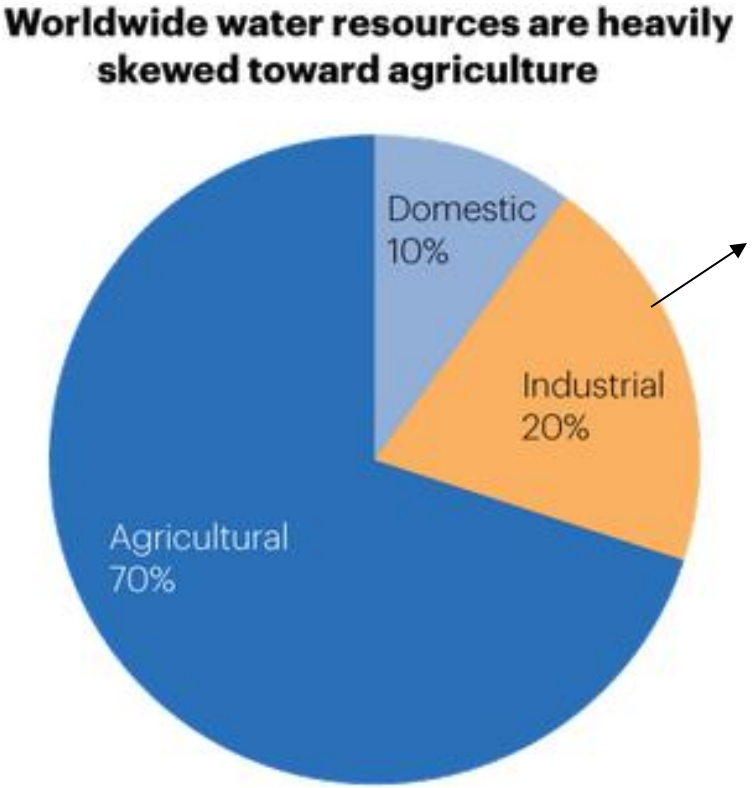


Igor A Shiklomanov (1999). State Hydrological Institute (St Petersburg) and UNESCO (Paris)

Water-Energy challenges Worldwide

Organization of American States

• Water is a vital component but there is an **intense competition for water** among other sectors and stakeholders.



United Nations Educational, Scientific and Cultural Organization (UNESCO)

• **Climate Change** adaptation is primarily about water: droughts, floods and changes in precipitation and their implication for water availability and subsequently energy.

* International Energy Agency (IEA) 2010 estimation

Water-Energy & Climate Change

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Water-Energy challenges are Climate Change driving forces

1. **Population growth**: seen as the root of climate changes, it creates more consumer demand for resources, including water (drinking water, health & sanitation, food and energy).

2. **Technological development**: along with population growth demand more energy and materials.

3. **Economic growth**: leds to more water and energy demand. In the next 15 years a 50% increase in economic growth is expected.

4. **Governance and institutions**: may favor activities that cause climate change by not having the right incentives for greener initiatives or by subsiding water and energy the resources may be used incorrectly.

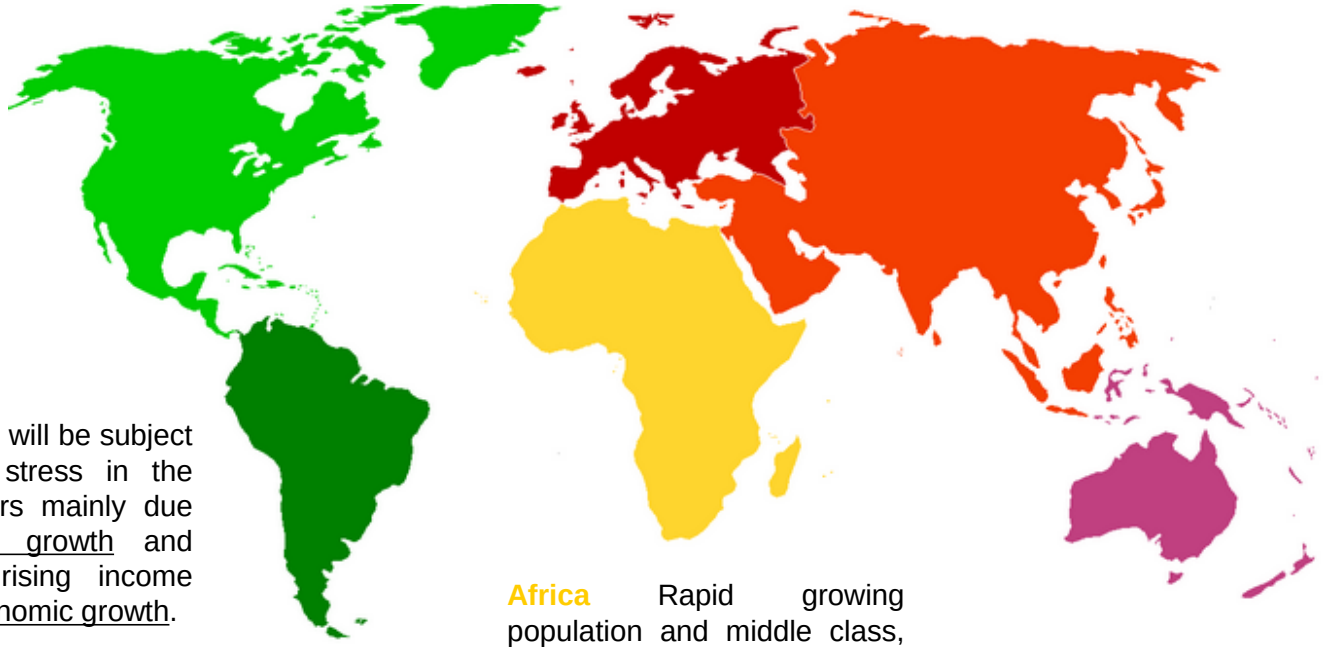
5. **Attitudes and believes**: increasing standards of living translates to high consumption patterns, specially within the middle class (2,500 million people are expected to belong to the middle class in the next 15 years).

Water-Energy Nexus perspective by region

Organization of American States

In **Europe** water and energy policies are not sufficiently integrated, resulting in neglecting interconnected effects. Furthermore, economic incentives to adopt efficient water and energy technologies are inadequate.

In **Asia** there is a wide existing evidence on water scarcity, partly because of increasing wealth in China and India, resulting changes in lifestyle and consumption.



The Americas will be subject to increased stress in the upcoming years mainly due to population growth and urbanization, rising income levels and economic growth.

Africa Rapid growing population and middle class, highest rate of urbanization on Earth / 1 of 4 workers by 2050 will be African).

