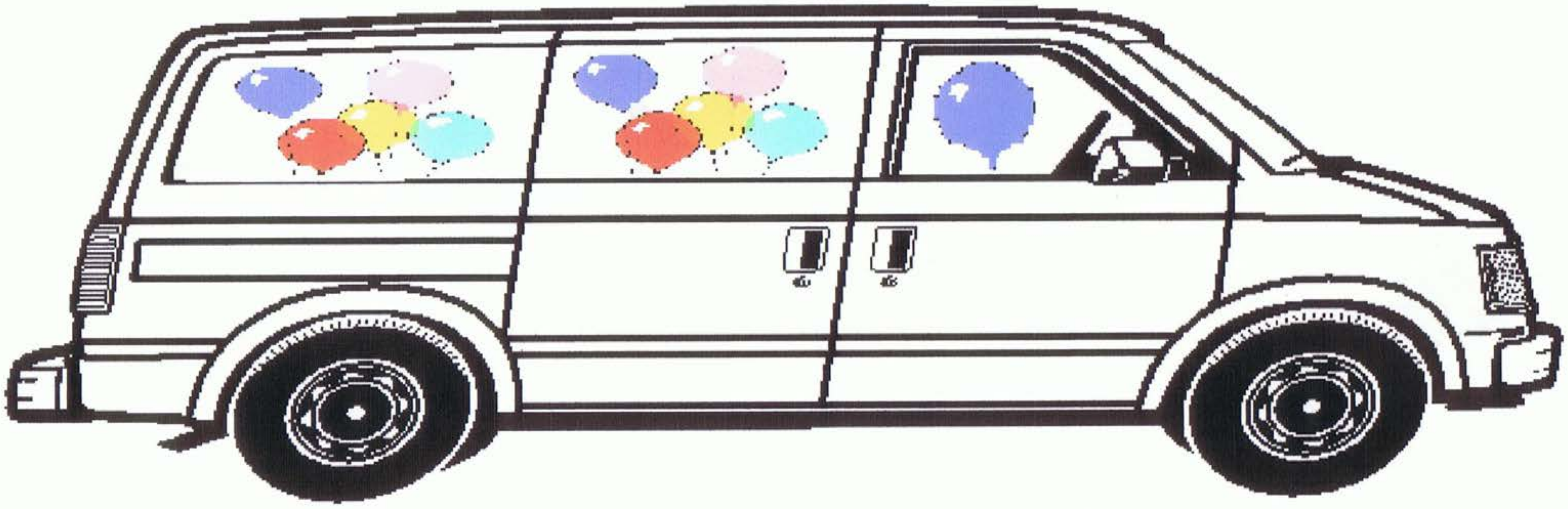
Water Shortage on the Water Planet

where 71 percent of surface area is water.

