ITU-SUDACAD Regional Forum on Internet of Things for Development of Smart and Sustainable Cities

Khartoum, Sudan 13-14 Dec 2017

Emerging and Environmental Trends and Challenges of Water Resources in Smart Cities

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ITU expert

Outline:

The Water Cycle

Is there enough Renewable Freshwater Resources (RFWR)?

Smart Management of the Fresh Water Resources (Conventional and Non- Conventional Water Resources)

Conventional Water Resources

- Surface water (Fresh & Saline)
- Groundwater

Non-Conventional Water Resources

- Frozen water (Icebergs)
- Rainwater harvesting & flood management
- Recycle of the residential water (black and greywater)
- Smart water irrigation, smart water agriculture, smart water industry
- Reforming water policies

Integrated Water Resource Management (IWRM)

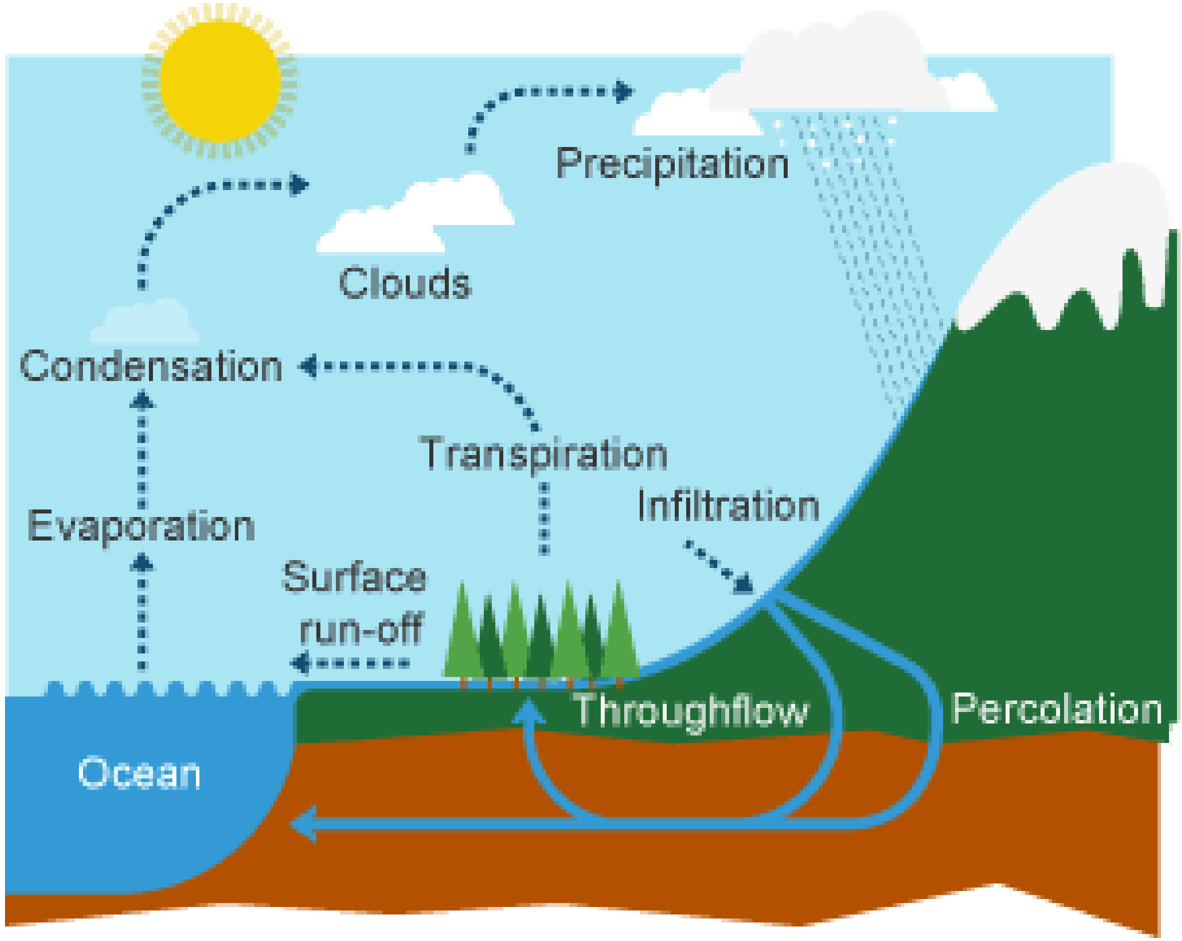
Case Study (South Korea)

The Water Cycle

The water on the Earth flows from the atmosphere to the ground. And then from the rivers to the sea, from where it returns to the atmosphere.

Horizontal Flows: Water runoff on the surface.
Vertical Flows: Water infiltration and evaporation.

Blue Water: Surface water and groundwater
Green Water: Soil water, available for plants
White Water: Atmospheric water



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The Water Cycle

Collocation	Area covered [$10^6 km^2$]	Volume [$10^6 km^3$]	%	% of fresh water
Oceans	361.300	1.338	96.5	-
Groundwater	134.8	23.4	1.7	-
Fresh grundwater		10.530	0.76	30.1
Soil humidity	82	0.0165	0.001	0.05
Perennial ice and snow	16.2275	24.0641	1.74	68.7
Antarctic	13.980	21.600	1.56	61.7
Greenland	1.8024	2.340	0.17	6.68
Arctic islands	0.2261	0.0835	0.006	0.24
Mountain areas	0.224	0.0406	0.003	0.12
Permafrost	21	0.3	0.022	0.86
Water in lakes	2.0587	0.1764	0.013	-
Fresh water in lakes	1.2364	0.091	0.007	0.26
Salt water in lakes	0.8223	0.0854	0.006	-
Lagoons and swamps	2.682.6	0.01147	0.0002	0.006
Rivers	148.8	0.00212	0.0002	0.0006
Water in living beings	510	0.0012	0.0.0001	0.0003
Water in the atmosphere	510	0.0129	0.001	0.04
Water total	510	1385.98561	100	-
Fresh water total	148.8	35.02921	2.53	100

Data Source: Global Change in the Geosphere-Biosphere, NRC.

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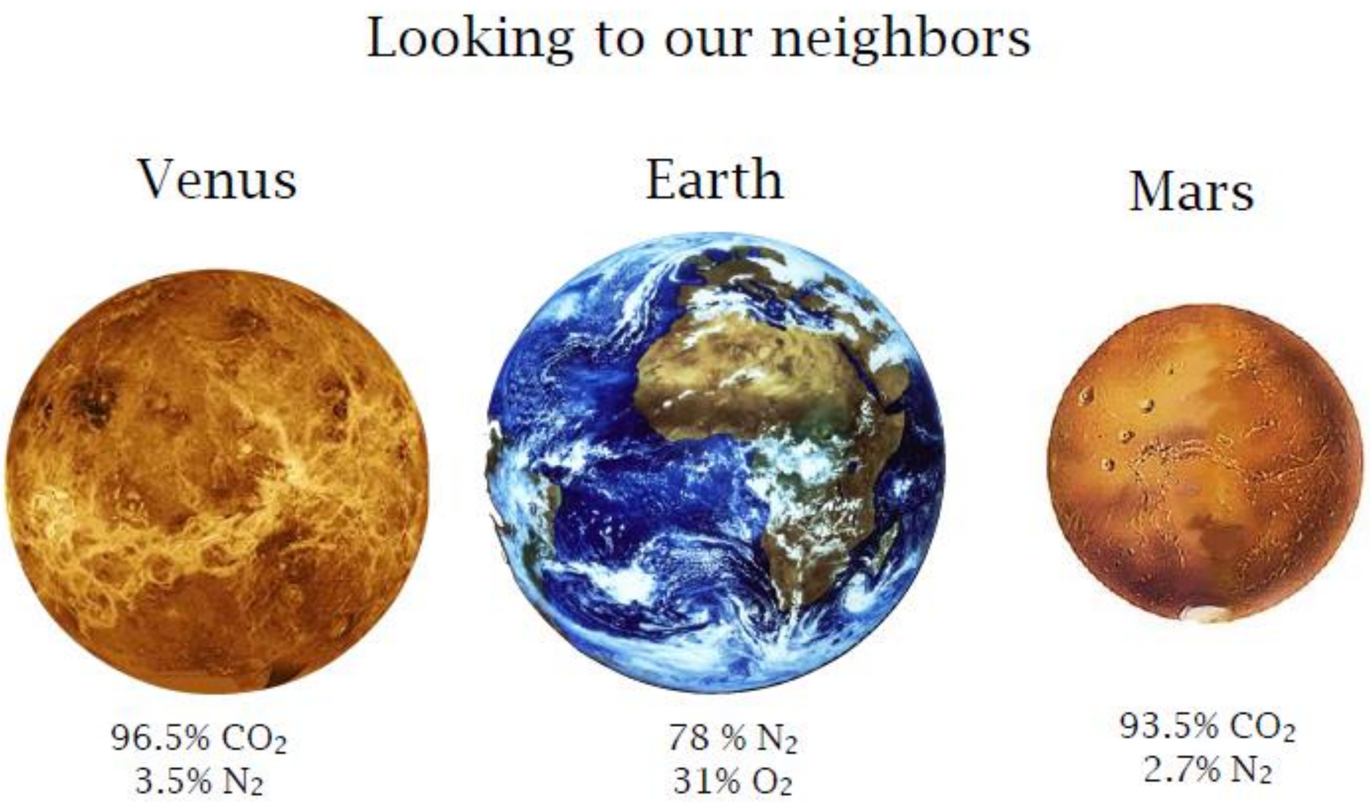
The Water Cycle

- Sustains Life on Earth
- Shapes the Surface of the Earth
- Regulates the Climate



No one has very much Oxygen and Water

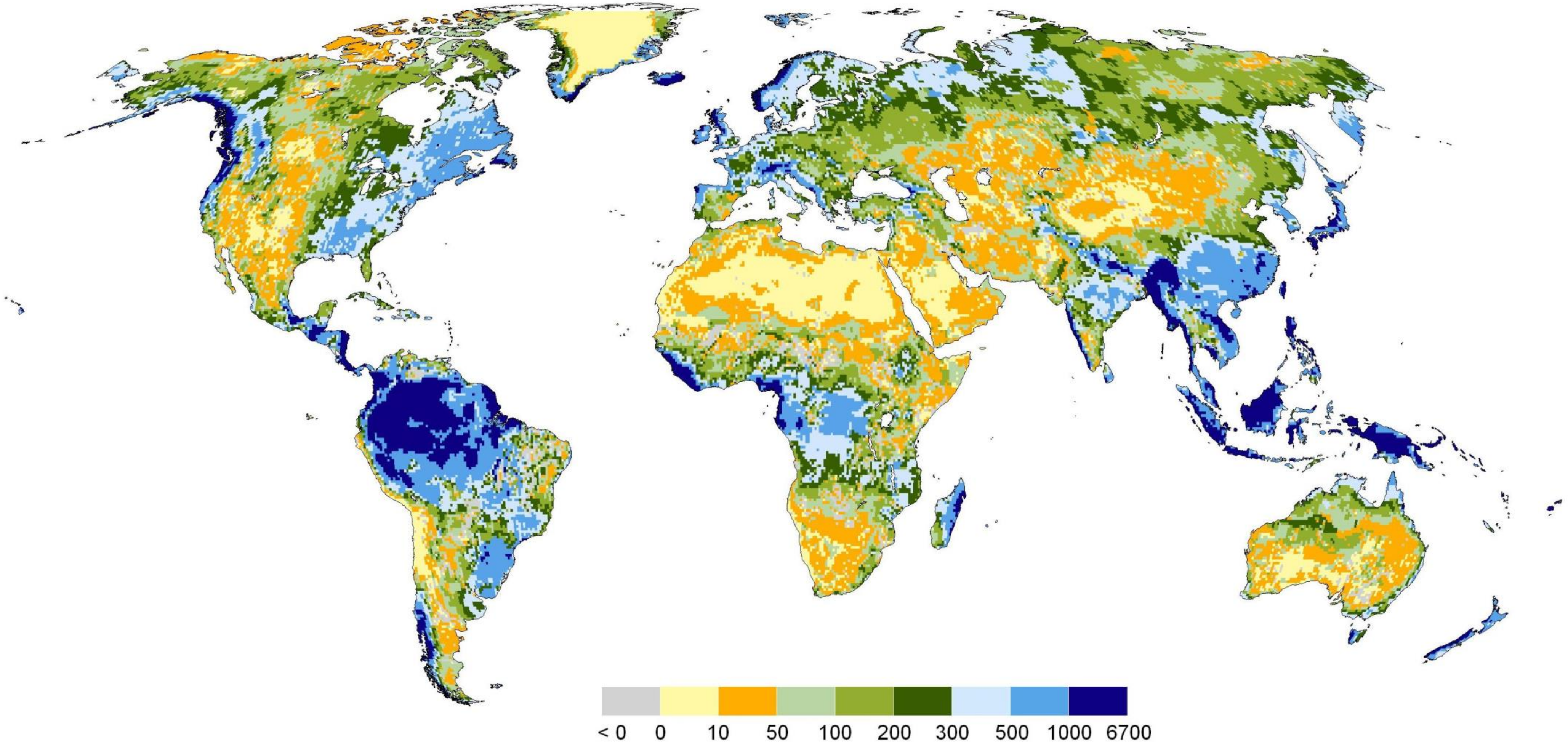
Is there enough Renewable Freshwater Resources (RFWR)?

- Driven by increasing populations (the world population rises by approximately 200,000 a week), growing urbanization, changing lifestyles, and economic development, the total demand for freshwater in urban areas is rising dramatically.

- According to a World Bank study (2007), the renewable fresh water availability per capita is expected to halve by 2050 (relative to 2007), due to climate change which makes many regions hotter and drier.

- Water stress and water scarcity challenges will have a severe economic and social implications. Noteworthy, the challenges for governments and water utilities are not only to increase the absolute volume of the freshwater supply but also optimizing the efficiency of water use and distribution.

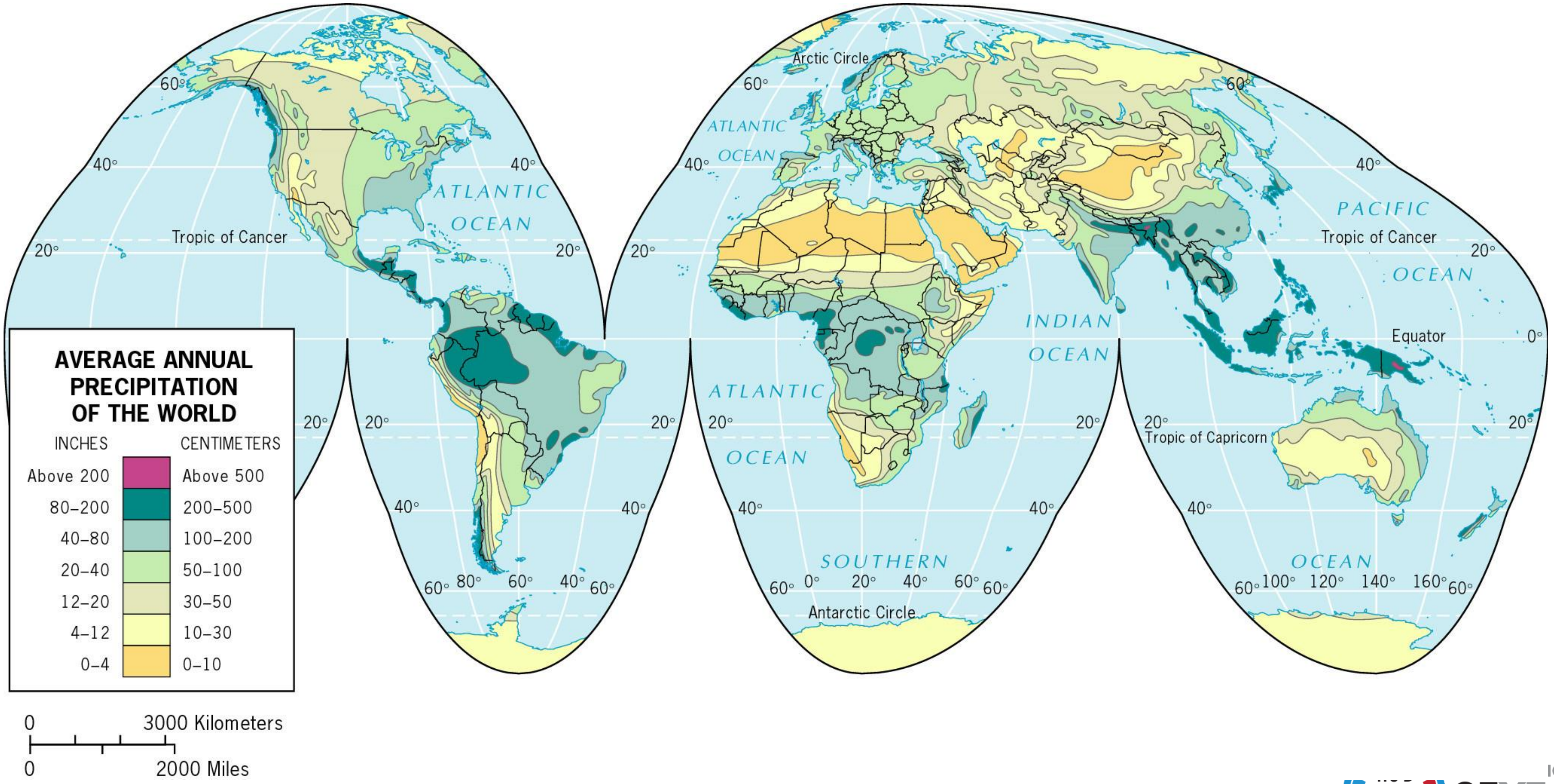
Is there enough Renewable Freshwater Resources (RFWR)?