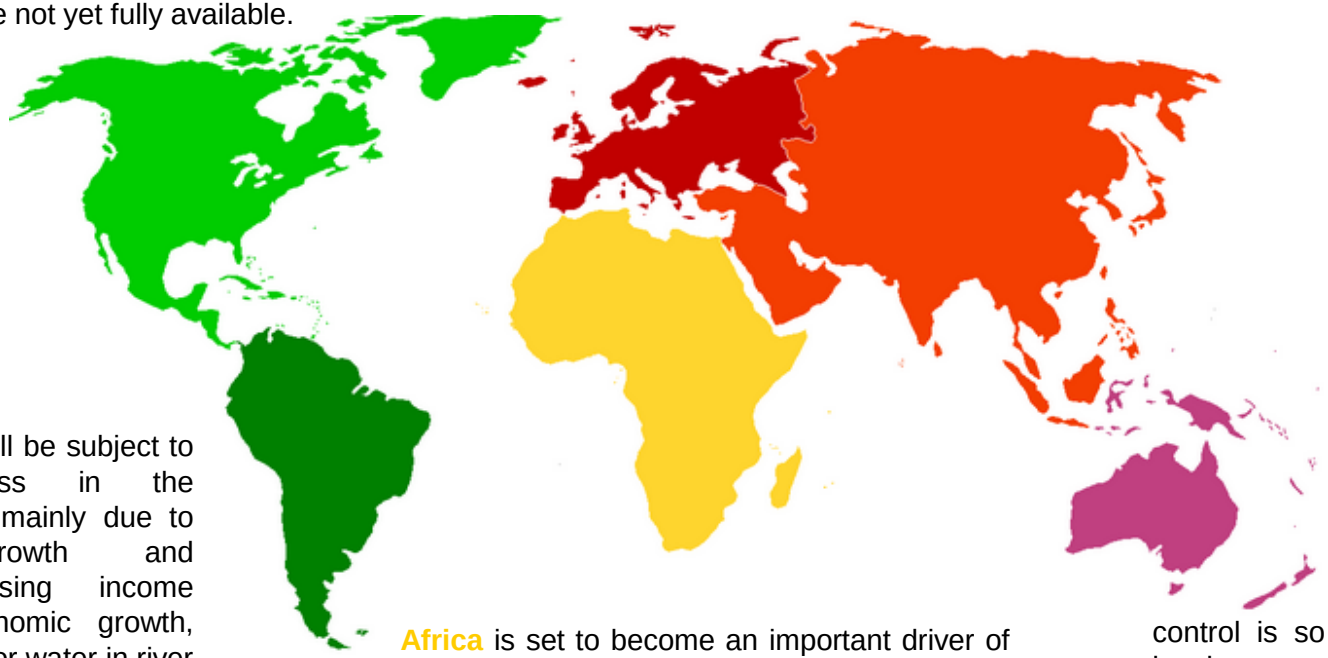
Oceania, in Australia planning for water sensitive cities has become a priority for sustainable urban development.

Water-Energy Nexus perspective by region

Organization of American States

In **Europe** water and energy policies are not sufficiently integrated, resulting in neglecting interconnected effects. Furthermore, economic incentives to adopt efficient water and energy technologies are inadequate. Water and wastewater processes lack low energy technologies, whereas the application of renewable energy is hindered by low efficiency. And efficient and cost-effective technologies to recover energy from wastewater are not yet fully available.

In **Asia** there is a wide existing evidence on water scarcity, partly because of increasing wealth in China and India, resulting changes in lifestyle and consumption. At the sate time the growing urban middle class has emerge as a result of the economical growth, and is now requiring more energy and water because of their new consumption patterns.



The Americas will be subject to increased stress in the upcoming years mainly due to population growth and urbanization, rising income levels and economic growth, and competition for water in river basins; all this added in the context of climate change.

Africa is set to become an important driver of global resource demand, in a fashion similar to East Asia. (rapid growing population and middle class, highest rate of urbanization on Earth/ 1 of 4 workers by 2050 will be African).

- 90% of agricultural farming depends on rainwater.

Oceania, in Australia planning for water sensitive cities has become a priority for sustainable urban development. Meanwhile in New Zealand there is a Zero Waste Strategy, that states that because legislation waste control is so new and at a local level, an educational campaign was set to educate local authorities. It is stated that 72% of local authorities have adopted the Zero Waste Strategy but the lack of legislation support has caused some frustration.

Water-Energy constraints Worldwide

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Water constraints are already impacting energy production around the world, including in:

- **South Africa**
- **United States**
- **India**
- **Australia**
- **Brazil**

Between 2000-2015, this countries were forced to shut down, reduce power generation or change cooling systems in power plants due to lack of water resources.

In some cases, power generation was insufficient and cuts in energy consumption was order by the government.

Water-Energy success cases Worldwide

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India: Gujarat region

Nexus: redistributing electrical power and using “intelligent rationing”.

Method: 2 power supplies
- for villages (24 hrs)
- for irrigation (8 hrs uninterrupted full voltage power)

Results
-reliable supply of water during critical periods
- annual growth in agricultural GDP of 9.6%

Kenya

Nexus: payments for ecosystem services to support land and water management.

Method
-Financial mechanisms
-Soil and water conservation measures

Results
- improved land and water management by improving water quality and reducing erosion and sedimentation.

Jordan

Nexus: an efficient energy use of its water supply and wastewater treatment.

Method
-Wastewater recycling
- Low-energy pumps
- Renewable energy production (specially solar)

Results
- Generate 20% of energy demand from water pumping.

Water-Energy Nexus in the Americas

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Water availability in the Americas