By Tibor Varga



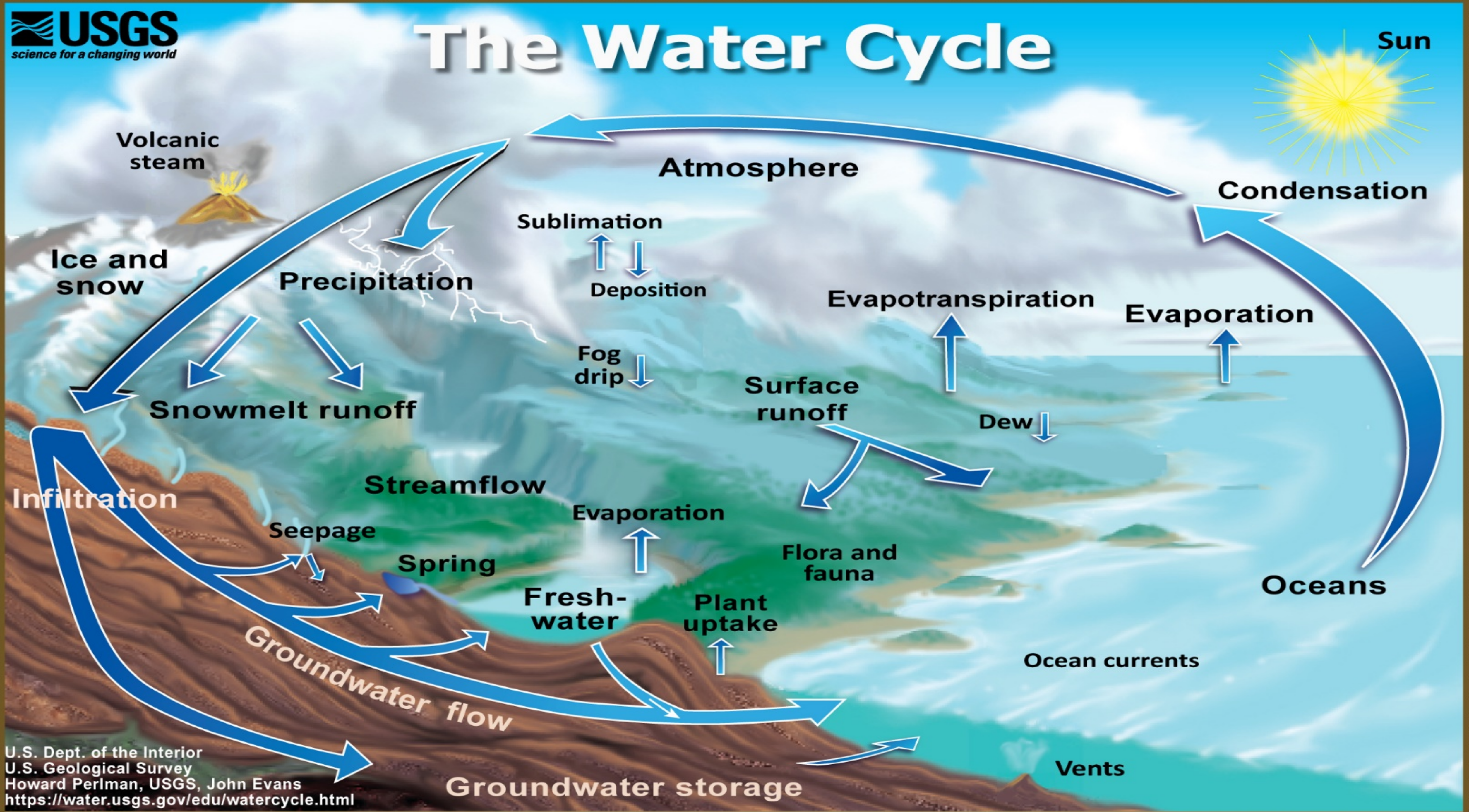
Party Van with Helium Balloons

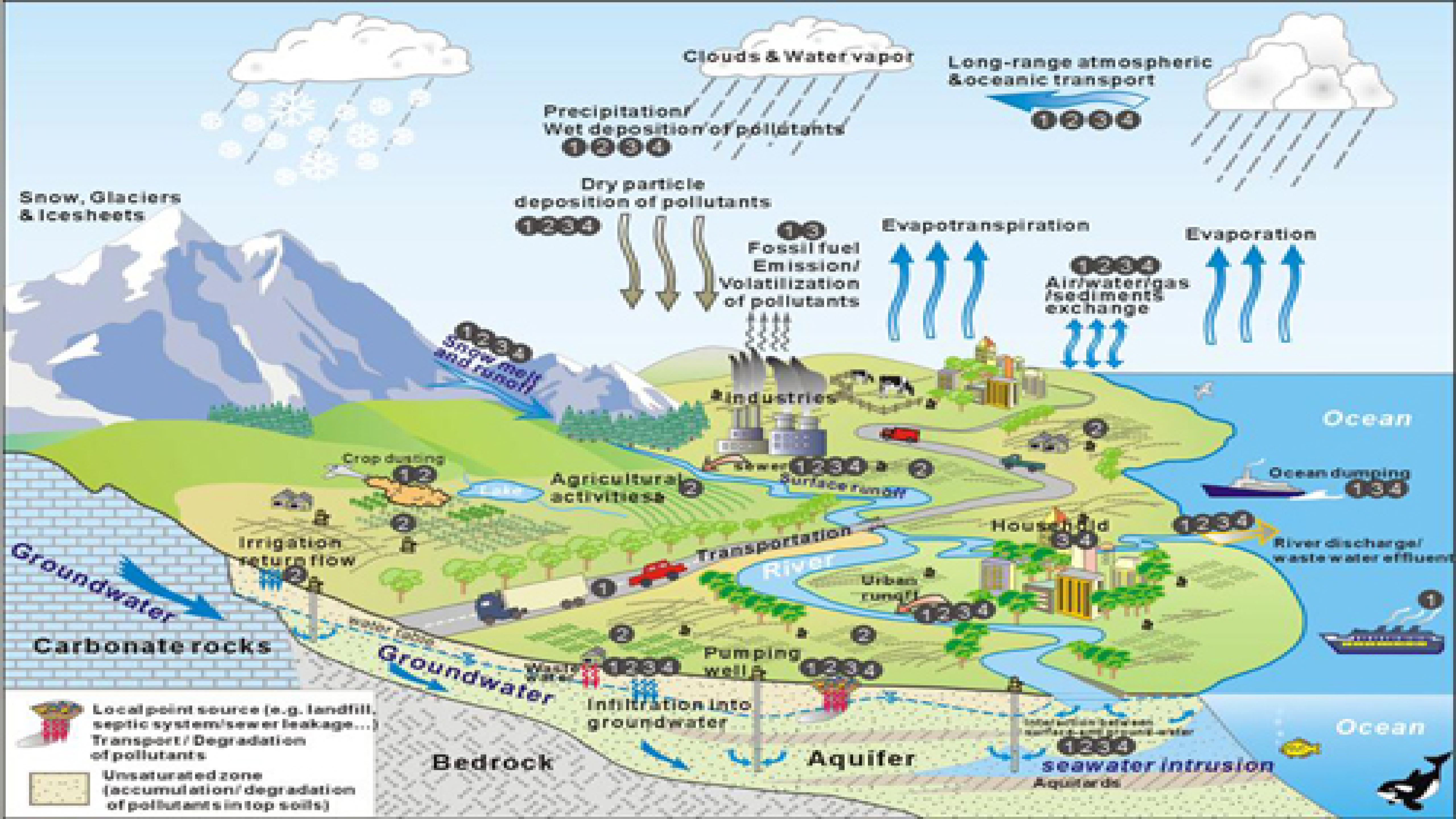
Water is a Compound

Made up of Hydrogen and Oxygen

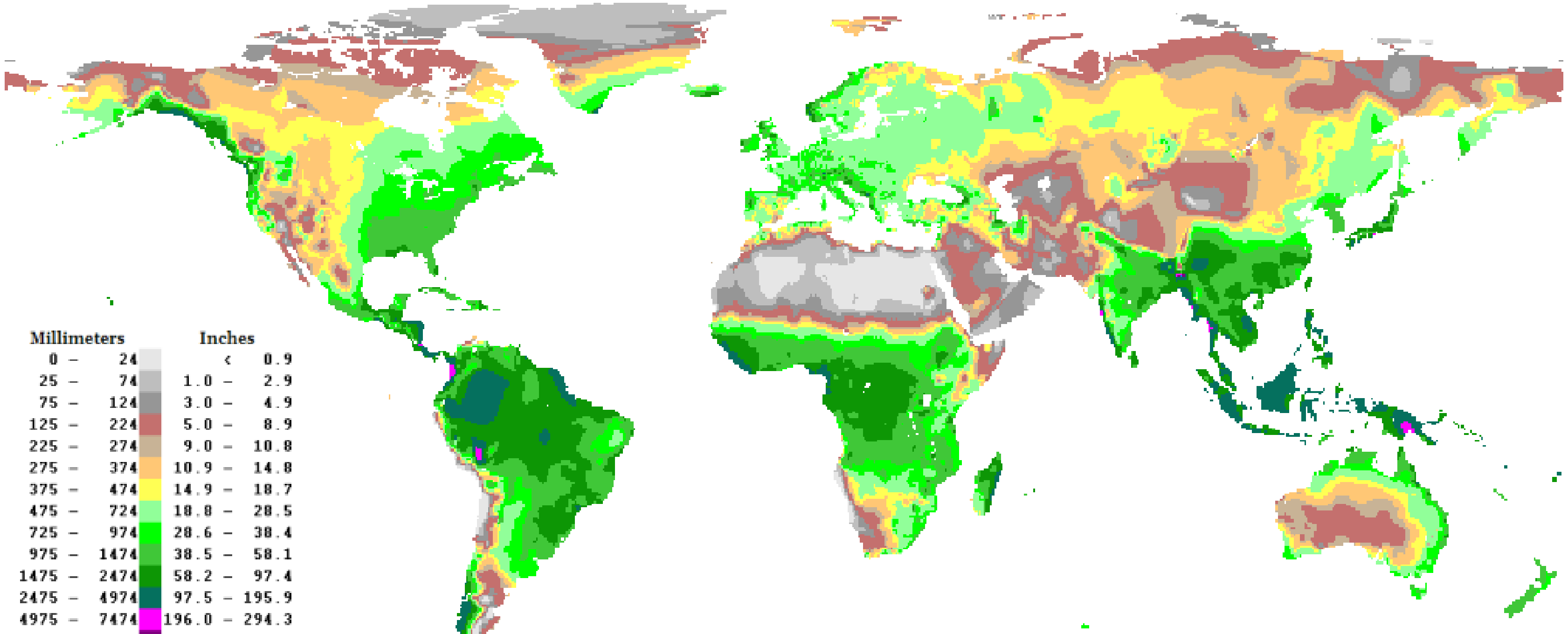
We may produce water by burning/oxidizing hydrogen.
It’s a universal solvent, almost never pure.
Its may be gas, liquid or solid on this Planet.
Celsius temperature scale based on water freezes at 0° and boils at 100° under standard conditions.
Its is most dense at 4 Celsius so Ice Floats
Covers 71% of the Earth surface and make up 50 to 78% of our bodies.