Total renewable freshwater resources of the world, in mm/yr (1 mm is equivalent to 1 l of water per m²)

Source: Döll, P., Fiedler, K. (2008): Global-scale modeling of groundwater recharge. Hydrol. Earth Syst. Sci., 12, 863-885.

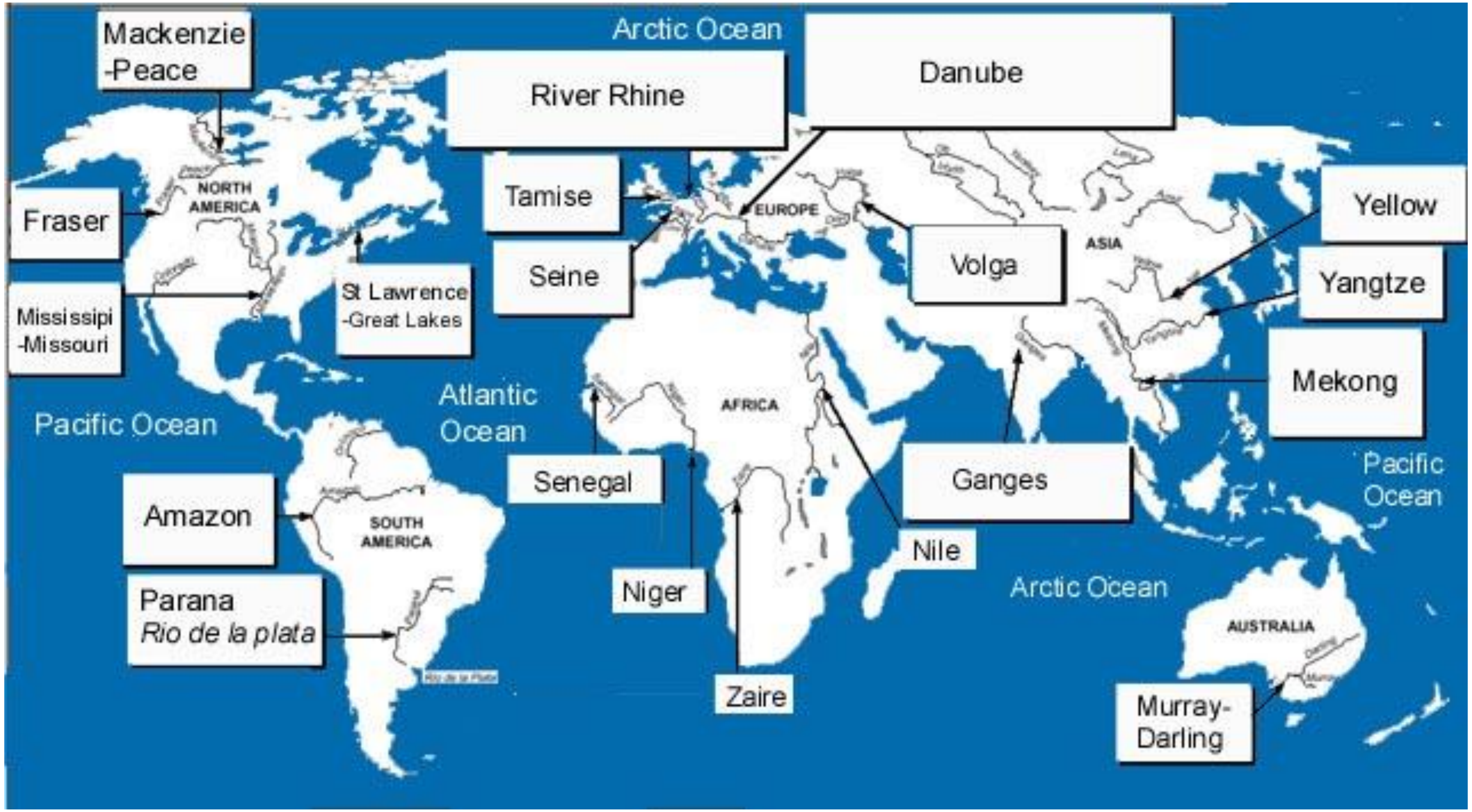
Is there enough Renewable Freshwater Resources (RFWR)?



Distribution of Mean Annual Precipitation

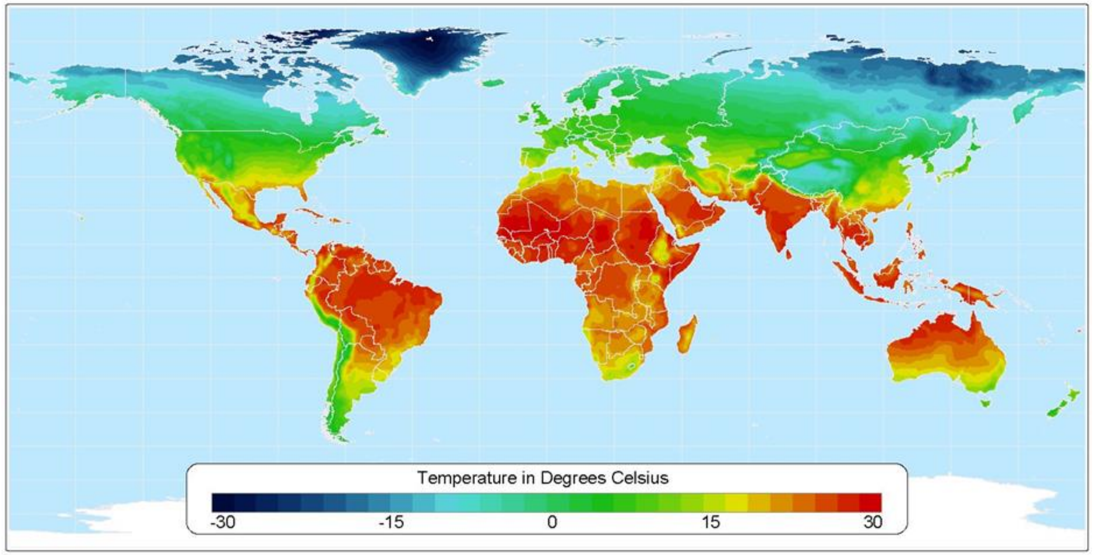
Is there enough Renewable Freshwater Resources (RFWR)?

Rivers have been, and remain, our most vital water infrastructure.



The Largest Rivers on Earth

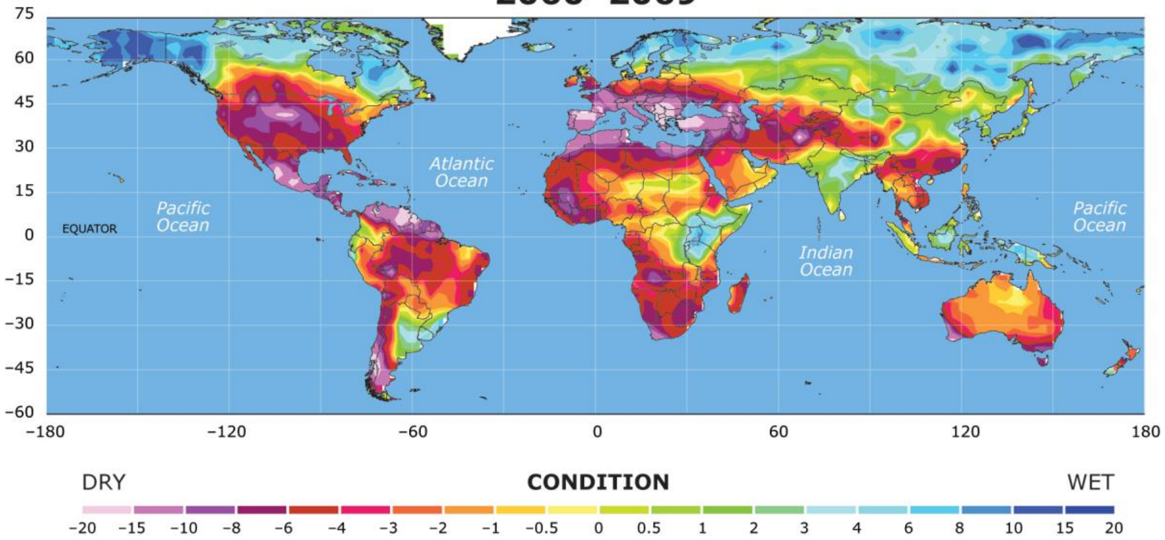
2016 Average Annual Temperature



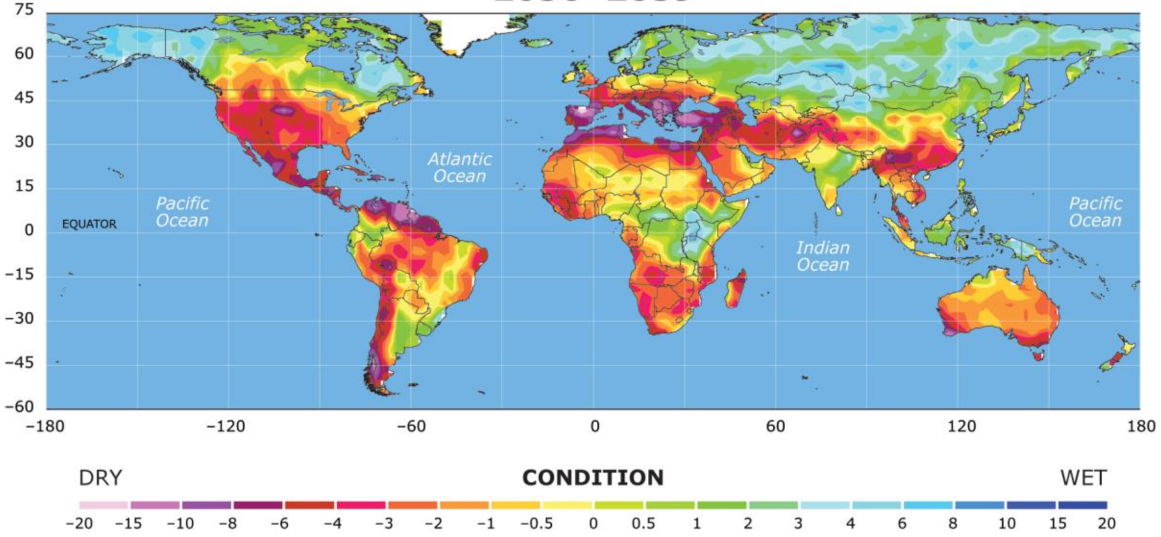
Data taken from: CRU 0.5 Degree Dataset (New, et al.)

Atlas of the Biosphere
Center for Sustainability and the Global Environment
University of Wisconsin - Madison