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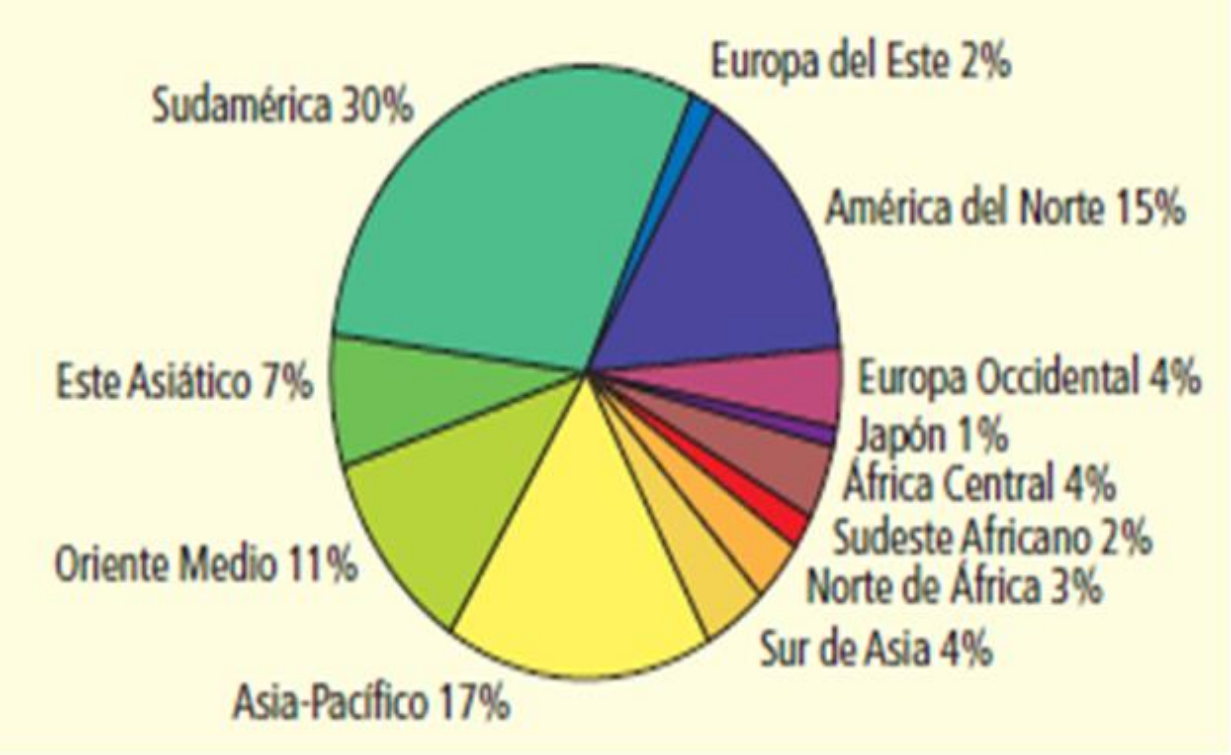
The Americas has 45% of the water resources in the world, it has the highest availability in compared to the rest of the regions in the world.



SASI Group (University of Sheffield) and Mark Newman (University of Michigan) 2006 available in the presentation of Colombia's OAS Ambassador Andrés Gonzalez Diaz "LA IMPORTANCIA DE LA RESOLUCIÓN AG/RES. 2780 (XLIII-O/13) "PROMOVIENDO LA GESTIÓN INTEGRADA DE LOS RECURSOS HÍDRICOS EN LAS AMÉRICAS"

Hydropower in the region

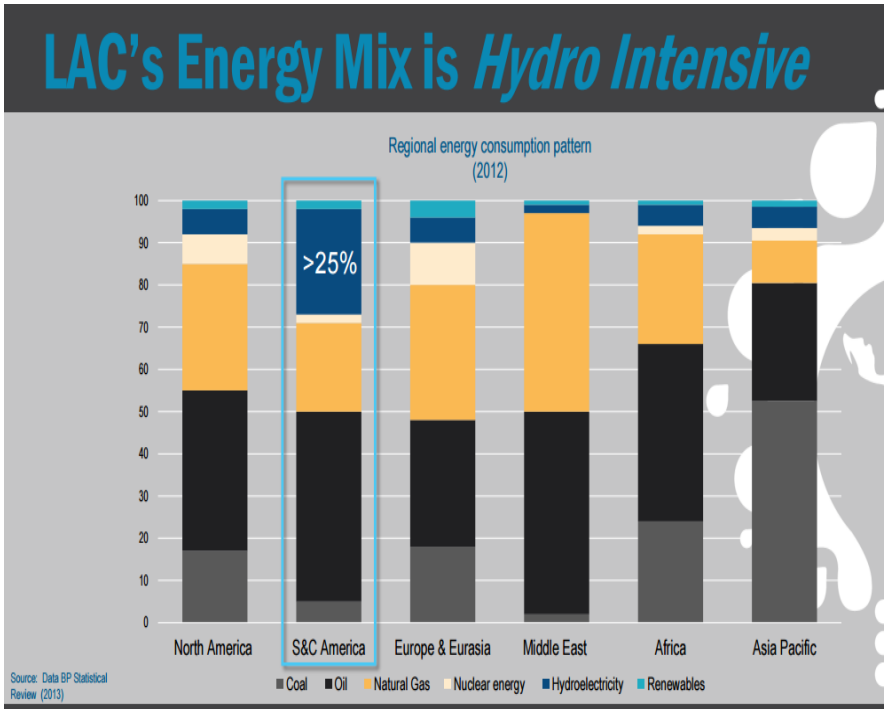
Organization of American States

The Americas is the region with the most hydropower intensity in the world, more than 25% of it's energy is hydro generated, thereby energy availability is highly dependent on water.

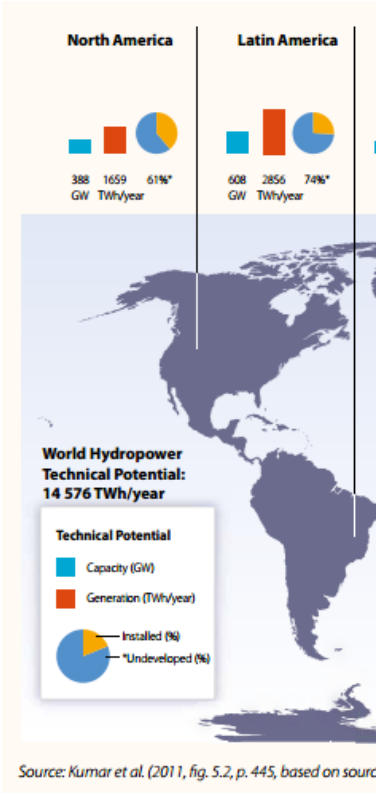
Hydropower provides some 65% of all electricity generated (even more in Brazil, Colombia, Costa Rica, Paraguay and Venezuela)

In 2011, hydroelectricity accounted for 11% of the total primary energy supply in 12 countries of the region (higher than the sector's 2% share of the world total).

Yet less then 30% of the region's hydropower potential has been developed.