Water is Essential to Life on Earth

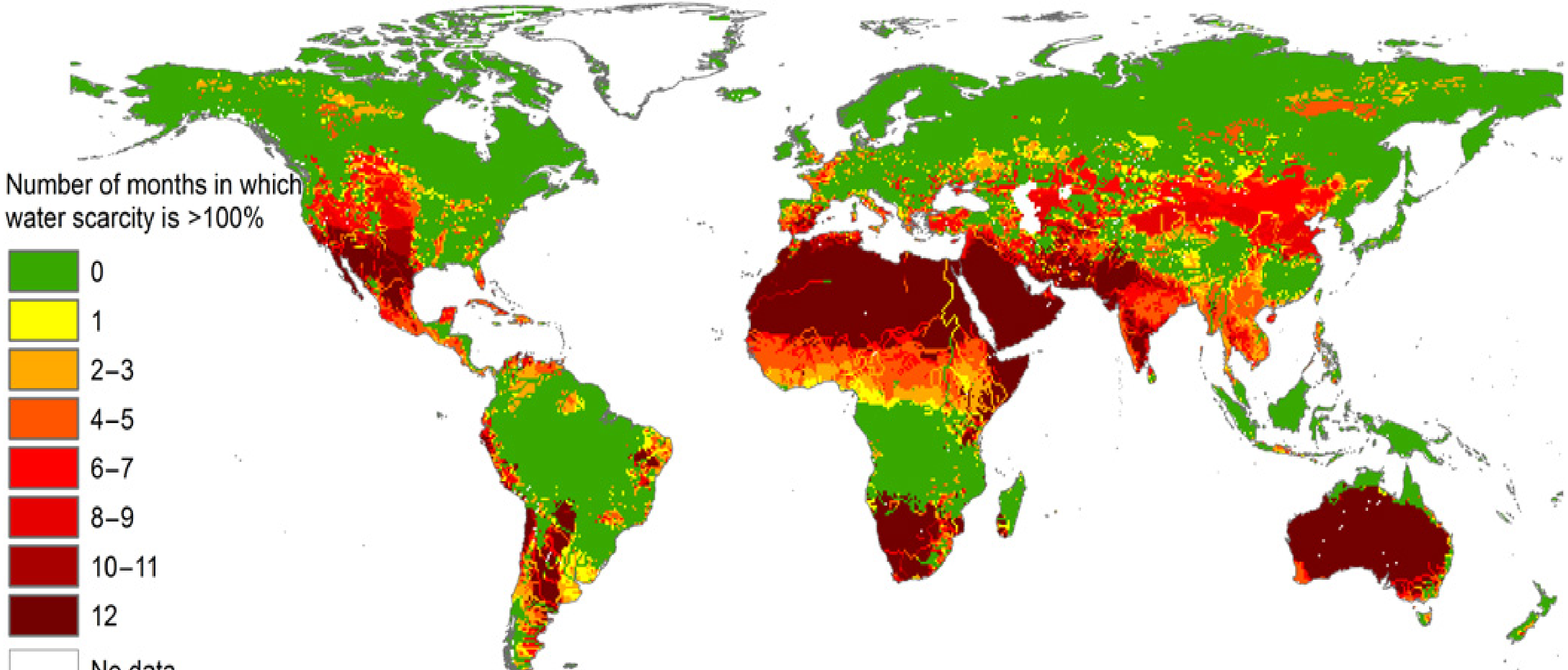

USGS
science for a changing world
The Water Cycle
Sun
Volcanic steam
Atmosphere
Condensation
Sublimation
Deposition
Ice and snow
Precipitation
Evapotranspiration
Evaporation
Fog drip
Surface runoff
Snowmelt runoff
Dew
Streamflow
Infiltration
Evaporation
Seepage
Spring
Flora and fauna
Oceans
Fresh-water
Plant uptake
Groundwater flow
Ocean currents
Vents
Groundwater storage
U.S. Dept. of the Interior
U.S. Geological Survey
Howard Perlman, USGS, John Evans
https://water.usgs.gov/edu/watercycle.html