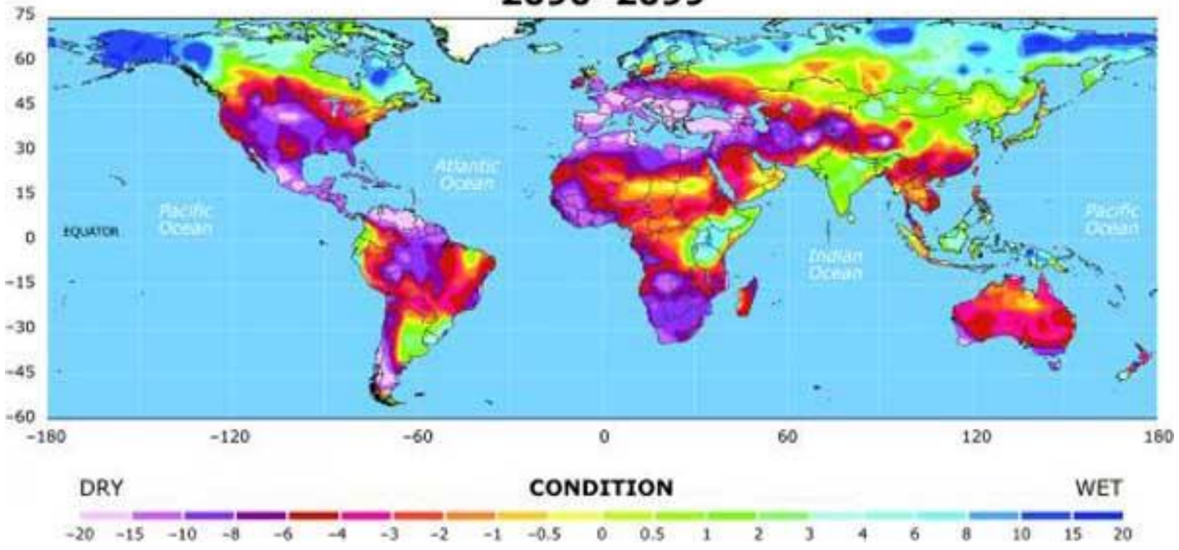
2060–2069



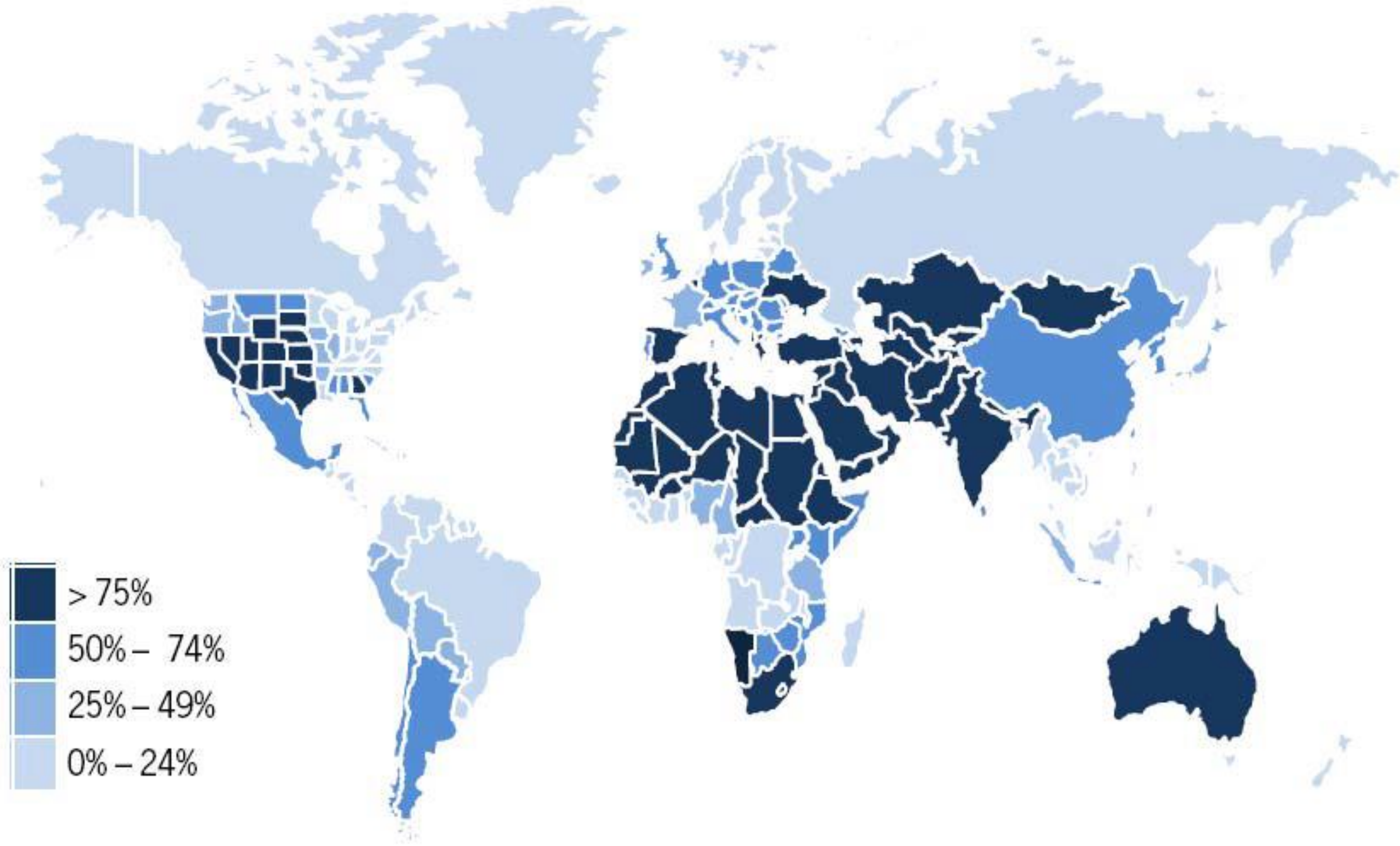
2030–2039



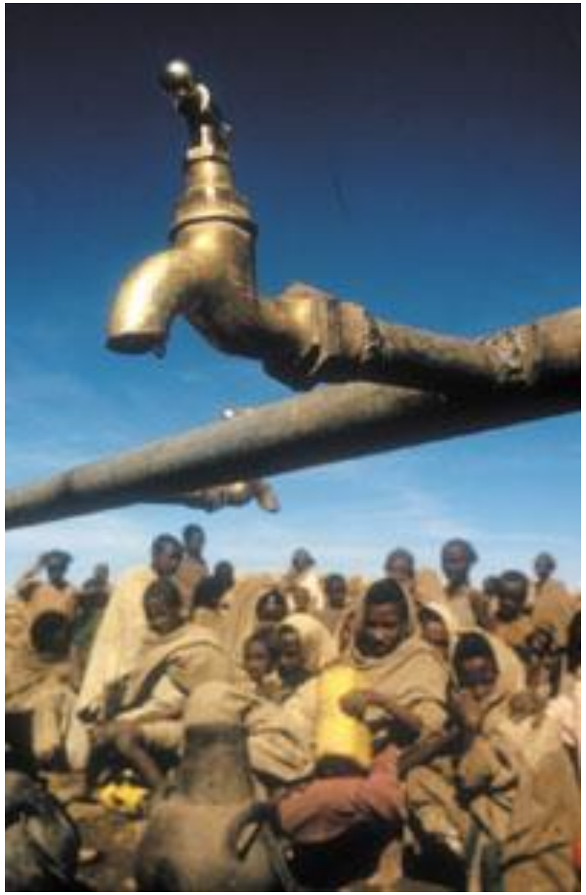
2090–2099



Percent of Population Facing Severe Water Stress, 2030

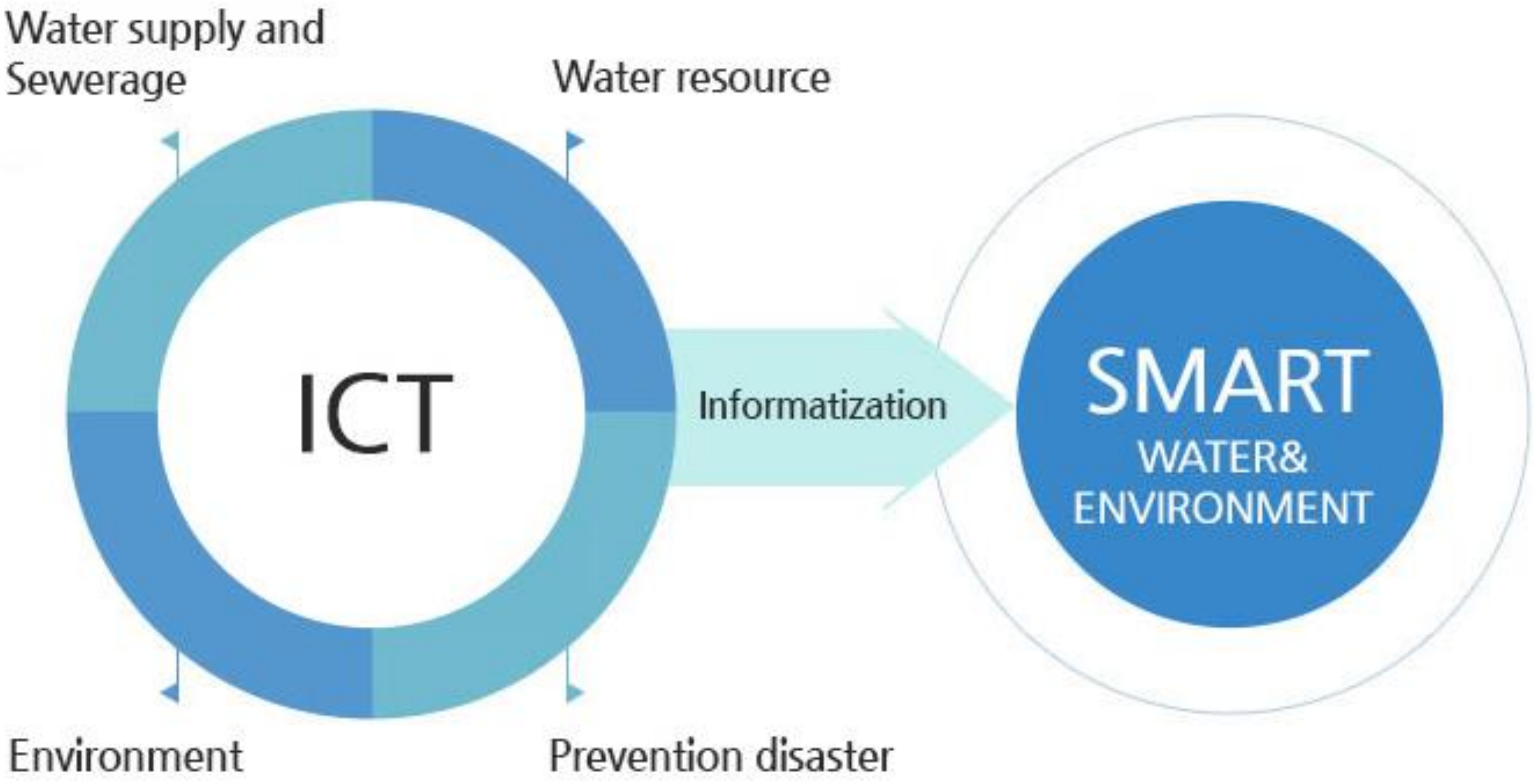


Source: OECD.



2017 Publications; 41% of the world population is in drought or water stressed regions. International Water Management Institute predicts that by 2025, all of Africa and Middle East, as well as most of South and Central America and Asia, will run out of water or not be able to afford it.

Therefore, ICT smart management of the water resources is a MUST…..

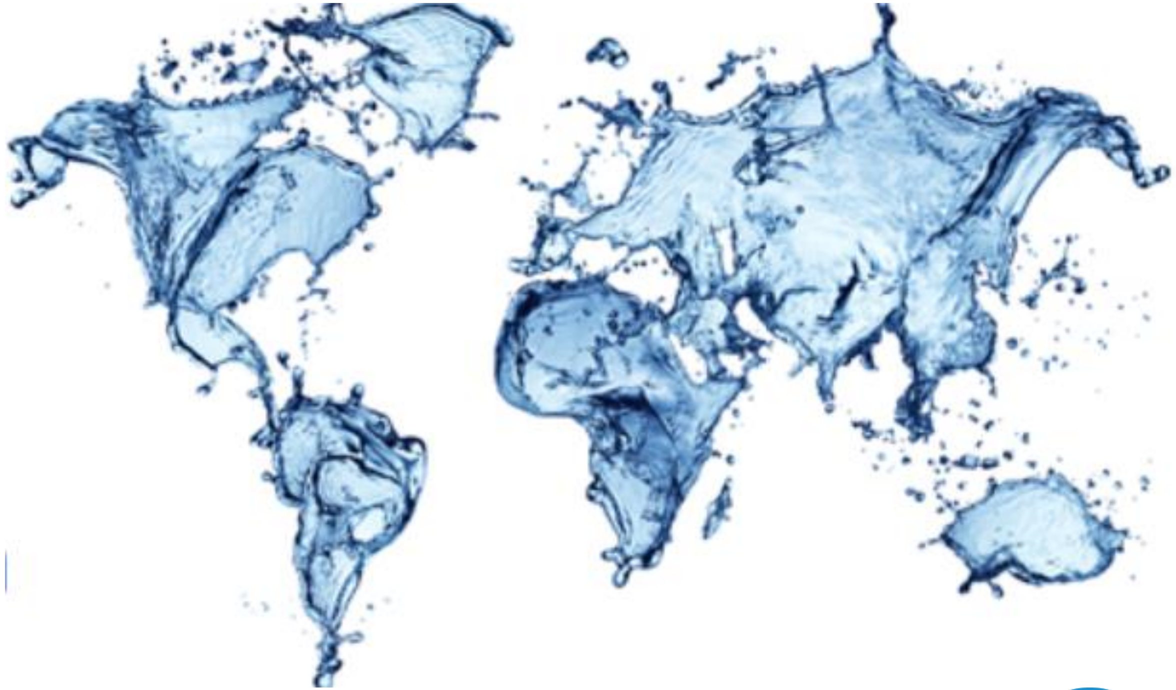


Smart Management of the Fresh Water Resources

Conventional water resources	Non- Conventional water resources
• Surface water (Fresh & Saline) • Groundwater	• Frozen water (Icebergs) • Rainwater harvesting & flood management • Recycle of the residential water (black and greywater) • Smart Irrigation, smart agriculture, smart industry • Reforming water policies

Conventional water resources

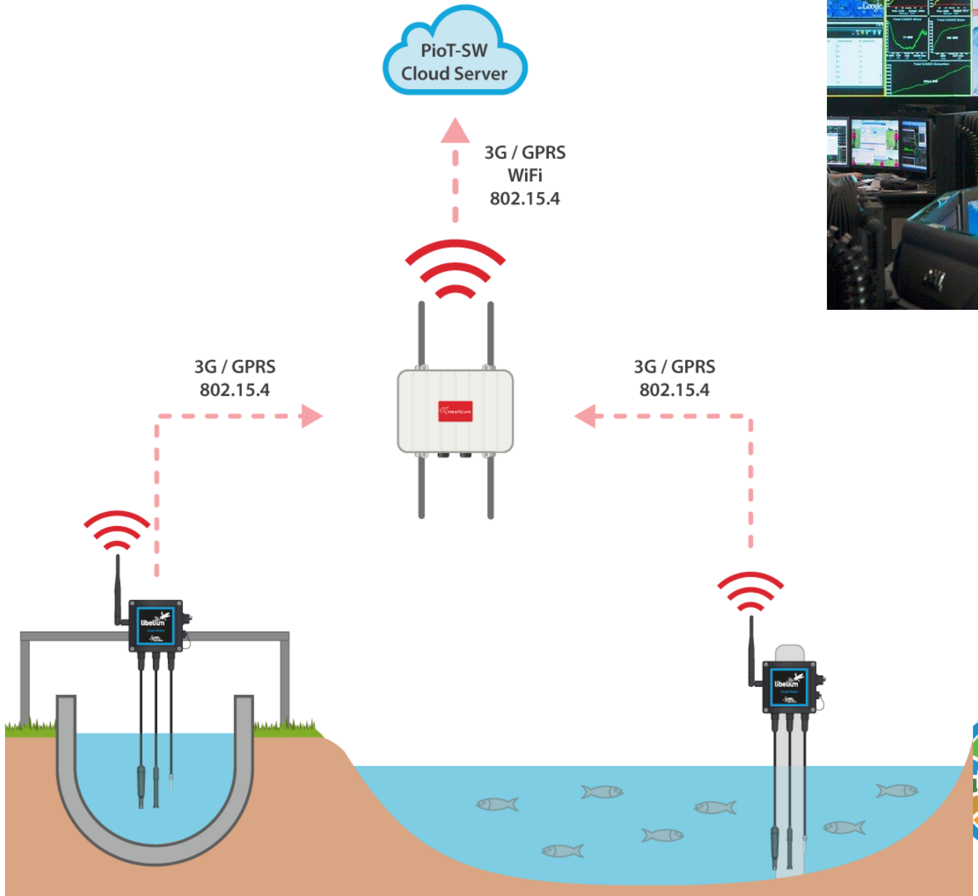
- Surface water (Fresh & Saline)
- Groundwater



- **Surface water (Fresh)**

Which comprises rivers, streams, lakes, lagoons,….etc.