Garrón M. (2014) Latin America's Water-Energy Nexus: Harnessing the Power of GIS and geospatial data



The United Nations World Water Development Report 2014

Hydropower in the region

Organization of American States

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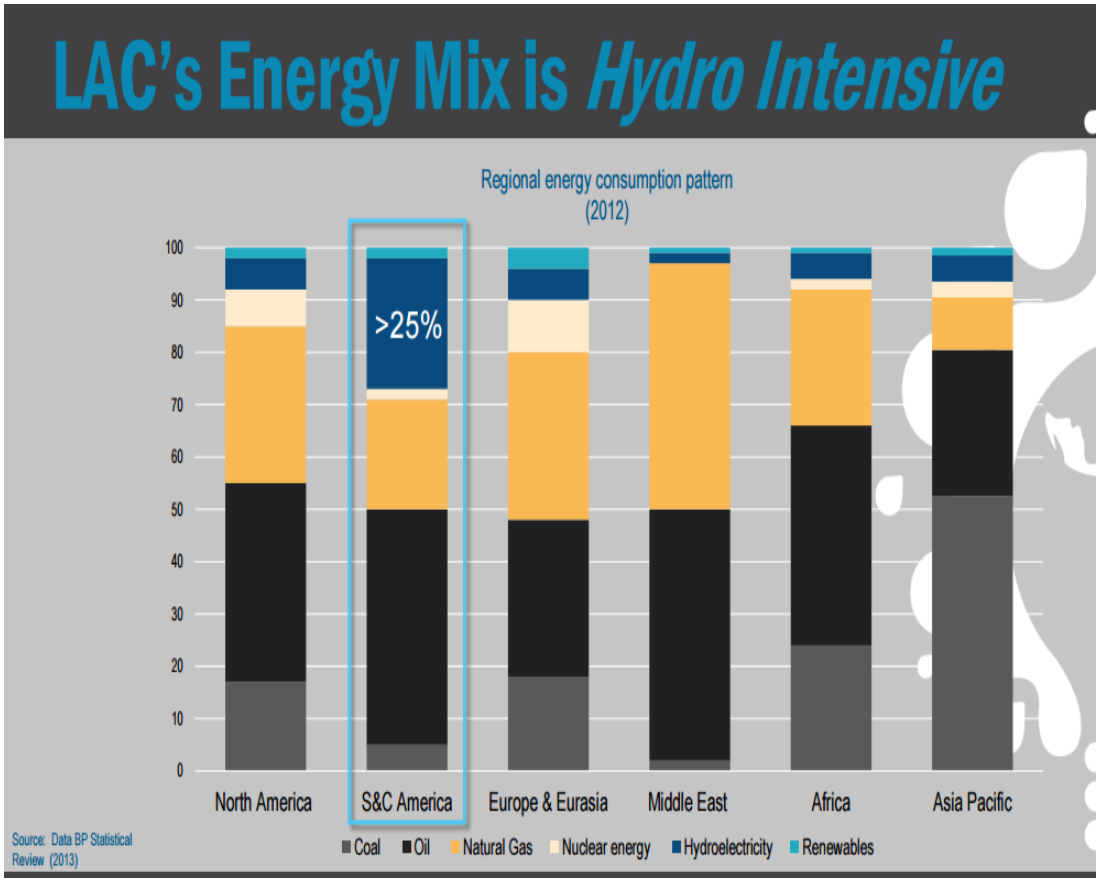

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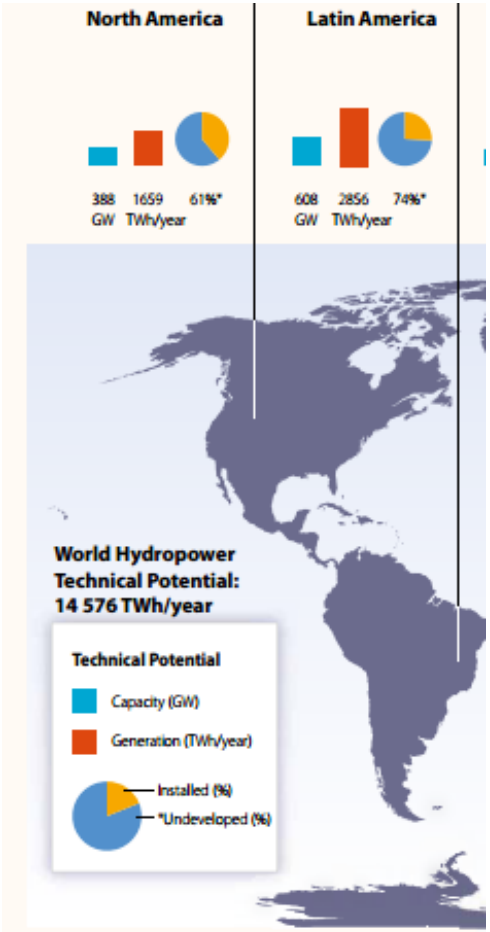

The United Nations World Water Development Report 2014

Water scarcity in the Americas

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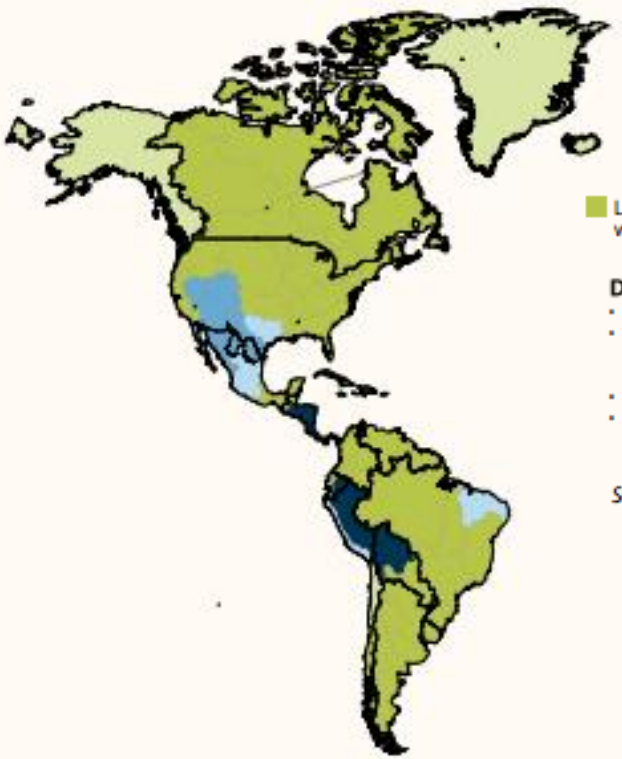
Although the Americas has 45% of the water resources in the world, there are regions that are suffering from water scarcity.