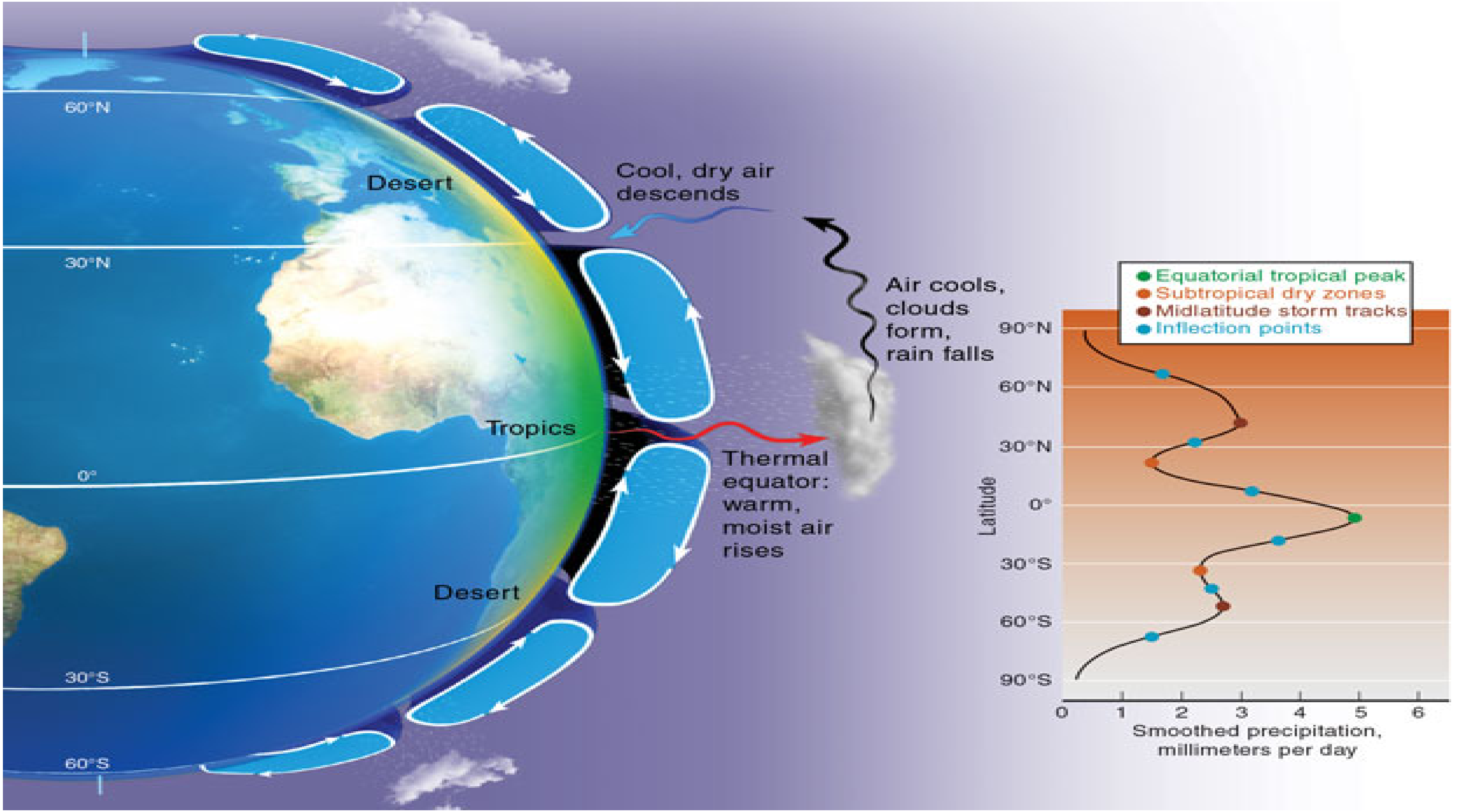


Clouds & Water vapor
Long-range atmospheric
&oceanic transport
1 2 3 4
Precipitation/
Wet deposition of pollutants
1 2 3 4
Snow, Glaciers
& Icesheets
Dry particle
deposition of pollutants
1 2 3 4
1 3
Fossil fuel
Emission/
Volatilization
of pollutants
Evapotranspiration
Evaporation
1 2 3 4
Air/water/gas
/sediments
exchange
1 2 3 4
Snow melt
and runoff
Industries
Ocean
Crop dusting
1 2
Sewer 1 2 3 4
Surface runoff
Lake
Agricultural
activities 2
Ocean dumping
1 3 4
Household
3 4
1 2 3 4
River discharge/
waste water effluent
Transportation
River
Irrigation
return flow
2
Groundwater
Urban
runoff
1 2 3 4
1
Carbonate rocks
Groundwater
Pumping
well
Waste
water 1 2 3 4
1 2 3 4
Local point source (e.g. landfill,
septic system/sewer leakage...)
Transport / Degradation
of pollutants
Unsaturated zone
(accumulation/ degradation
of pollutants in top soils)
Infiltration into
groundwater
Bedrock
Aquifer
1 2 3 4
seawater intrusion
Aquitards
Ocean