ICTs play a crucial role in;



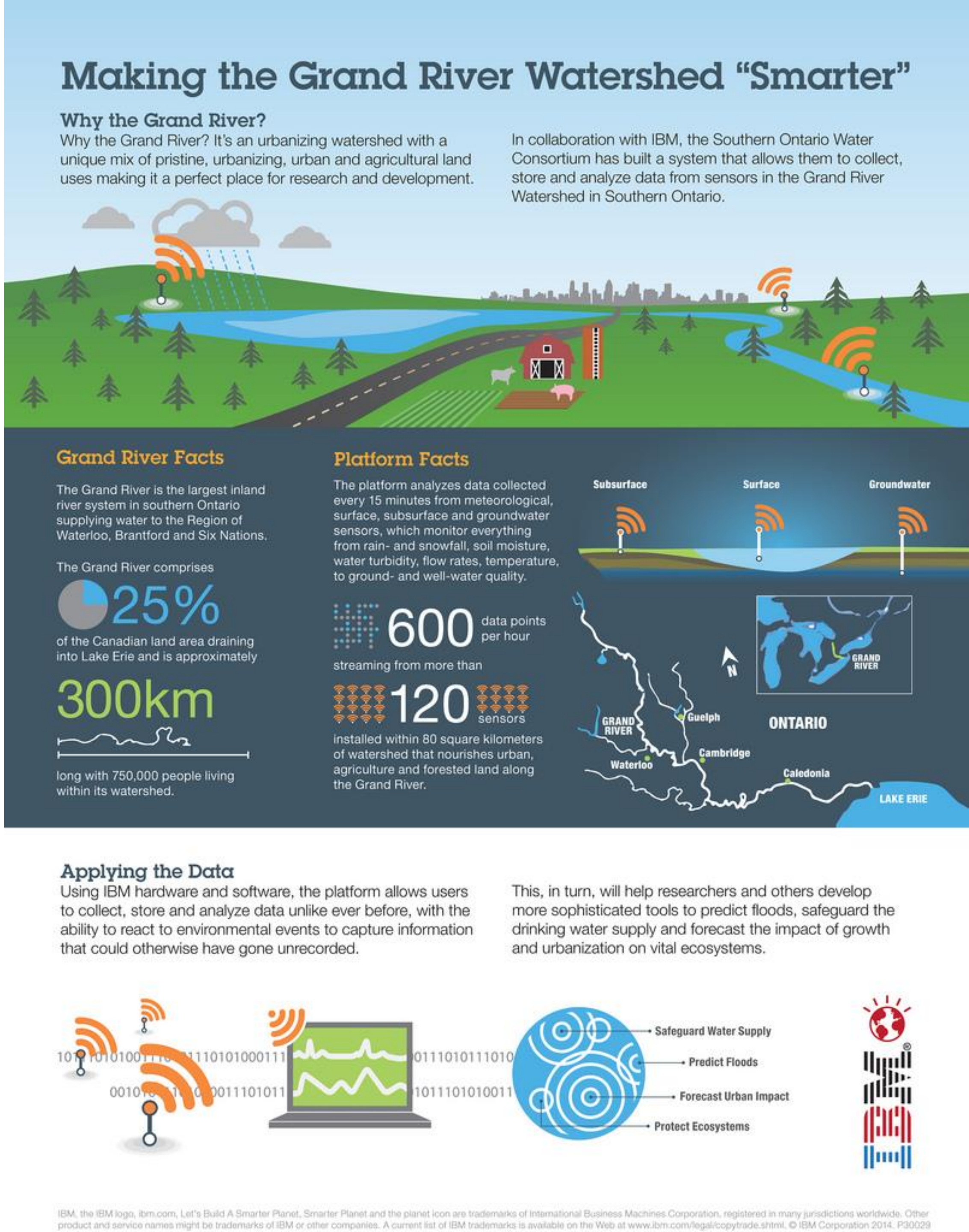
❑ **Telemetering and telecontrol systems**

Real time monitoring and diagnosis, as well as automatic controls improve the supervision and optimize of water resources management.

❑ Big Data Analytics:

Smart monitoring and metering at scales from basins to households will enable robust management of big data

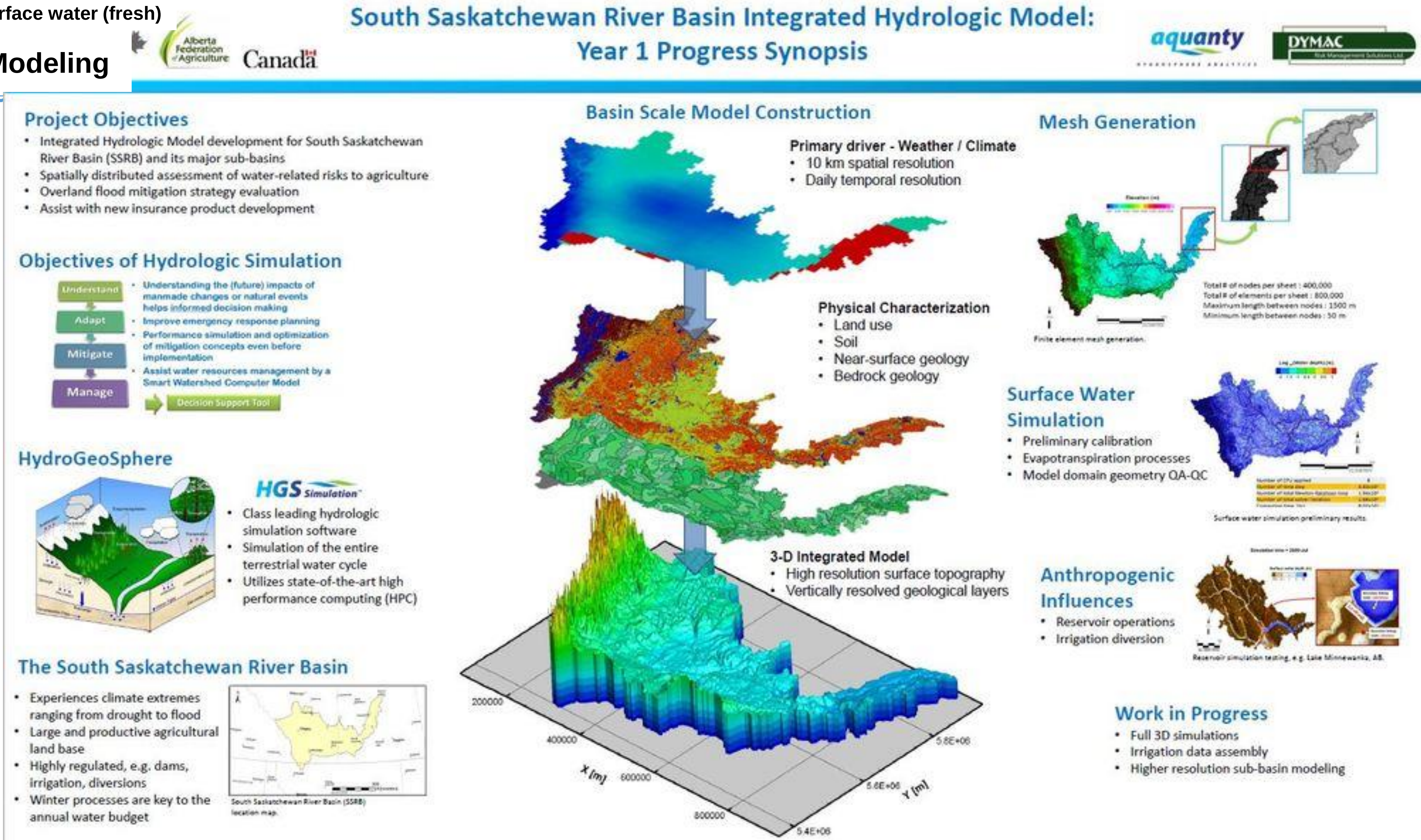
Grand River, Ontario, Canada



ICT in surface water (fresh)

❑ Modeling

The Saskatchewan River is a major river in Canada, about 550 kilometres long,



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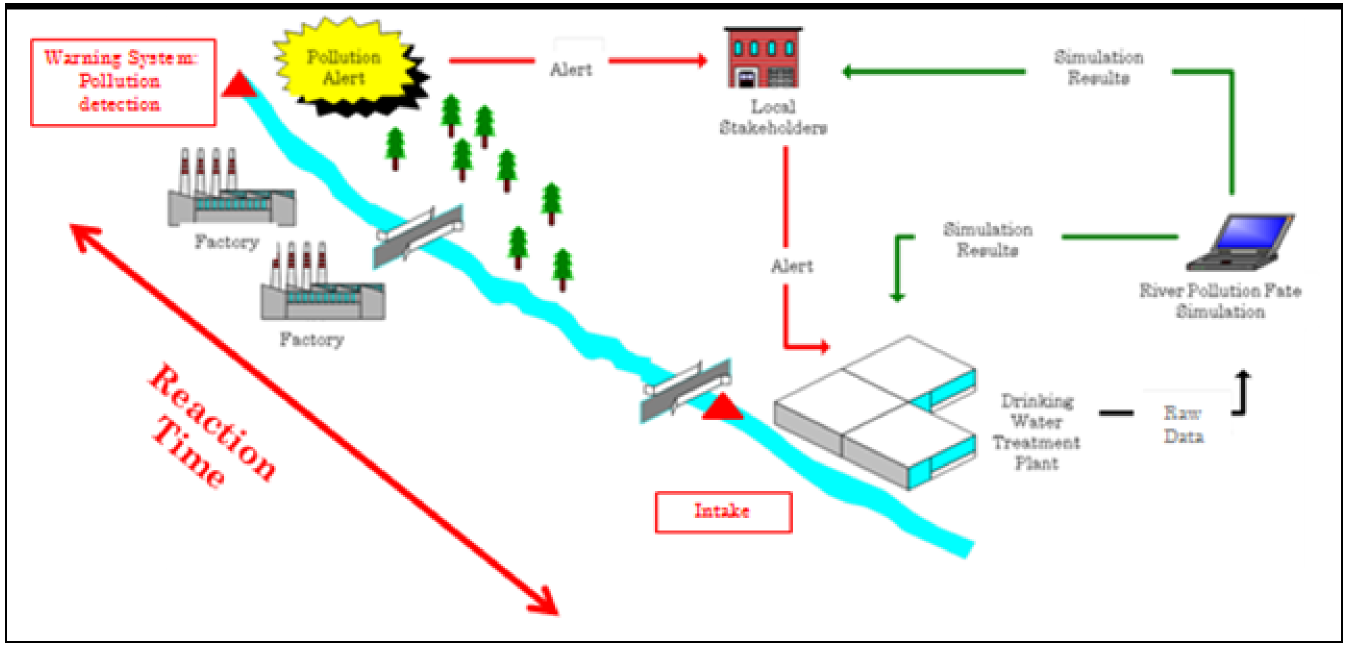
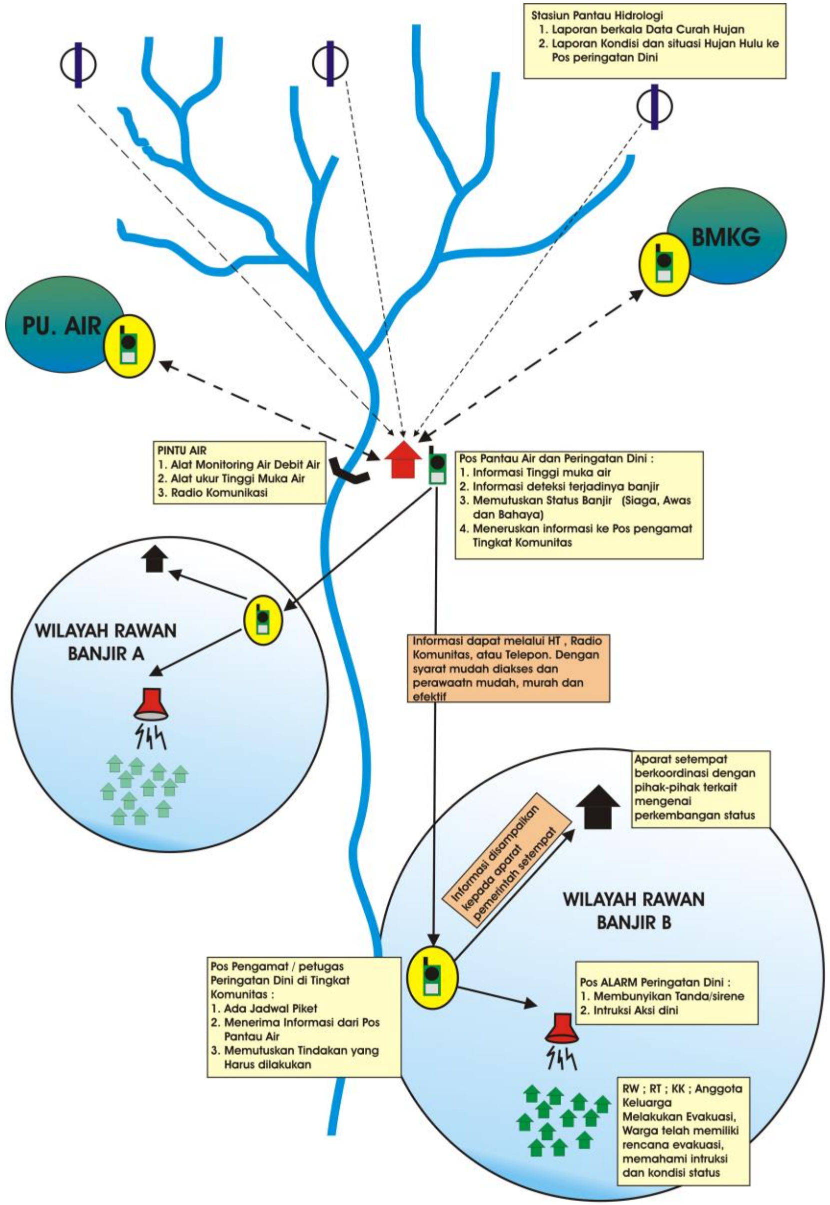
❑ Risk assessment and early warning system (EWS)





Benefits:

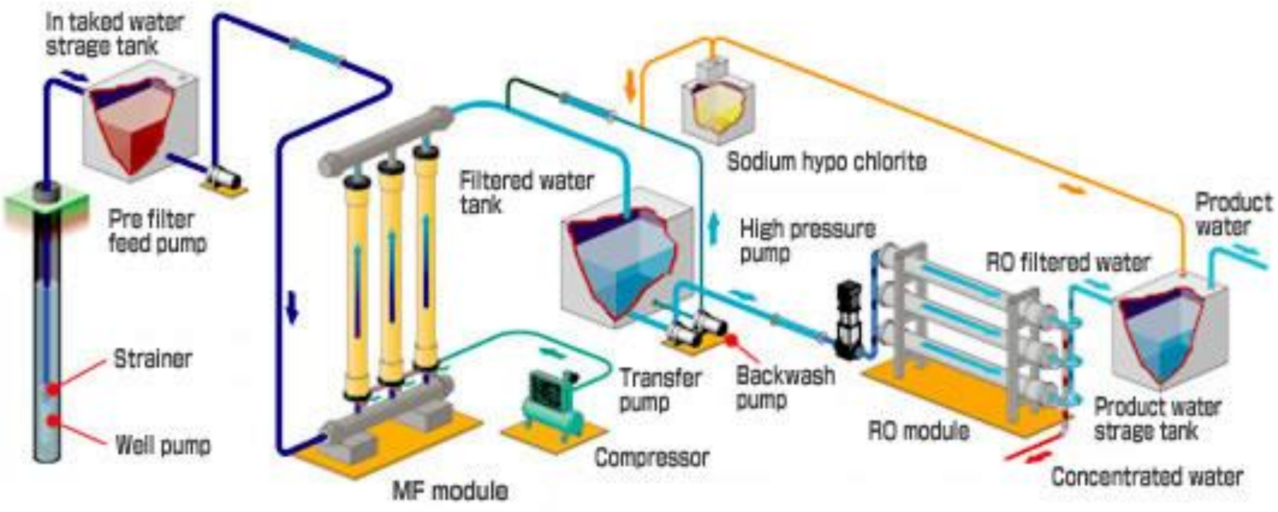
ICTs smart technology (intelligent sensors, wireless communications, code-division multiple access (CDMA), satellite images, and GIS) will enable;

- ✓ Real-time efficient management of reliable water demand and supply,
- ✓ Disaster prevention,
- ✓ Water quantity & quality,
- ✓ Optimized distribution, and
- ✓ Optimized ecosystem.

- **Surface water (Saline)**

Which comprises seawater & salt lakes,…..etc.