Little or no water scarcity | Physical water scarcity | Approaching physical water scarcity | Economic water scarcity | Not estimated

Definitions and indicators

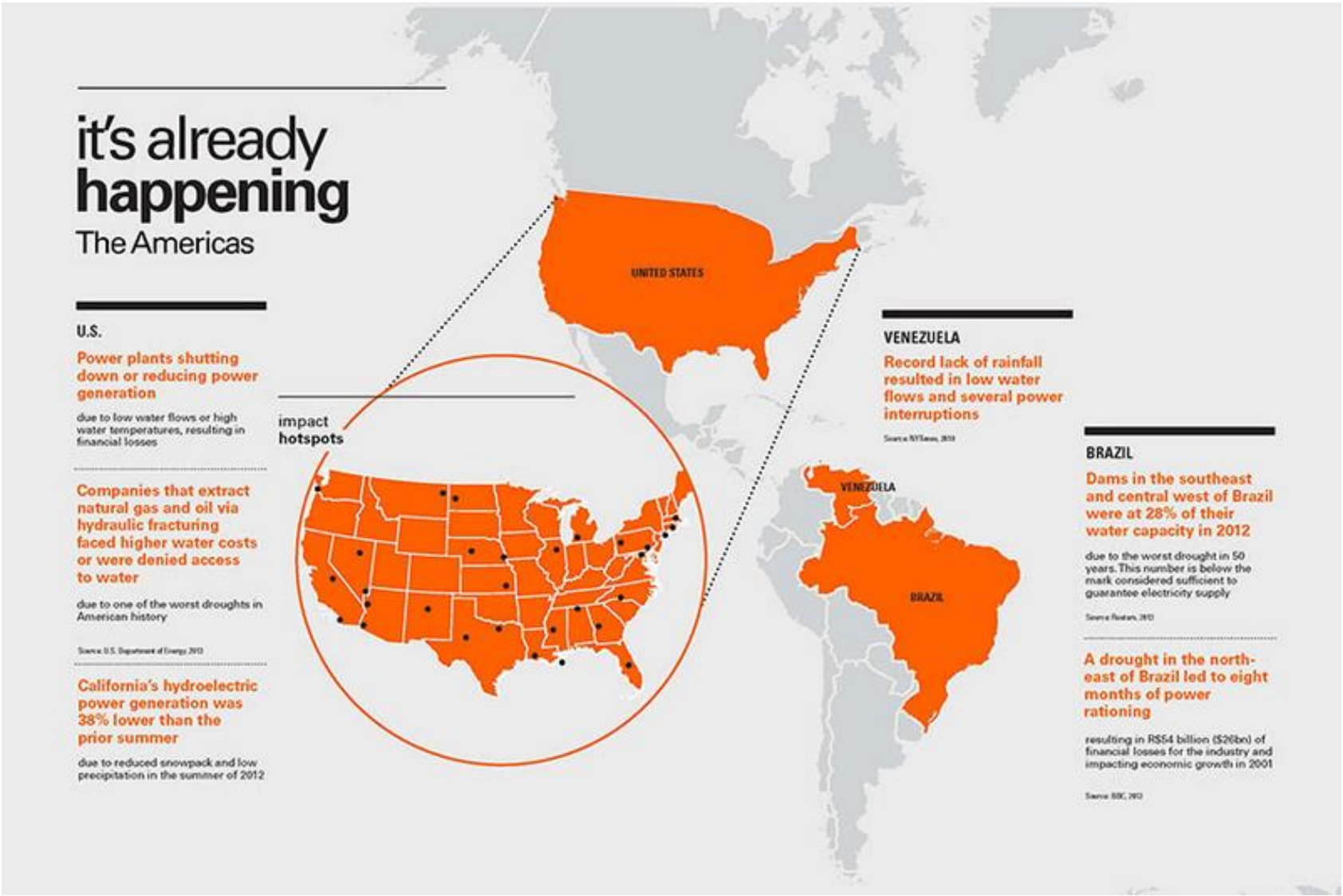
- Little or no water scarcity. Abundant water resources relative to use, with less than 25% of water from rivers withdrawn for human purposes.
- Physical water scarcity (water resources development is approaching or has exceeded sustainable limits). More than 75% of river flows are withdrawn for agriculture, industry and domestic purposes (accounting for recycling of return flows). This definition – relating water availability to water demand – implies that dry areas are not necessarily water scarce.
- Approaching physical water scarcity. More than 60% of river flows are withdrawn. These basins will experience physical water scarcity in the near future.
- Economic water scarcity (human, institutional and financial capital limit access to water even though water in nature is available locally to meet human demands). Water resources are abundant relative to water use, with less than 25% of water from rivers withdrawn for human purposes, but malnutrition exists.

Source: Comprehensive Assessment of Water Management in Agriculture (2007, map 2, p. 11). © IWMI, used under licence.

The United Nations World Water Development Report (2014). Water and Energy Volume I

Water- Energy threats in the region

Organization of American States



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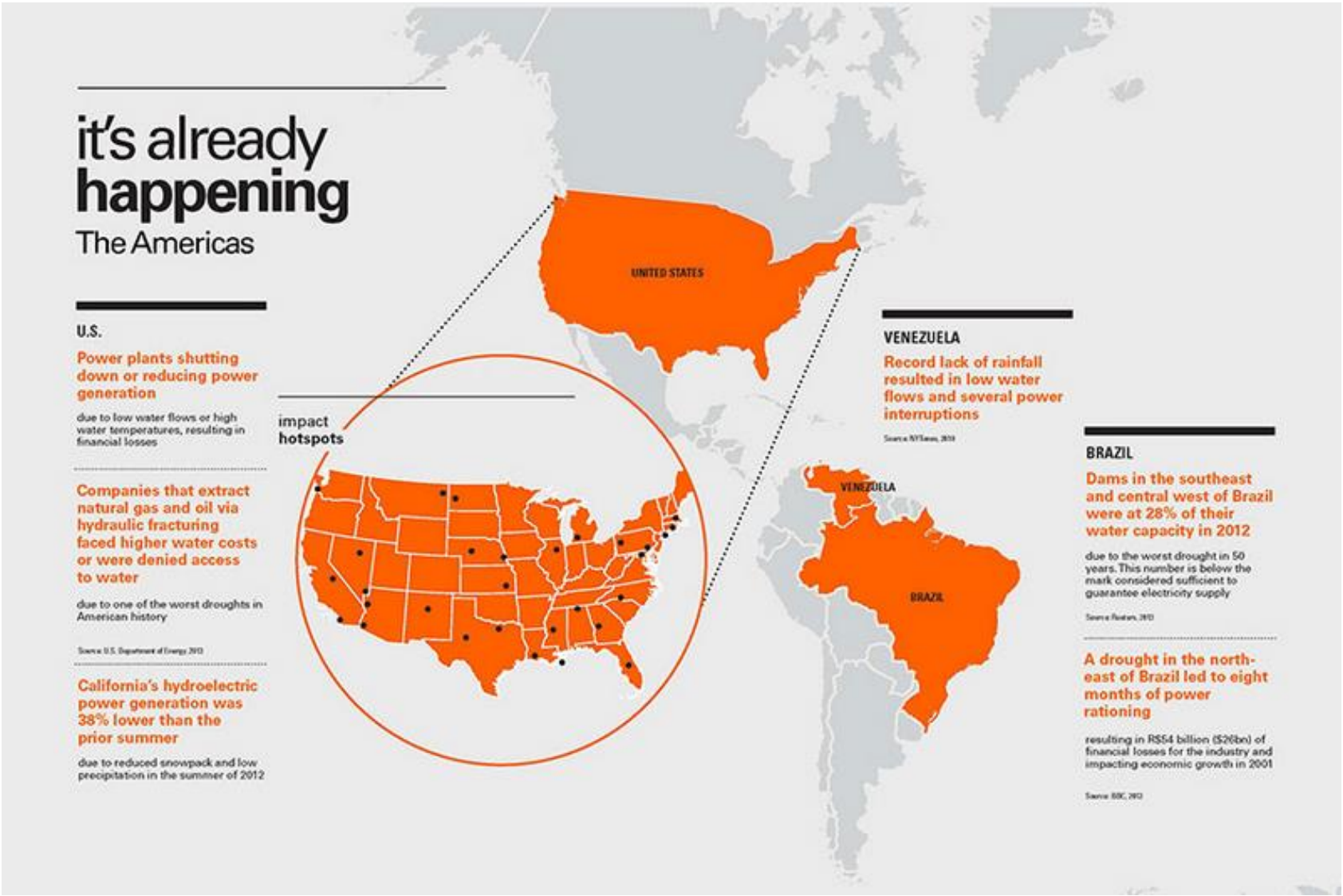
Water- Energy threats in the region