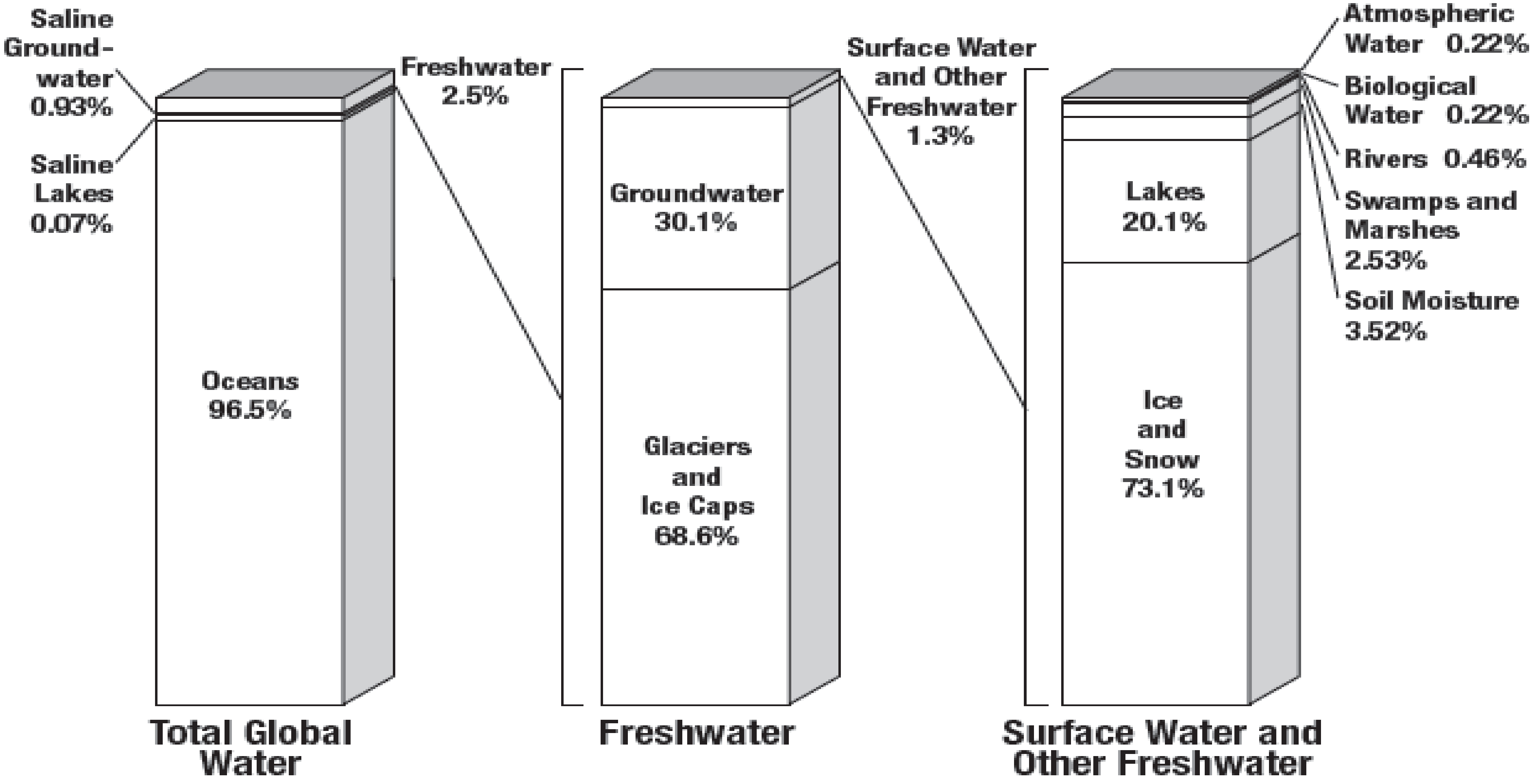


Total Annual Rainfall

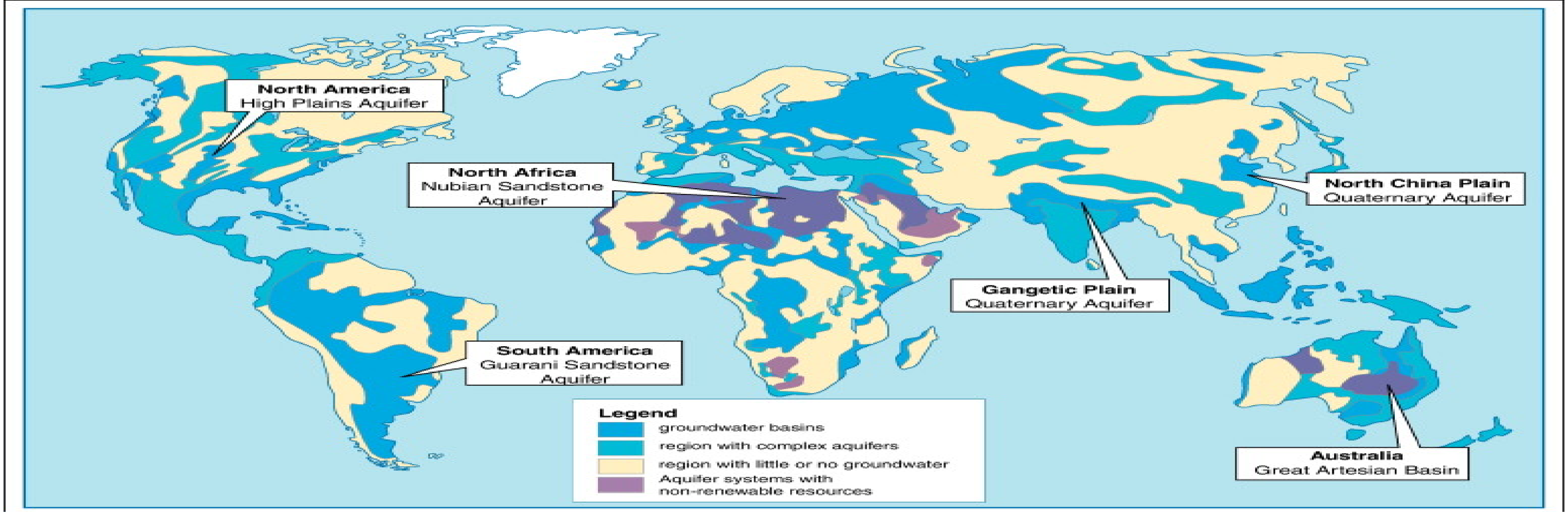


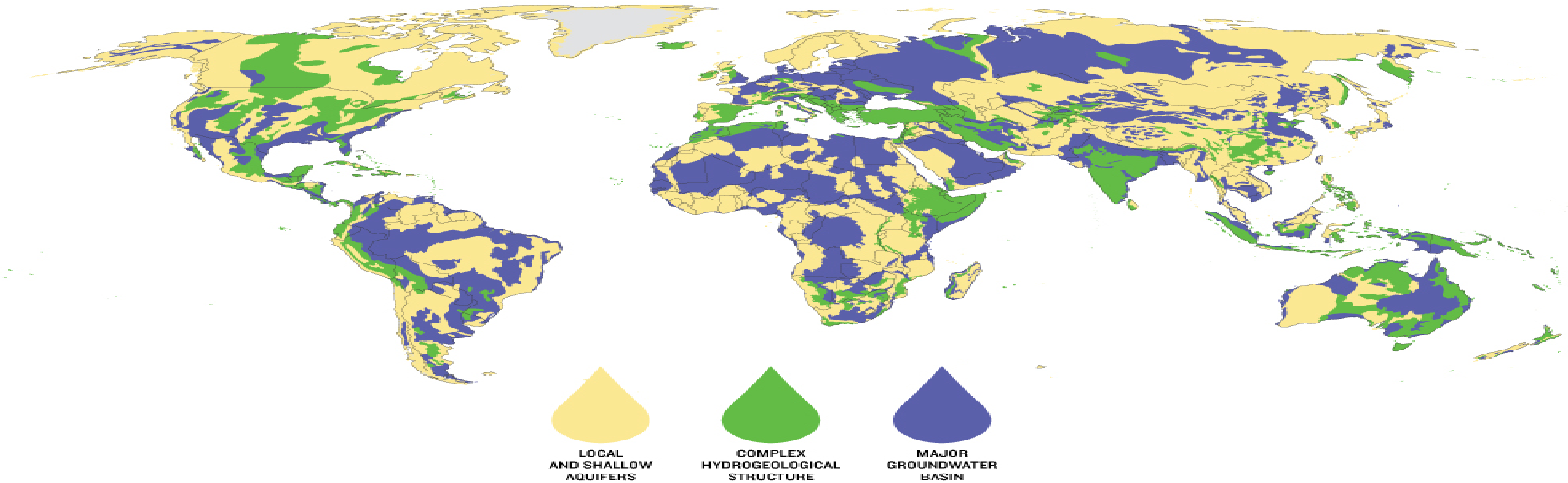

60°N
30°N
0°
30°S
60°S
Desert
Tropics
Desert
Cool, dry air descends
Air cools, clouds form, rain falls
Thermal equator: warm, moist air rises
Equatorial tropical peak
Subtropical dry zones
Midlatitude storm tracks
Inflection points
90°N
60°N
30°N
0°
30°S
60°S
90°S
Latitude
0 1 2 3 4 5 6
Smoothed precipitation, millimeters per day