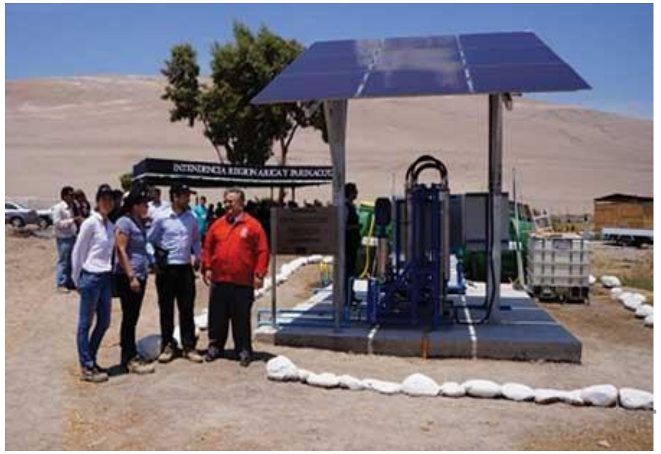
Saline water represents 97% of water on the earth



Membrane Filtration, Reverse-Osmosis Seawater Desalination System

ICTs play a crucial role in;

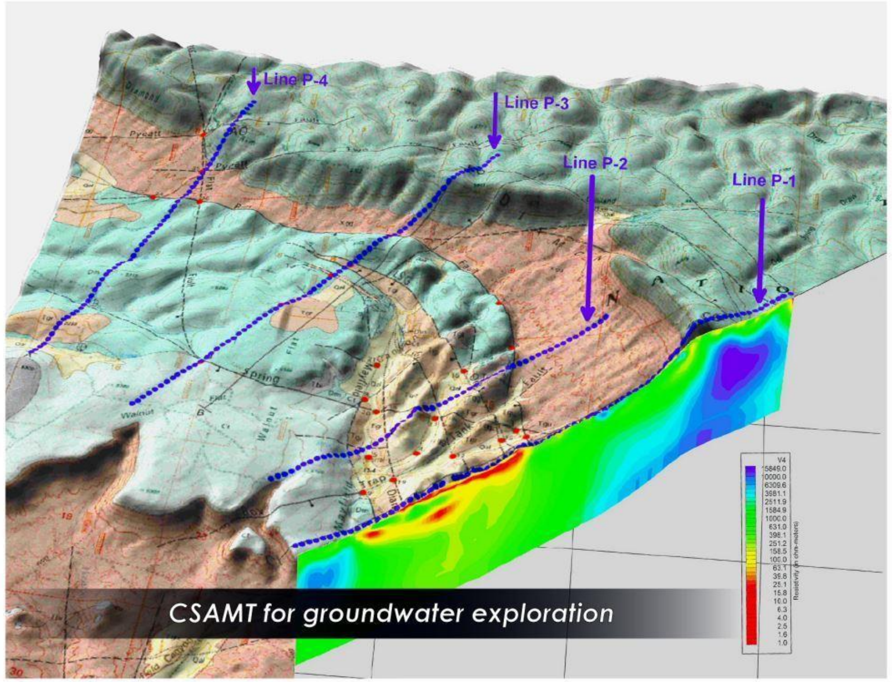
❑ **Desalination technologies**



Solar Powered Water Desalination

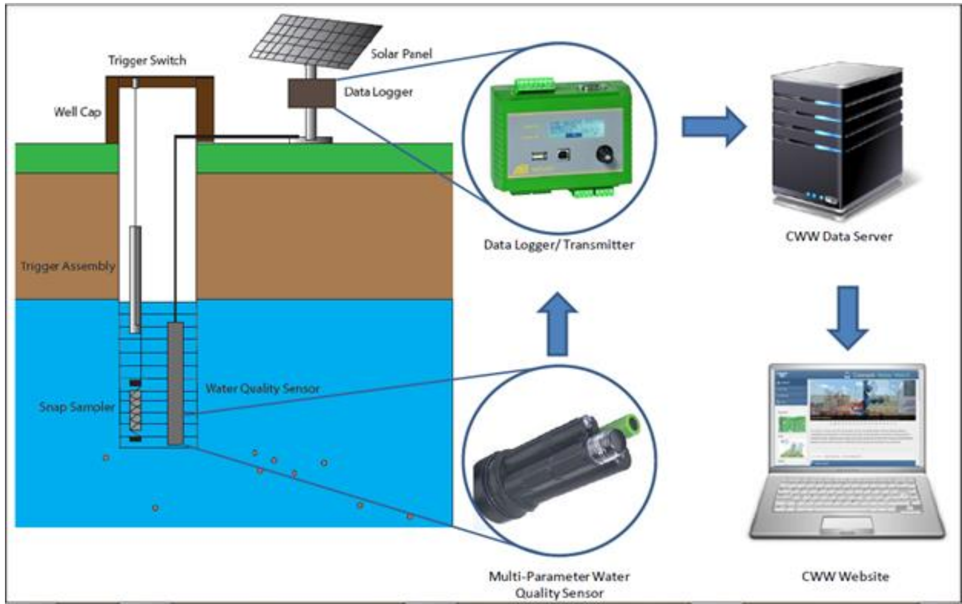
- **Groundwater**

Represents 30% of freshwater on the earth



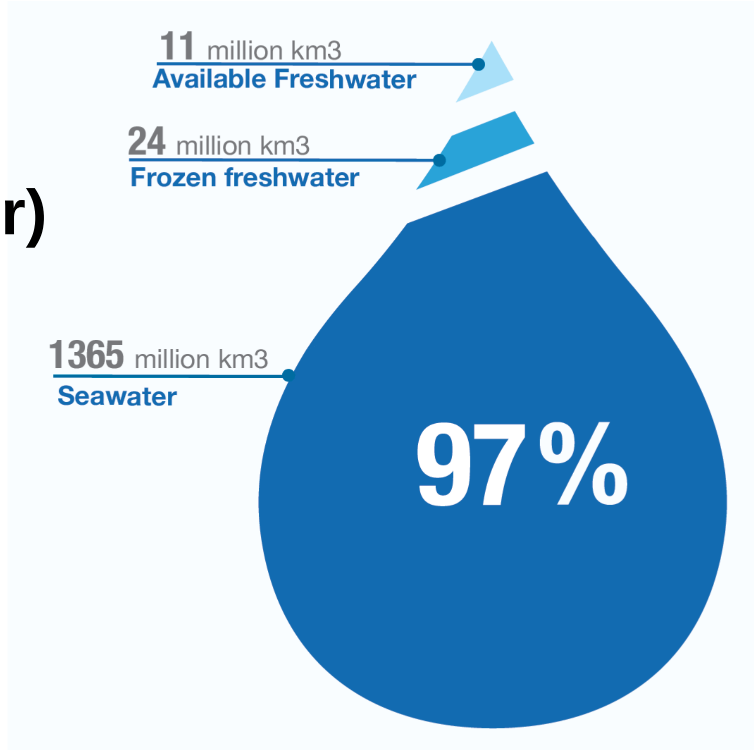
ICTs play a crucial role in;

- ❑ **Groundwater exploration**
- ❑ **Regular and real time monitoring, diagnosis, modeling, automatic controls for surface water resources**



Non-Conventional water resources

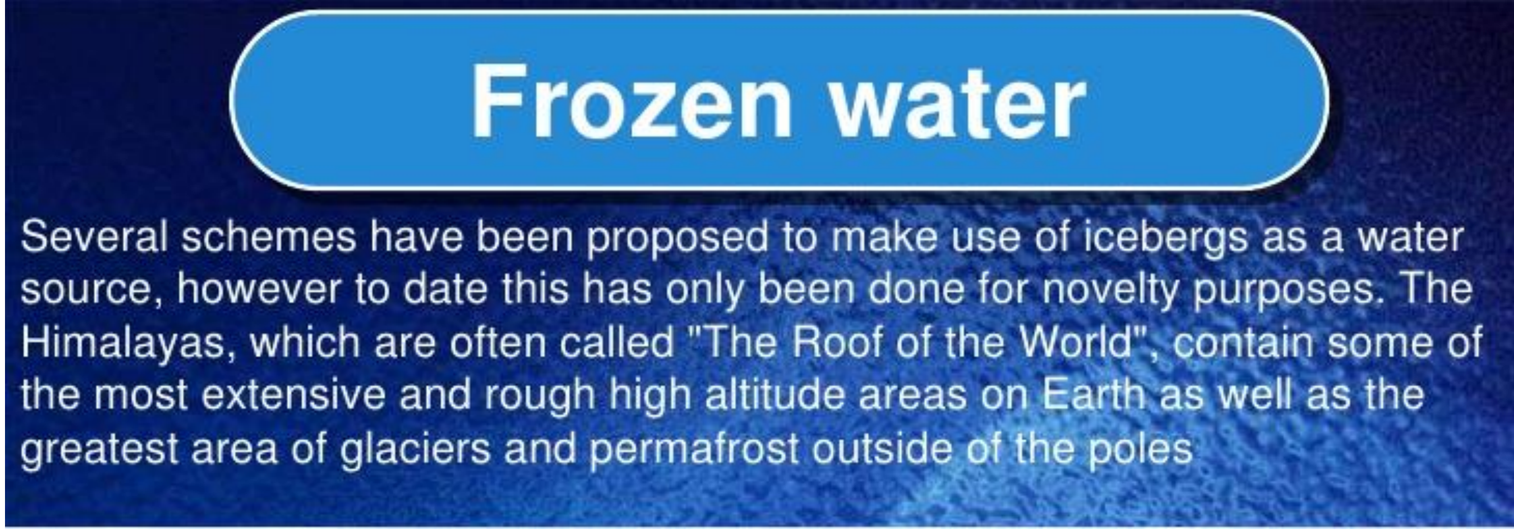
- Frozen water (Icebergs)
- Rainwater harvesting & flood management
- Recycle of the residential water (black and greywater)
- Smart irrigation, smart agriculture, smart industry
- Reforming water policies