Organization of American States



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Why is it important?

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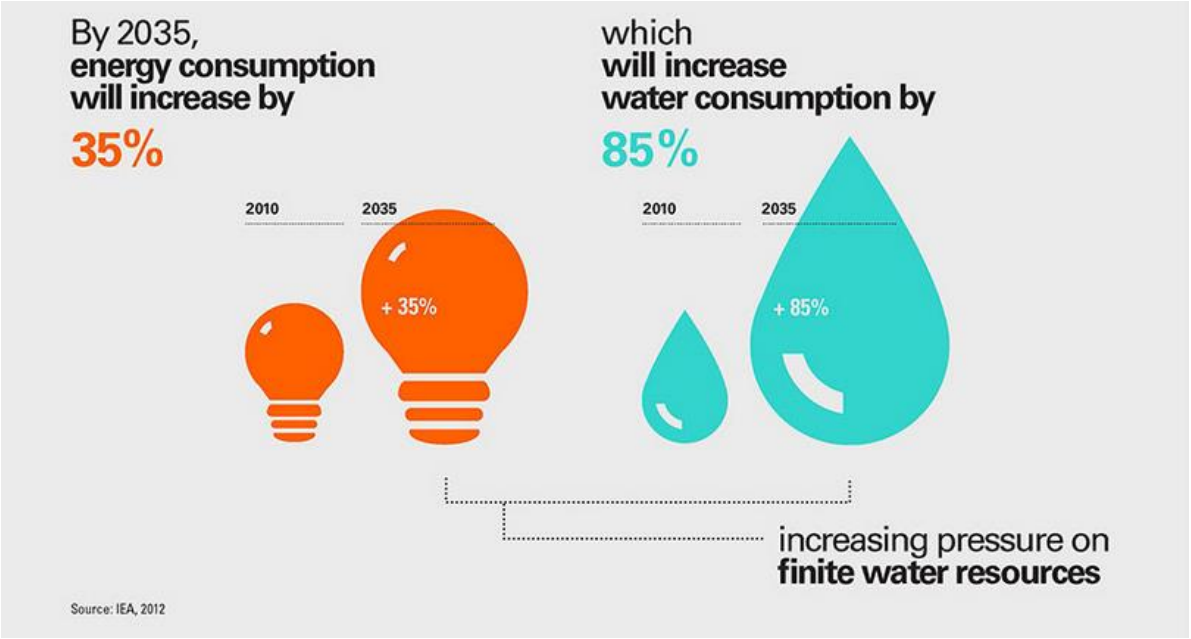
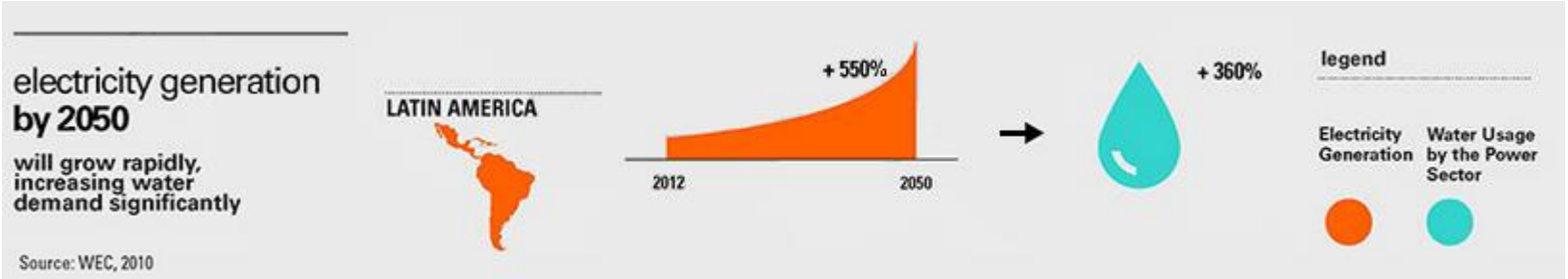
Estimated population growth if current economical and population patterns remain unchanged:
8 billion by 2035 and 9 billion by 2050. this means:





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Water-Energy challenges in the Americas

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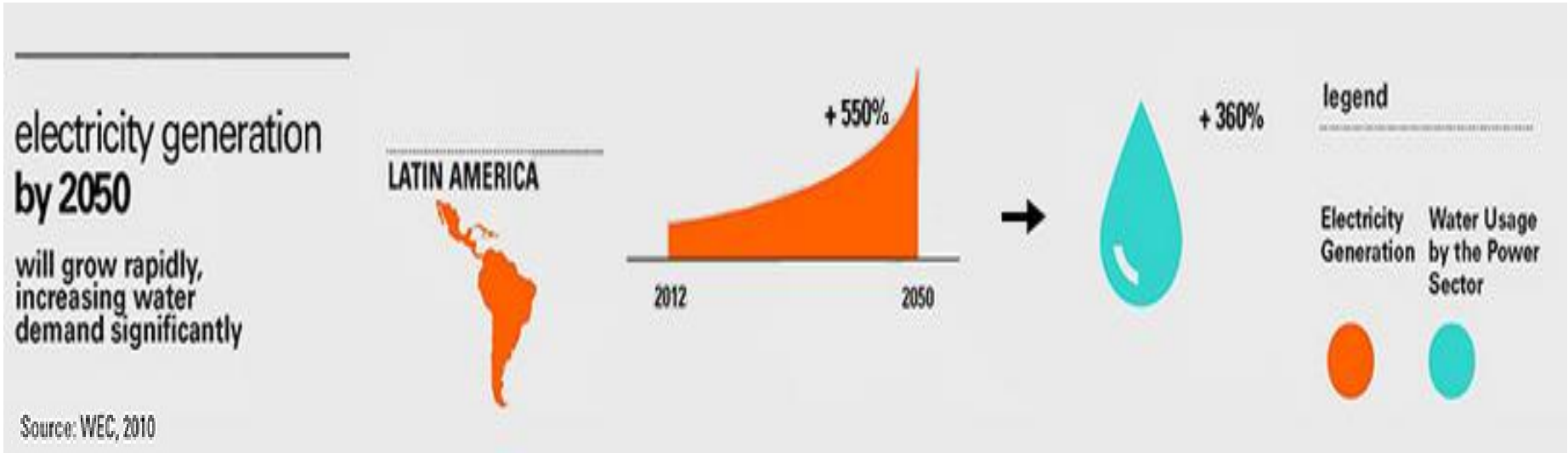