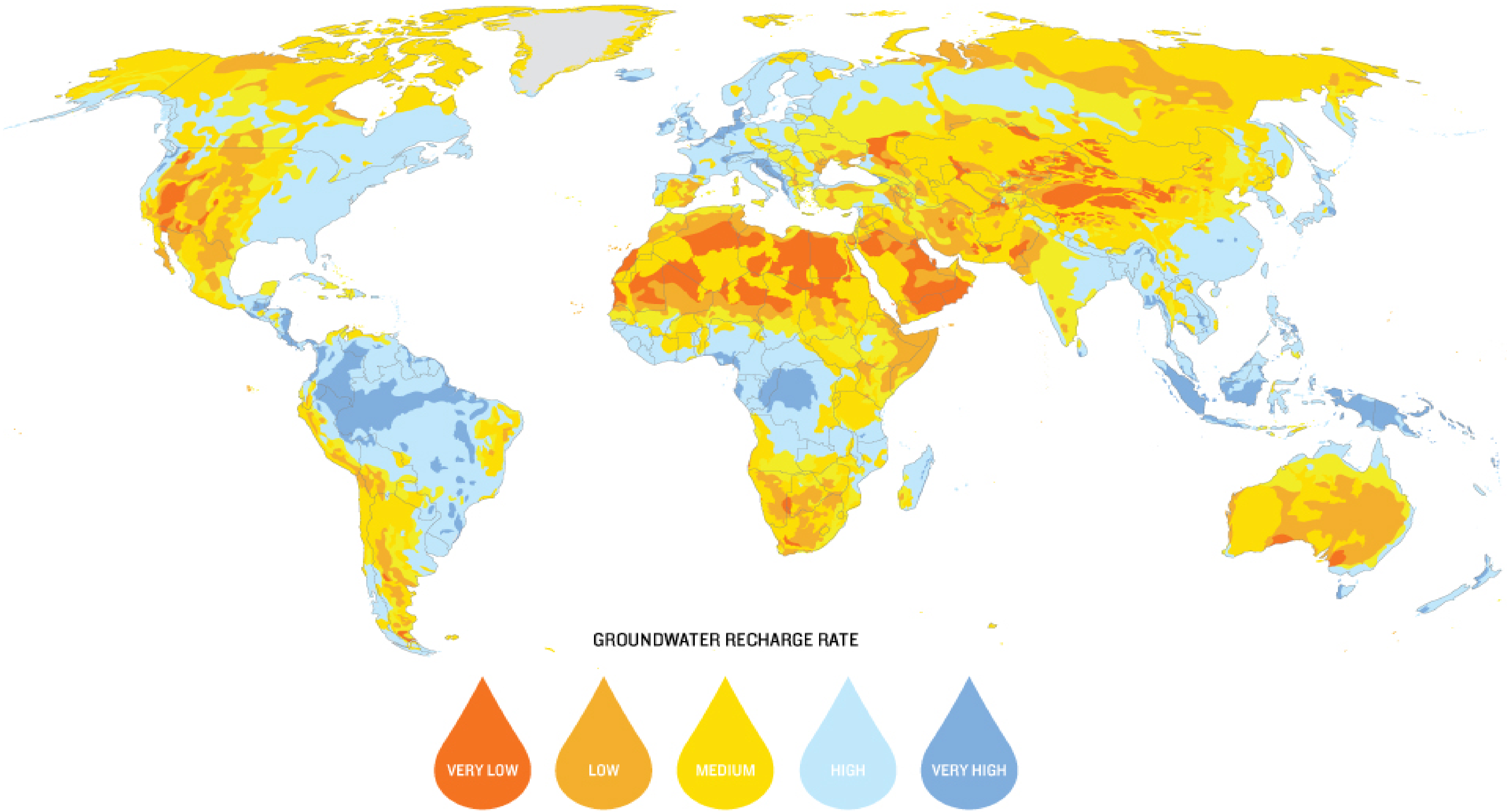
Distribution of Earth's Water



Source: Igor Shiklomanov's Chapter, "World Fresh Water Resources" in Peter H. Gleick (editor), 1993, Water in Crisis: A Guide to the World's Fresh Water Resources.