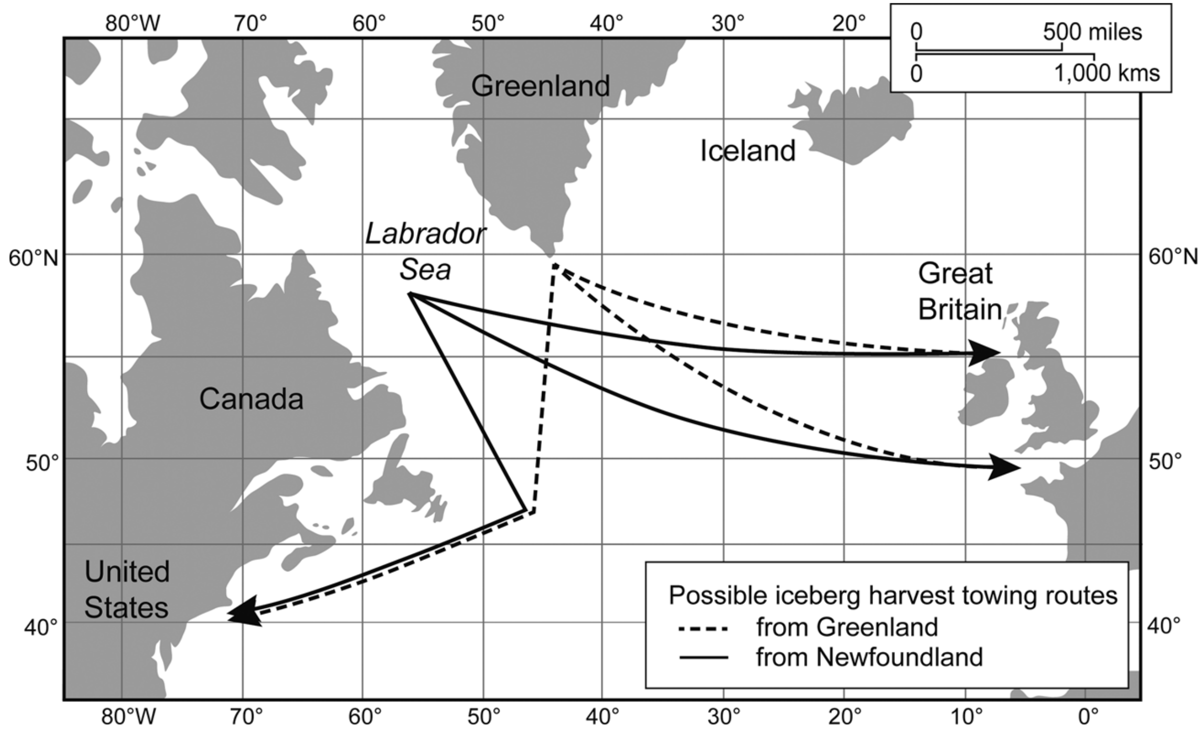


Non-Conventional water resources

- **Frozen water (Icebergs)**

Represents 68.7% of freshwater on the earth





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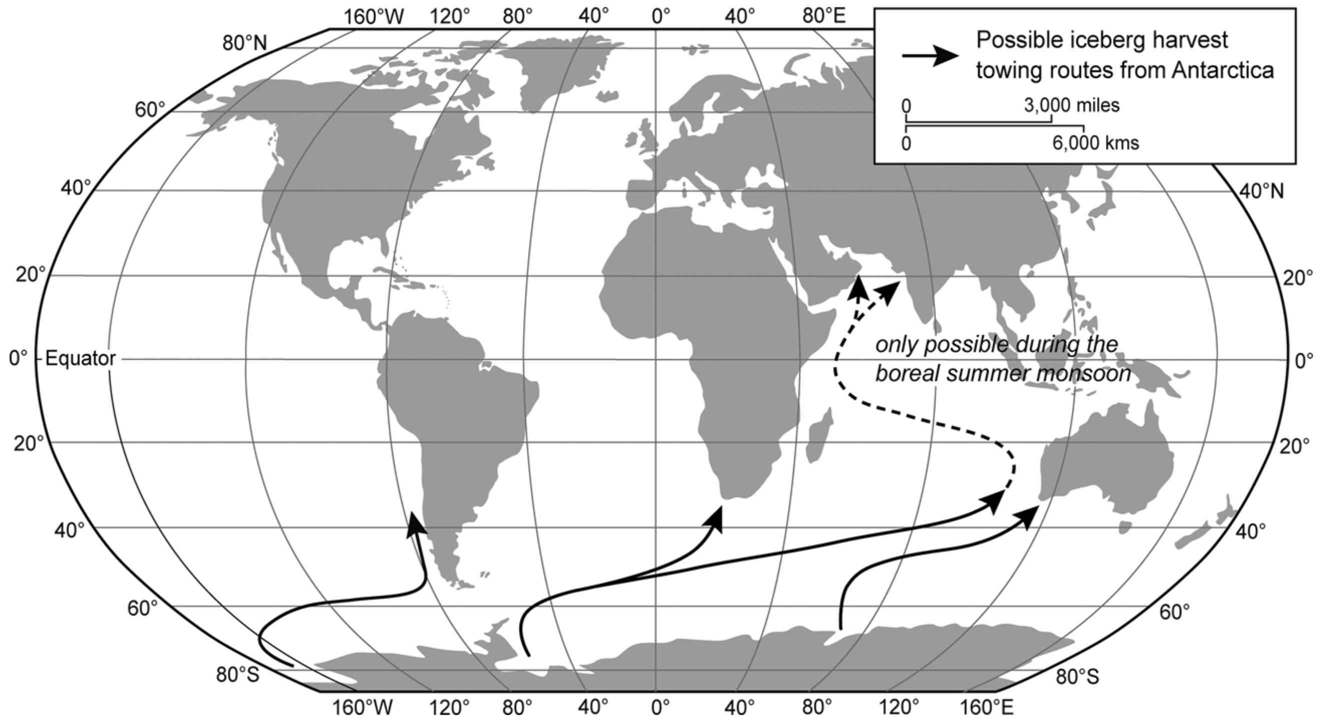
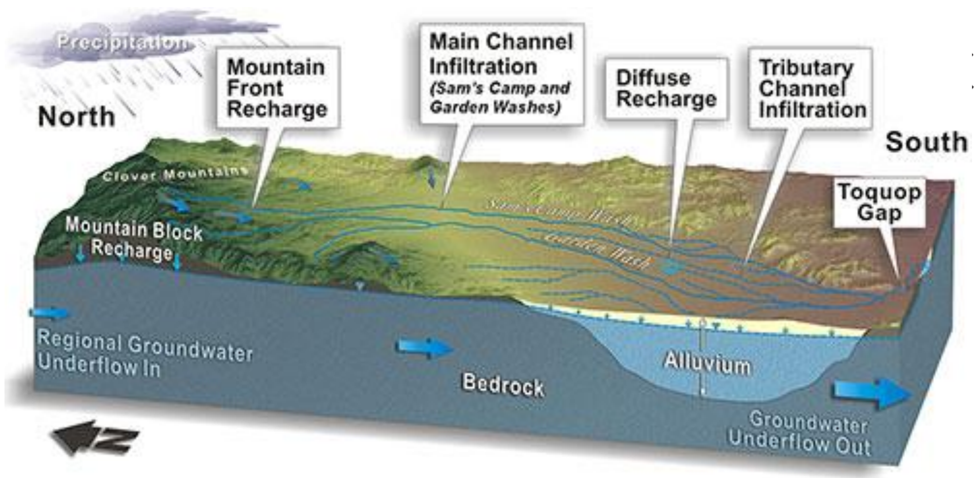
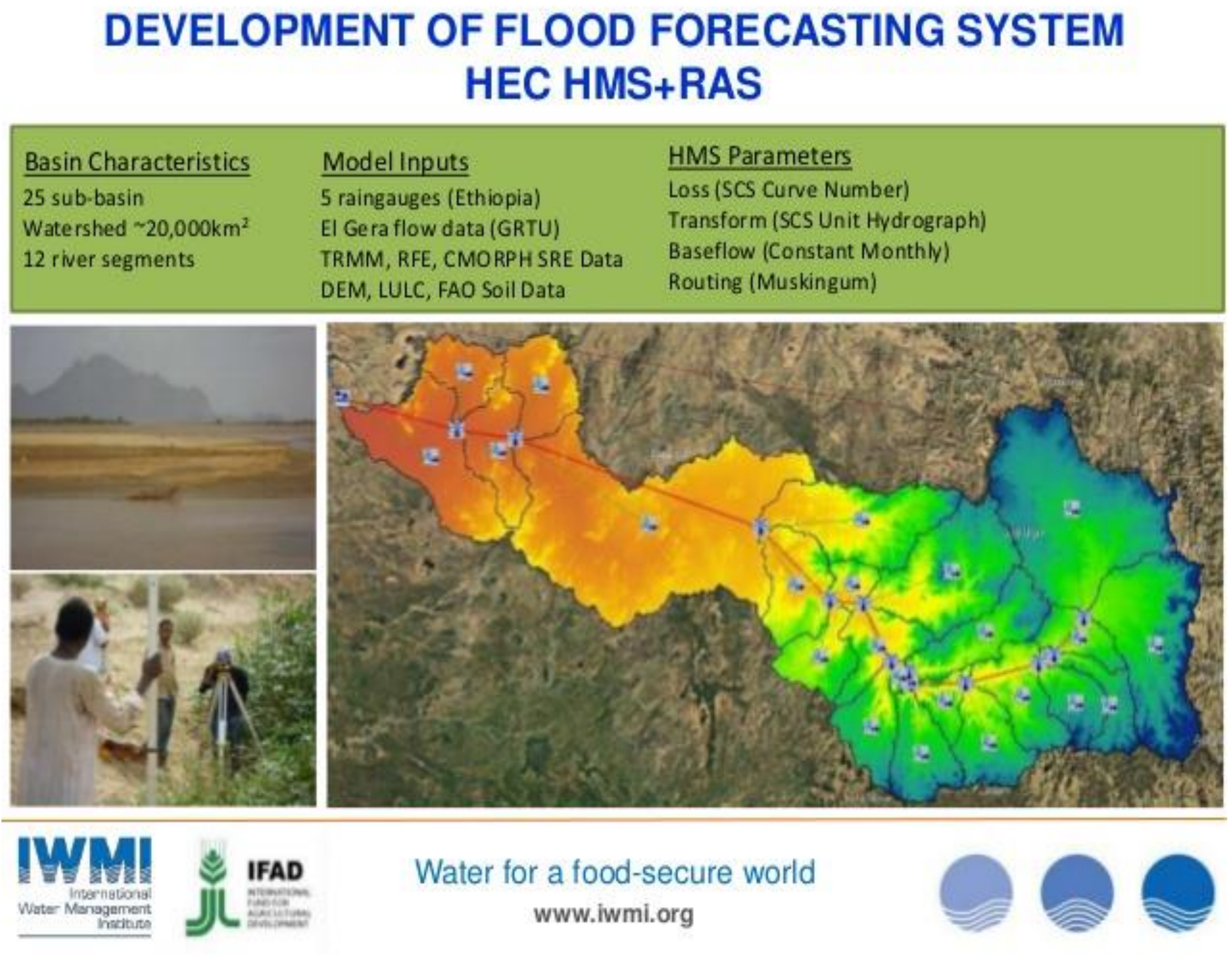
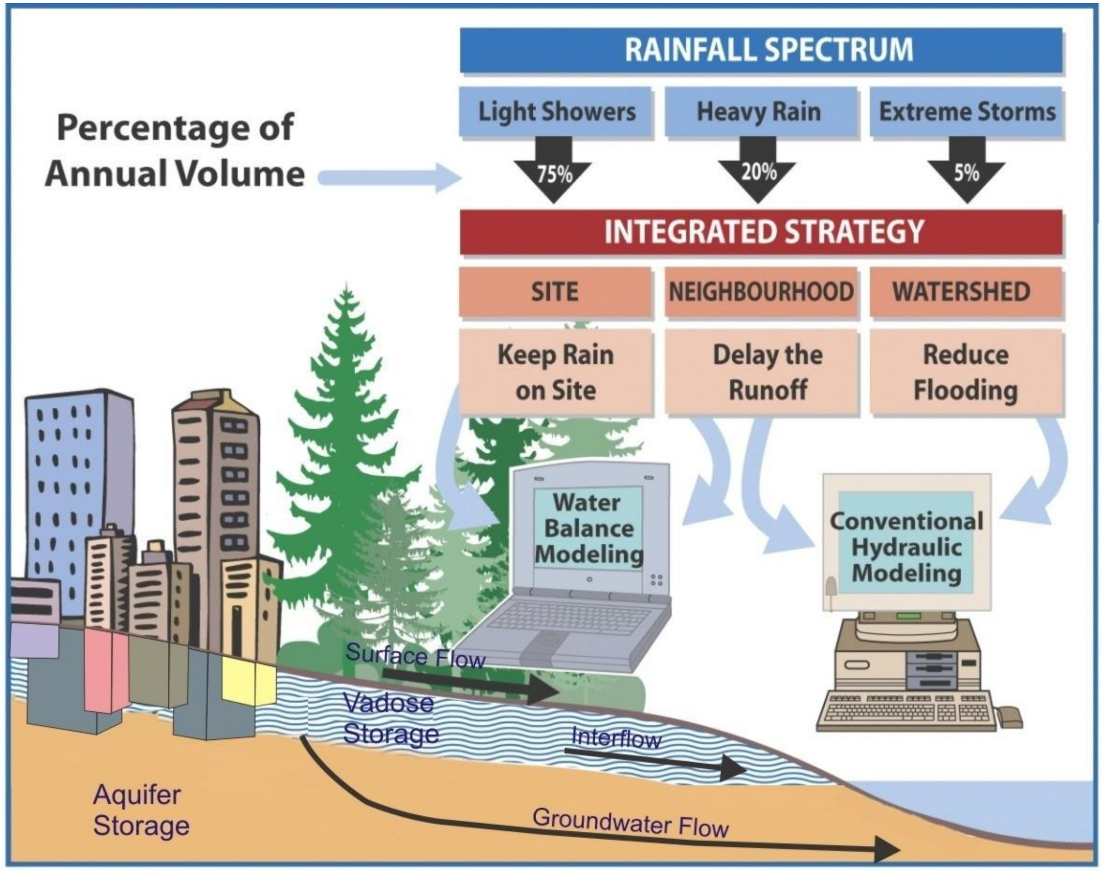