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Water-Energy challenges in the Americas

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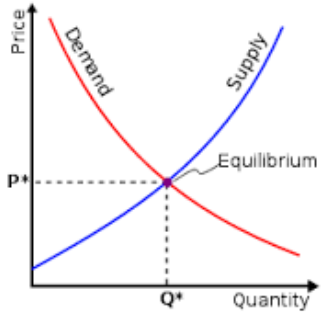
As the rest of the world

- demand-supply
- population growth
- increased standards of living
- climate change



• **Hydropower** also play a central role in the expansion plans of many countries but climate change is **threatening** water's availability in the region and therefore water for health, sanitation, agriculture and energy security.

• **Decision and policy makers in the region are poorly informed** about policy tradeoffs between water and energy, and this is much needed in order to achieve a better understanding of water scarcity issues and future energy needs. The current water-energy decision-making landscape is complex and fragments. Water and Energy policies have been developed independently from one another .The absence of integrated planning between these two sectors is socio-economically unsustainable.

Water-Energy challenges in the Americas

Organization of American States

- demand-supply
- population growth
- increased standards of living
- climate change

• **Hydropower** which plays a central role in many countries of the Americas is threaten by climate change.

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A key stakeholder: The OAS

Organization of American States

The Organization of the American States as the Organization of the Americas hold the responsibility of working together with policy and decision makers in order to strengthen the interaction and collaboration within a local, national and regional level in regards of the water-energy nexus.

The OAS is working thought these key components:

- Dialogs (to strength outreach and awareness)
- Information exchange (for better collaboration among its State Members)
- Good practices (thought regional case studies and intelligent networks)
- Integration (within countries, and integration models)
- Efficiency (water efficient energy systems and energy efficient water systems)
- Vulnerability reduction (thought it's water and energy programs)

When interaction, integration and collaboration is reached, this will enable more effective development, technologies, policies and inform decision-making in favor of a secure water-energy nexus that will promote economical and social development for the Americas.

OAS Country Offices in the Member States (2015) http://www.oas.org/en/about/offices.asp

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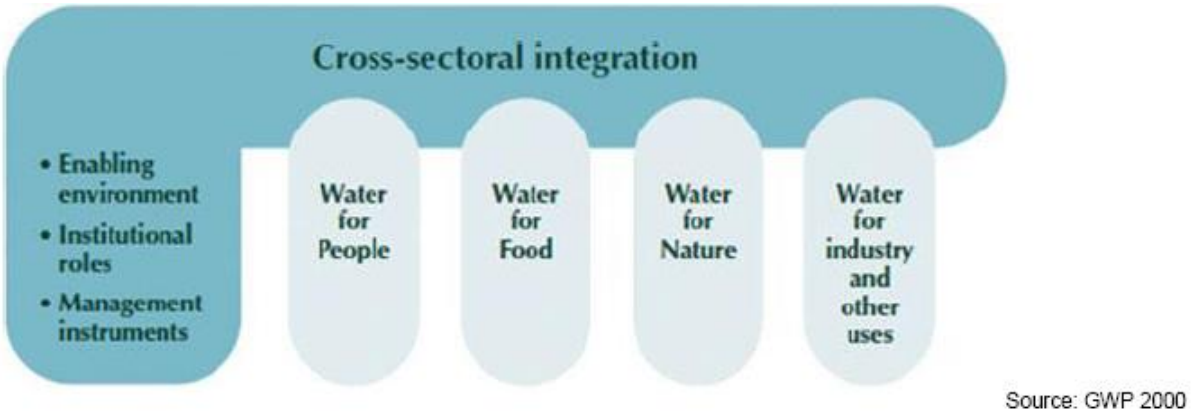

IUCN & IWA (2013). Nexus Dialogue on Water Infrastructure Solutions Latin America.

•**Population growth** increases consumer demand for water (drinking water, health & sanitation, food and energy).

• Economic growth leads to **increasing standards of living** which demand more water and energy, most notably by middle income households in developing and emerging economies.

• **Climate Change** has a profound effect on water (droughts, floods, changes in precipitation, etc. and their effect on water availability and subsequently on energy).

• **Water demand** for energy will increase as energy demand is expected to increase by more than one-third in the period 2010–2035.

Water-Energy constraints Worldwide

Organization of American States

The International Energy Agency (IEA) estimated that global water withdrawals for energy production in 2010 accounted for roughly 15% of the world's total (IEA 2012a), or roughly 75% of all industrial water withdrawals.

Water constraints are already impacting energy production around the world, including in:

1. South Africa: Lack of sufficient water resources in South Africa have forced all new power plants to shift to dry cooling systems, which cost more to build and are less efficient than water-cooled systems.

2. North America: In the United States, a number of power plants were forced to shut down or reduce power generation due to low water flows or high water temperatures, resulting in significant financial losses. In 2012, California's hydroelectric power generation was 38% lower than the prior summer due to reduced snowpack and low precipitation.

3. India: Last year in India a thermal power plant was forced to shut down because of severe water shortages.

4. Australia: During one of the worst droughts in 1,000 years, three coal power plants had to reduce electricity production to protect municipal water supplies in 2007.

5. Brazil: 2001 energy crisis due to a drought, in a country that is 60-70% dependent on hydroelectric dams; the government reacted by ordering a 20% cut in energy consumption.

Water-Energy Nexus in the Americas

Water perspective

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What to do?