Non-Conventional water resources

- **Rainwater harvesting & flood management**

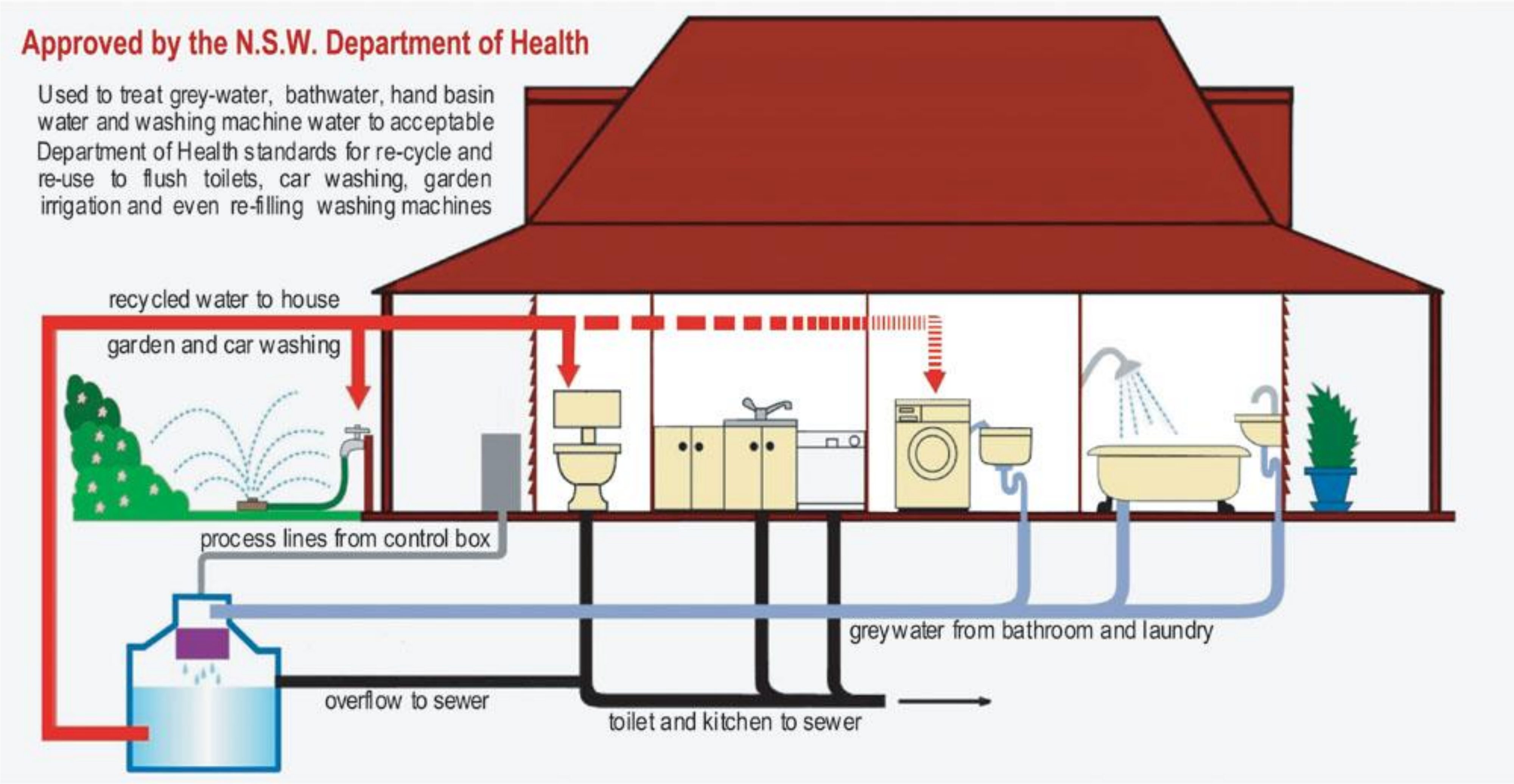






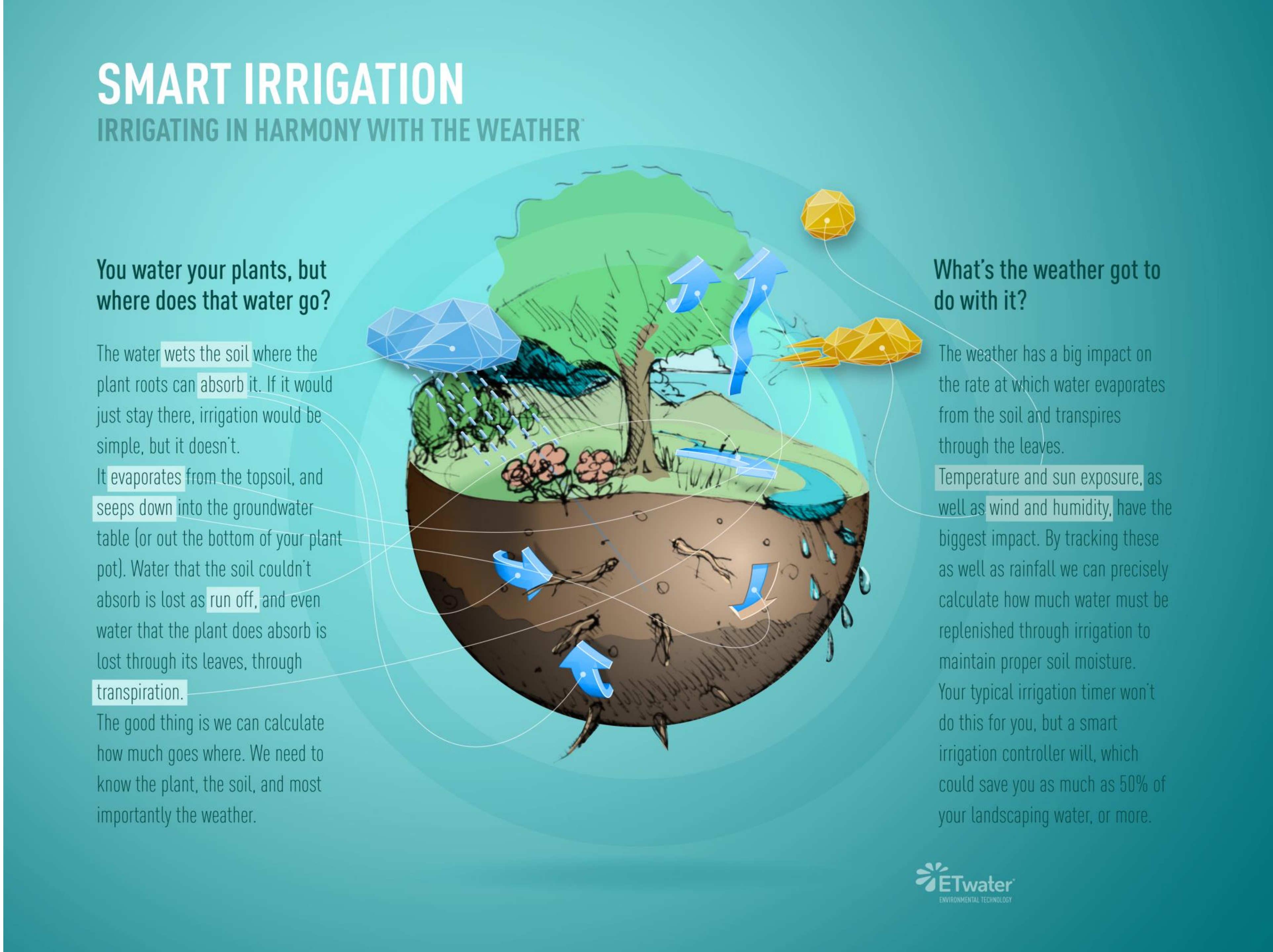
Non-Conventional water resources

- **Recycle of the residential water (black and greywater)**



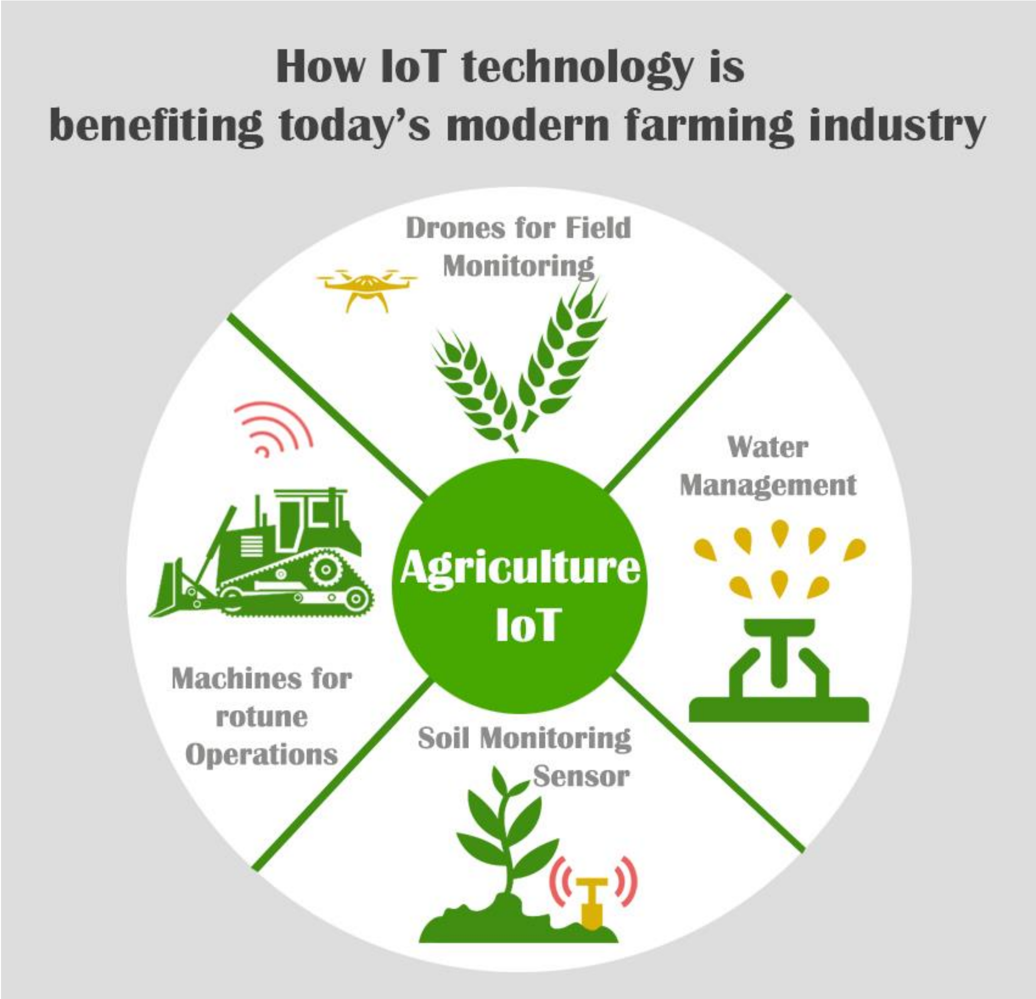
Non-Conventional water

- **Smart Irrigation**



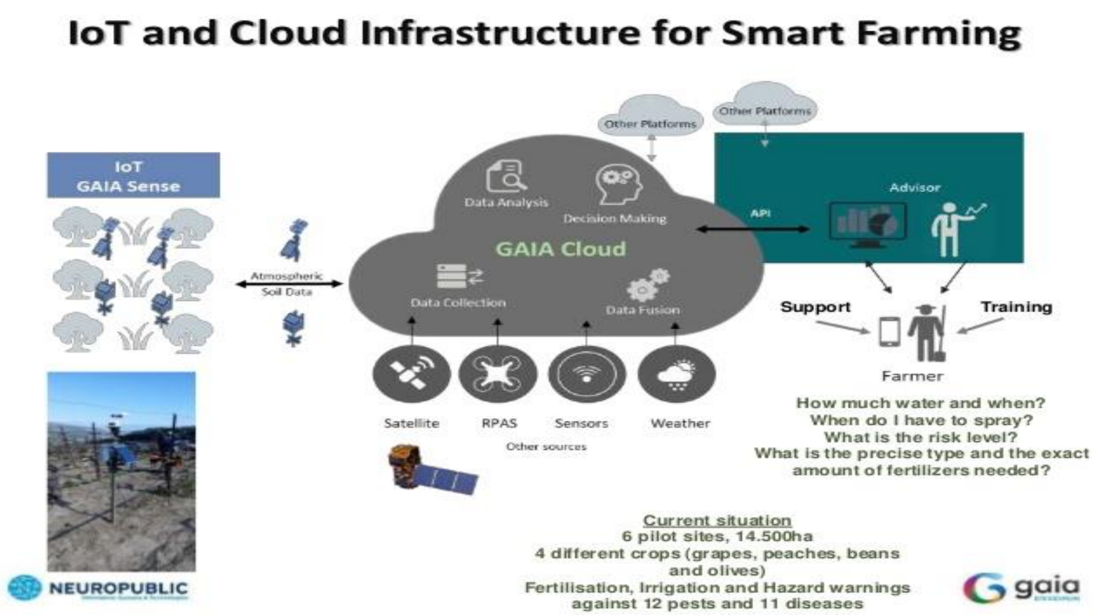
Non-Conventional water resources

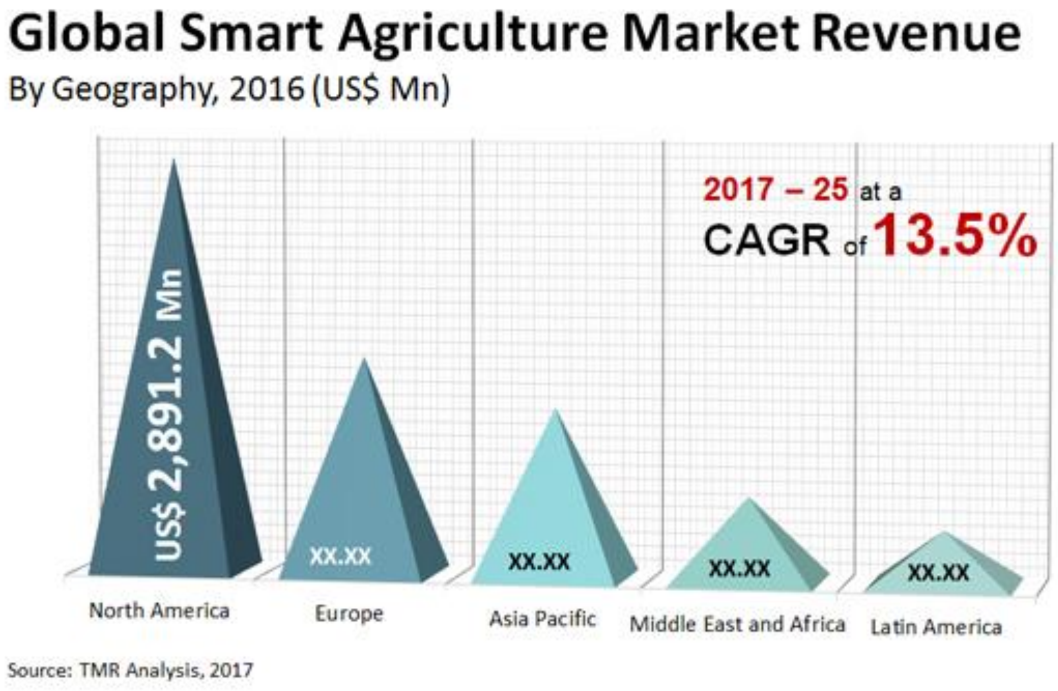
- **Smart agriculture**

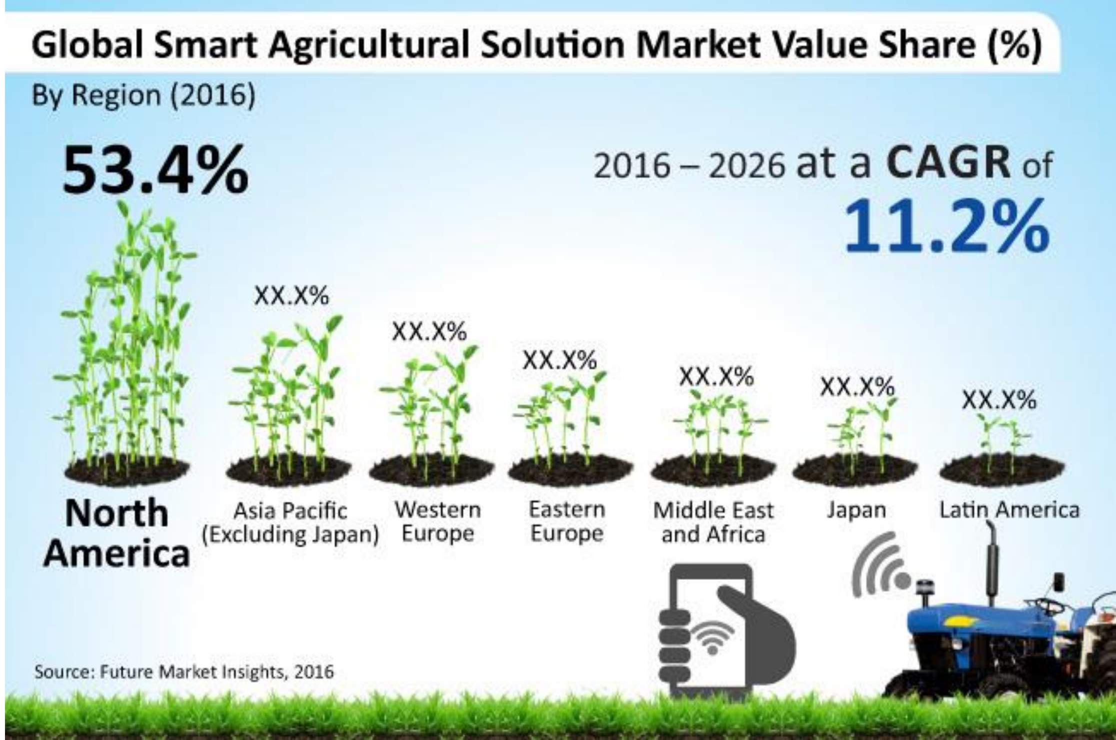


Non-Conventional water resources

- **Smart agriculture**

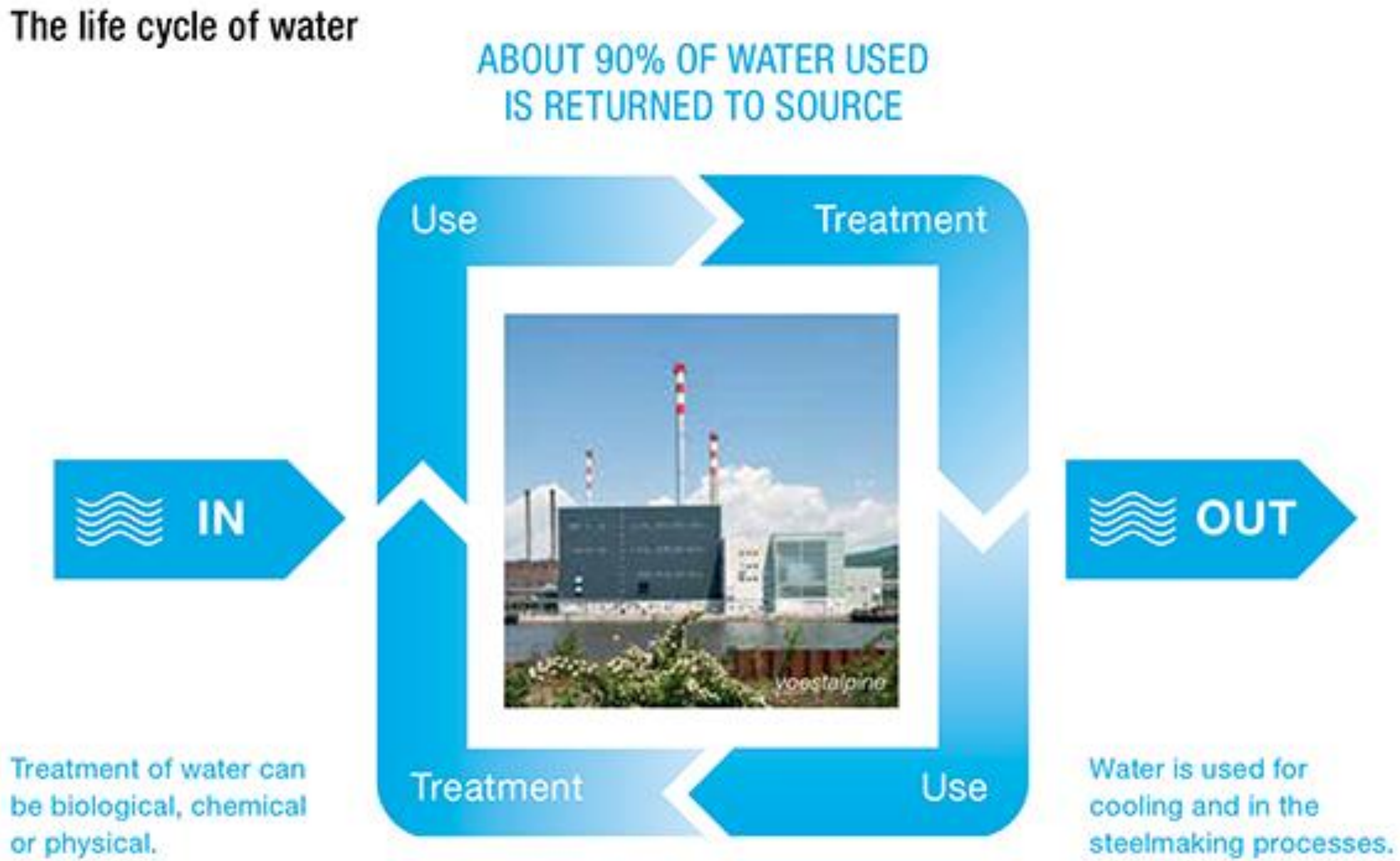






Non-Conventional water resources

- **Smart industry**

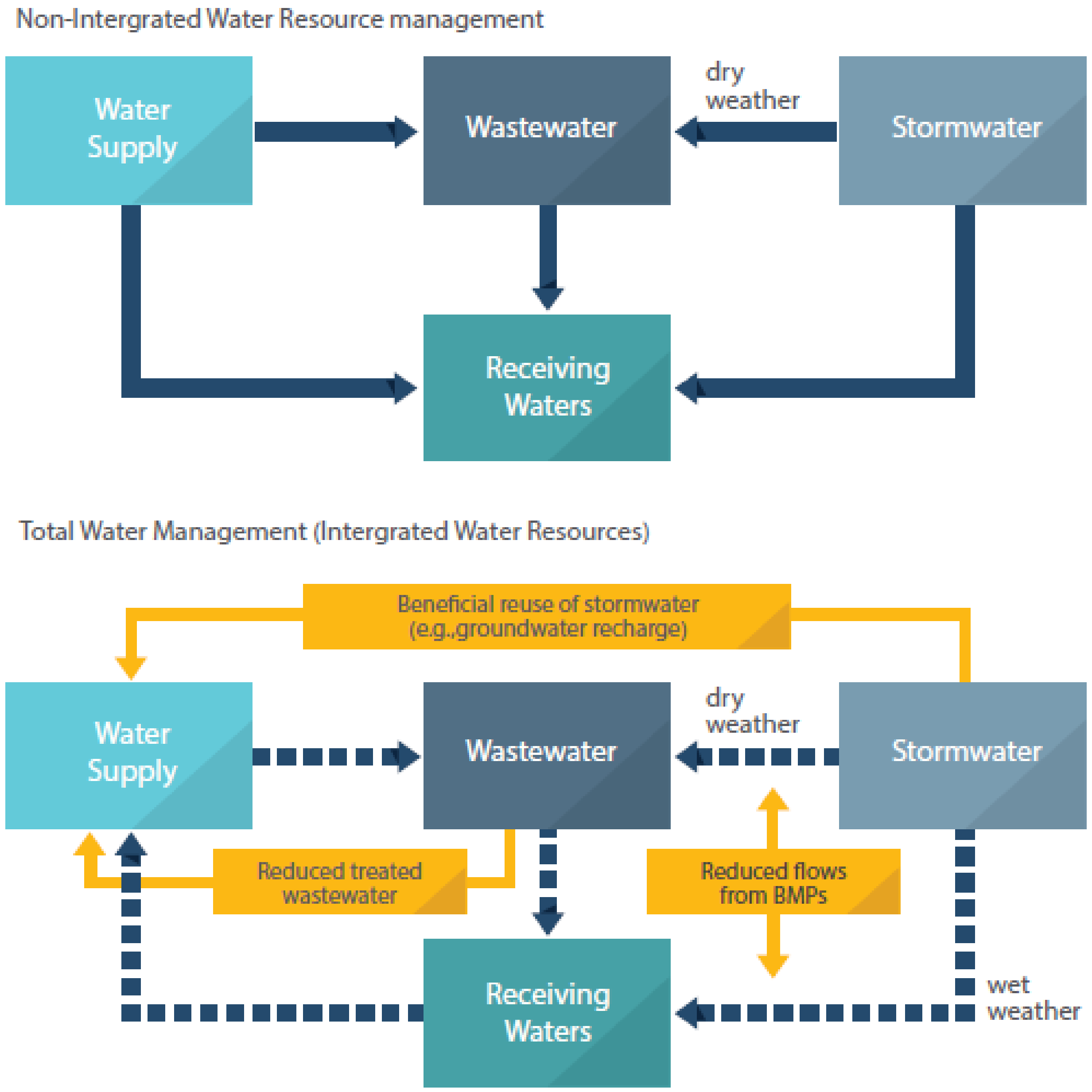


Non-Conventional water resources

- **Reforming water policies**

Should involve the society, public domain, governments, NGO, institution, academia, private sector,…etc

Integrated Water Resources Management (IWRM)

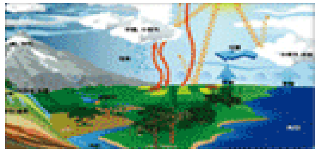


Traditional versus integrated water management including best management/LIDs (US EPA, 2012)

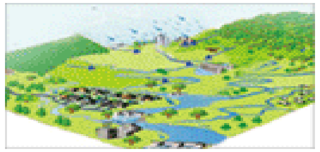
Integrated Water Resources Management

IWRM

Hydrological
Integrated consideration of rainfall, run-offs, evaporation, and other processes

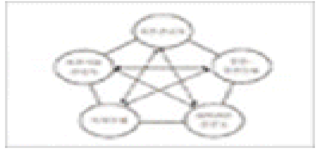


Topographical
Integrated management of water sources, valleys, streams, and estuaries

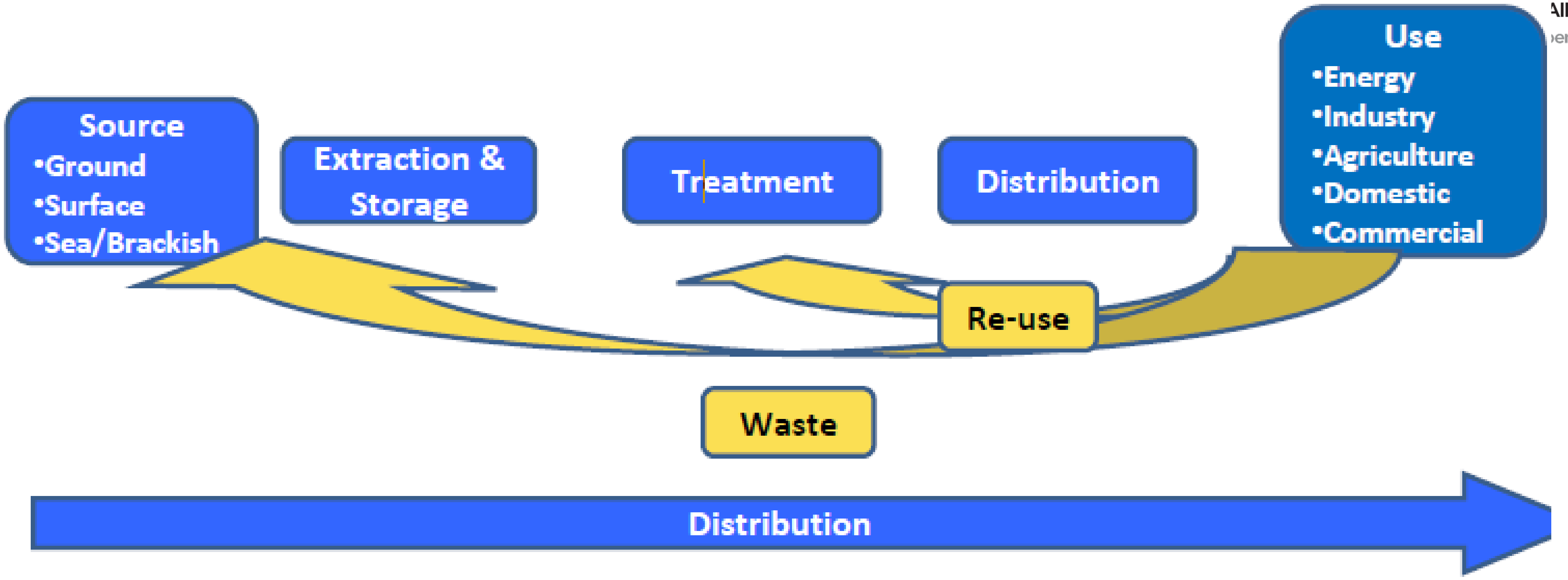


Functional
Integrated consideration of water quantity, quality,ecology, disaster prevention, and other factors

Social
Governance that all water-related entities in the basin participate in



Existing water managemnet (Water Grid)	+	Information and communication technology (Smart)	=	Smart Water Grid (SWG)
▪ Individual supply system ▪ Water and energy loss ▪ Supply-side, and unilateral		▪ Smart measuring devices ▪ Real-time information ▪ Transmitting and receiving		▪ Diversification of supply routes ▪ Integrated operation of infrastructure ▪ High efficiency,and reduction of energy ▪ Consumer-centered, and multi-directional



Match technical capability

Not just because “we can” …..
but because “we must”

INSTRUMENTED

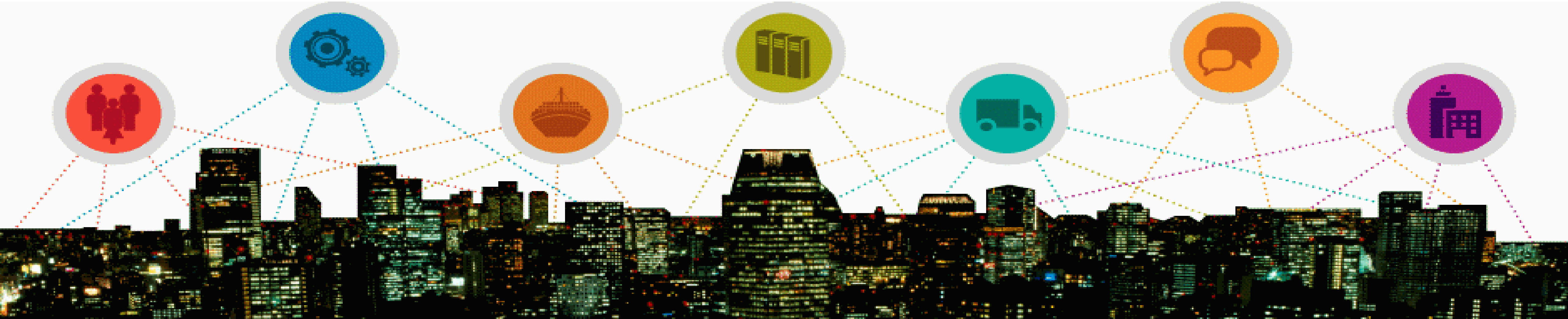
We now have the ability to measure, sense and see the exact condition of practically everything.

INTERCONNECTED

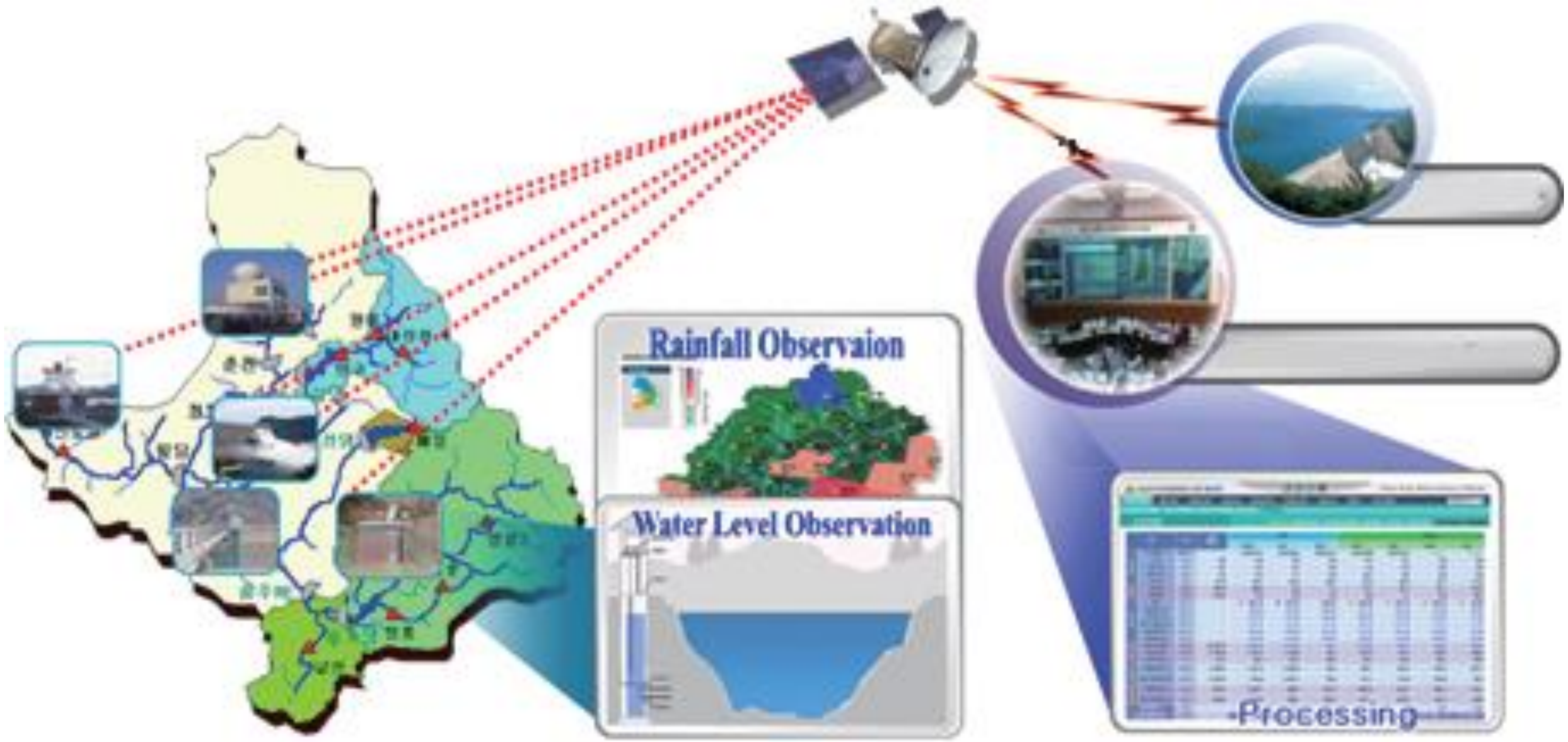
People, systems and objects can communicate and interact with each other in entirely new ways.

INTELLIGENT

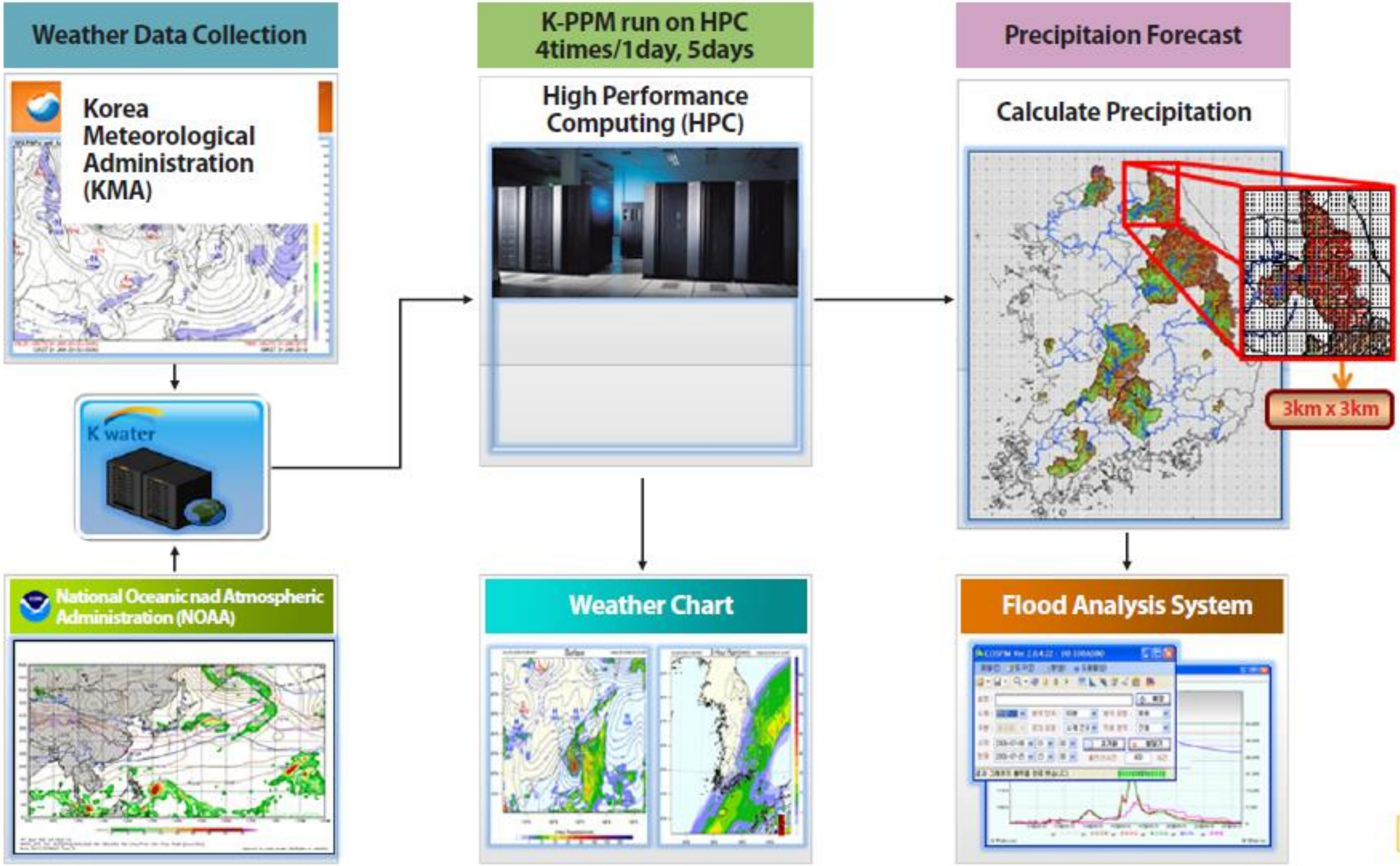
We can respond to changes quickly and accurately, and get better results by predicting and optimizing for future events.



Case Study (South Korea): The system functions to combine real-time data (covering water level, rainfall, water quality, …..etc.) and video of closed-circuit televisions from major dams, river, streams in the country for 24/7 monitoring services. K-water shares the data with the Korea Meteorological Administration, the Ministry of Land, Infrastructure and Transport of Korea



Korean communication satellite network (satellite + CDMA communication network)



Enterprise integrated water management system
between meteorological and hydrological data, South Korea

Thank You