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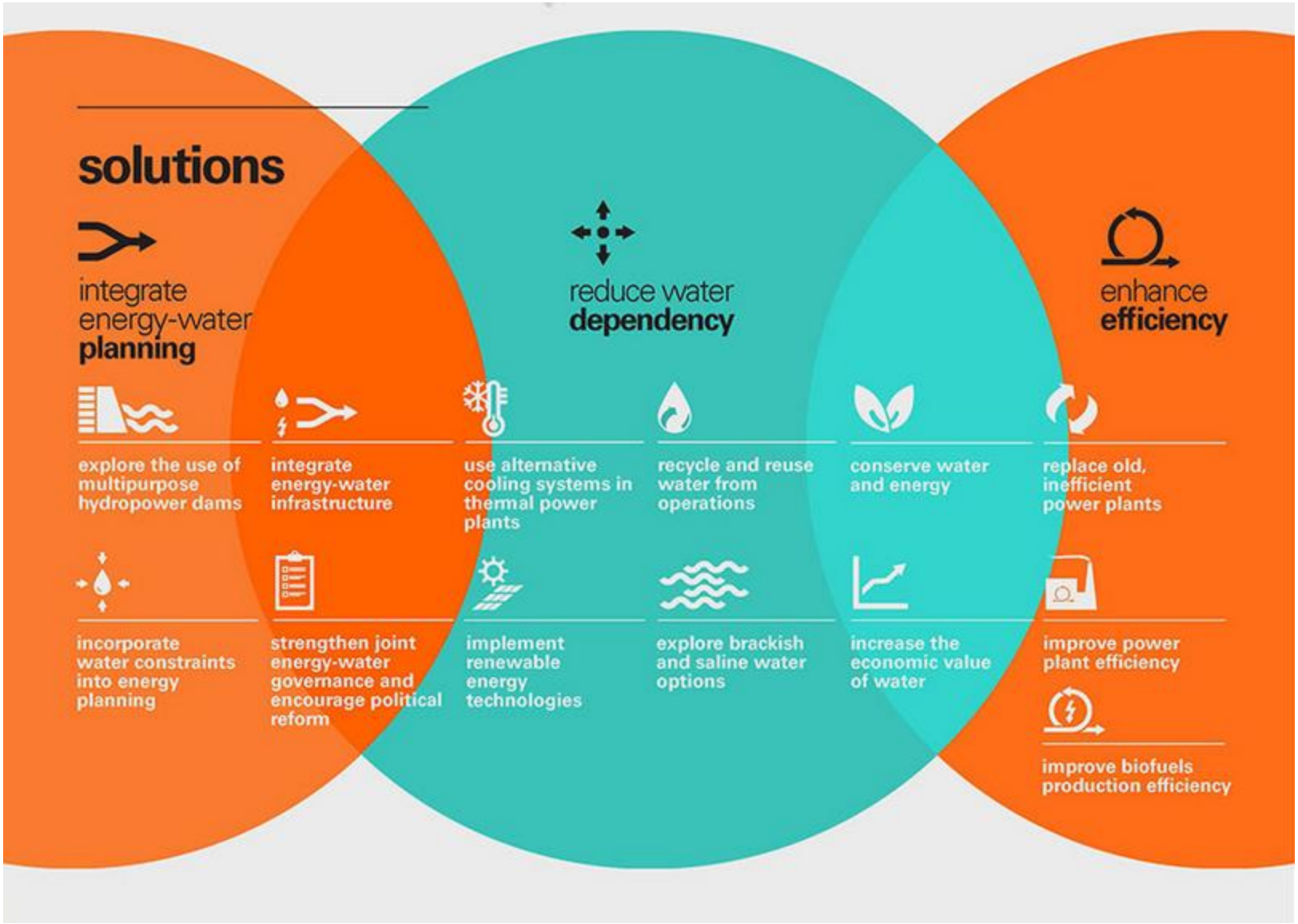

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Water-Energy involved agencies

Organization of American States

	Organization/Agency	Documents/Meetings
1	Asian Development Bank (ADB)	Asian Water Development Outlook 2013: Measuring Water Security in Asia and the Pacific; A Safe Space for Humanity: The Nexus of Food, Water, Energy and Climate, 2014
2	Asia-Pacific Center for Water Security, Tsinghua and Pekin Universities	Established a regional program on R&D on WFE security
3	Atlantic Council, Africa Center	Addressing the Food, Water, and Energy Nexus, Transatlantic Perspective and Africa's Great Chance, 2014
4	Banco de Desarrollo de America Latina (CAF)	The Water-Energy Nexus in Latin America & Flood Mapping in near-real- time, 2014
5	Department of Energy (DOE) / United States	The Water-Energy Nexus: Challenges and Opportunities, 2014
6	DHI the former Danish Hydraulic Institute	collaborates with IWA in the Floods and Droughts Management Tools
7	Federal ministry for the Environment, Natural Conservation, Building and Nuclear Safety (German government)	Bonn 2011 Nexus Conference, complete website with Initiatives and nexus in practice & collaborates with IWA in The Water and Wastewater Companies for Climate Mitigation project
8	Food and Agriculture Organization of the United Nations (FAO)	The Energy and Agriculture Nexus. 2000. Energy and Natural Resources Working Paper No.4
9	GIZ Deutsche Gesellshaft fur Internationale Zusammenarbeil GmbH	Bonn 2011 Nexus Conference, complete website with Initiatives and nexus in practice & collaborates with IWA in The Water and Wastewater Companies for Climate Mitigation project
10	Global Environment Facility (GEF)	collaborates with IWA in the Floods and Droughts Management Tools
11	International Energy Agency	World Energy Outlook 2012
12	International Food Policy Research Institute	A co-organizer of the Bonn 2011 Nexus Conference
13	International Union for Conservation of Nature (IUCN)	3 Nexus Dialogue on Water Infrastructure Solutions in Africa, Latin America and Asia, 2013-2014
14	International Water Management Institute (IWMI)	Environmental Livelihood Security in Southeast Asia and Oceania, a Water-Energy-Food-Livelihood Nexus Approach for Spatially Assessing Change, 2014
15	Stockholm Environment Institute	Prepared the background paper for Bonn 2011 Nexus
16	The International Water Association (IWA)	3 Nexus Dialogue on Water Infrastructure Solutions in Africa, Latin America and Asia, 2013-2014
17	The World Bank (WB)	Overcoming Barriers to International Cooperation of River Basing Critical for Food, Water, Energy Security
18	Transatlantic Academy	The Global Resource Nexus: The Struggles for Land, Energy, Food, Water and Minerals
19	United Nations Conference on Sustainable Development	Outcome document "The Future We Want"
20	United Nations Economic and Social Commission for Asia and the Pacific (UN ESCAP)	Low Carton Green Growth Roadmap for Asia and the Pacific, 2012 ; Water, Food and Energy Nexus in Asia and the Pacific, 2013
21	United Nations Environment Programme (UNEP)	collaborates with IWA in the Floods and Droughts Management Tools
22	Water Services Association of Australia	Energy-Water Nexus The Australian Experience
23	World Wildlife Organization (WWF)	Climate change, the Food Energy Water Nexus and food security in South Africa, 2014

Initial Source UNESCAP, Water, Food and Energy Nexus in Asia and the Pacific, 2013

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