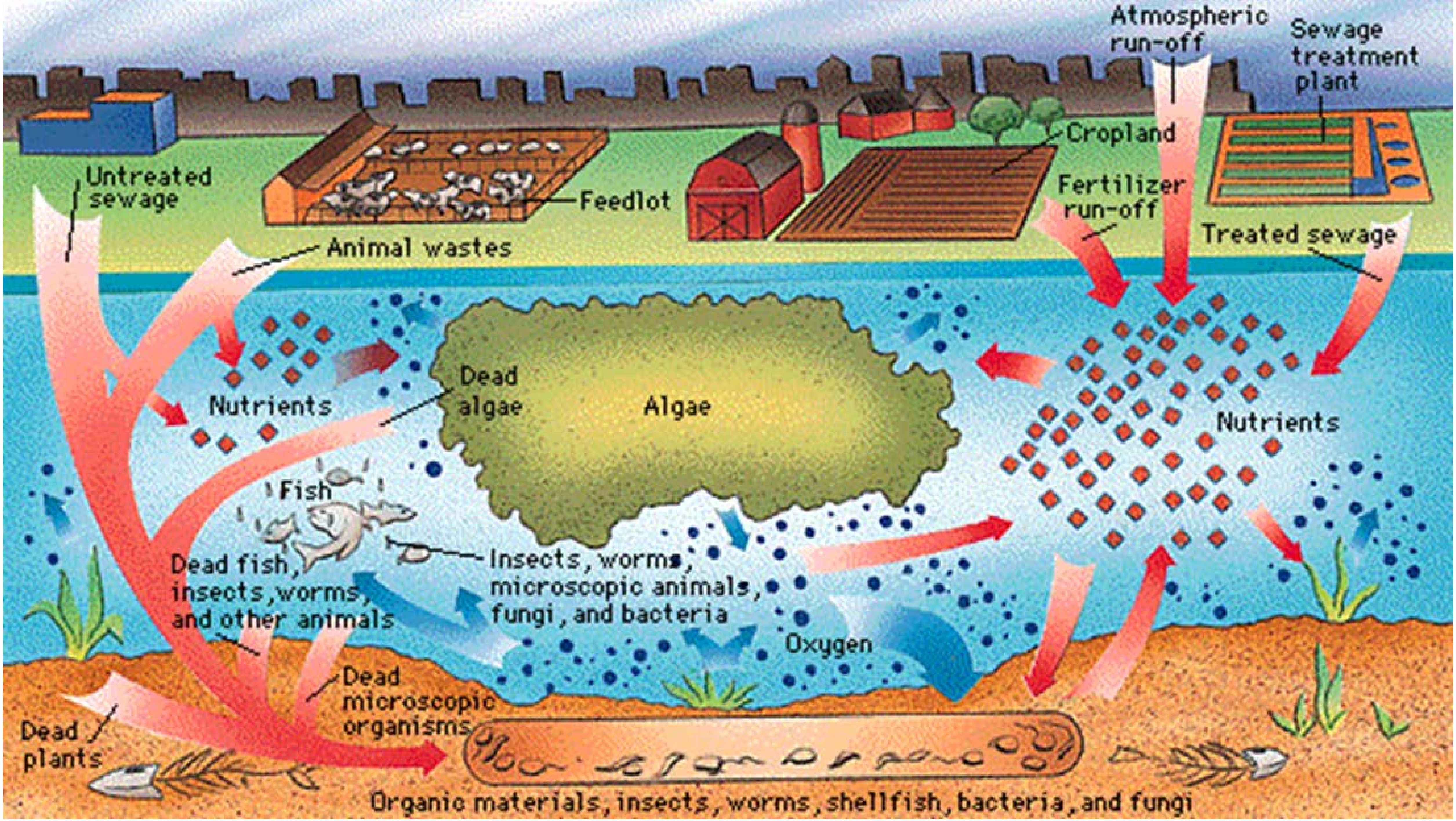

North America
High Plains Aquifer
North Africa
Nubian Sandstone
Aquifer
North China Plain
Quaternary Aquifer
Gangetic Plain
Quaternary Aquifer
South America
Guarani Sandstone
Aquifer
Australia
Great Artesian Basin
Legend
groundwater basins
region with complex aquifers
region with little or no groundwater
Aquifer systems with
non-renewable resources

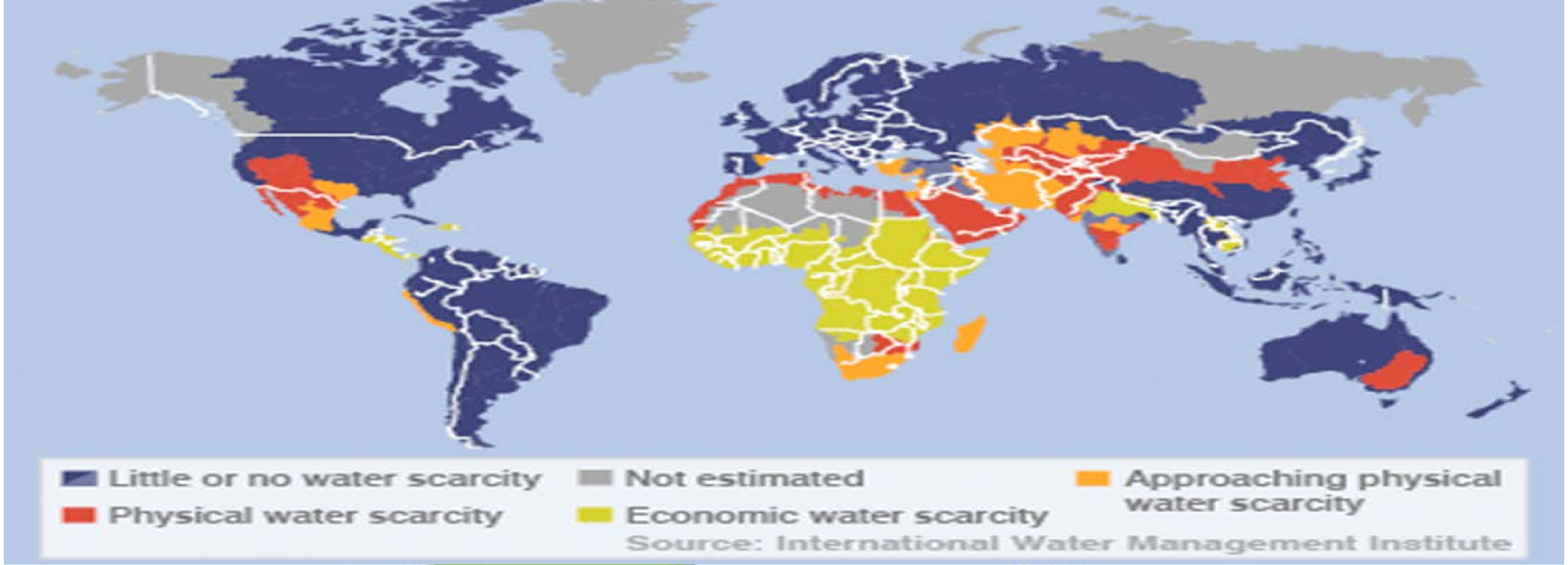

LOCAL
AND SHALLOW
AQUIFERS
COMPLEX
HYDROGEOLOGICAL
STRUCTURE
MAJOR
GROUNDWATER
BASIN


GROUNDWATER RECHARGE RATE
VERY LOW
LOW
MEDIUM
HIGH
VERY HIGH

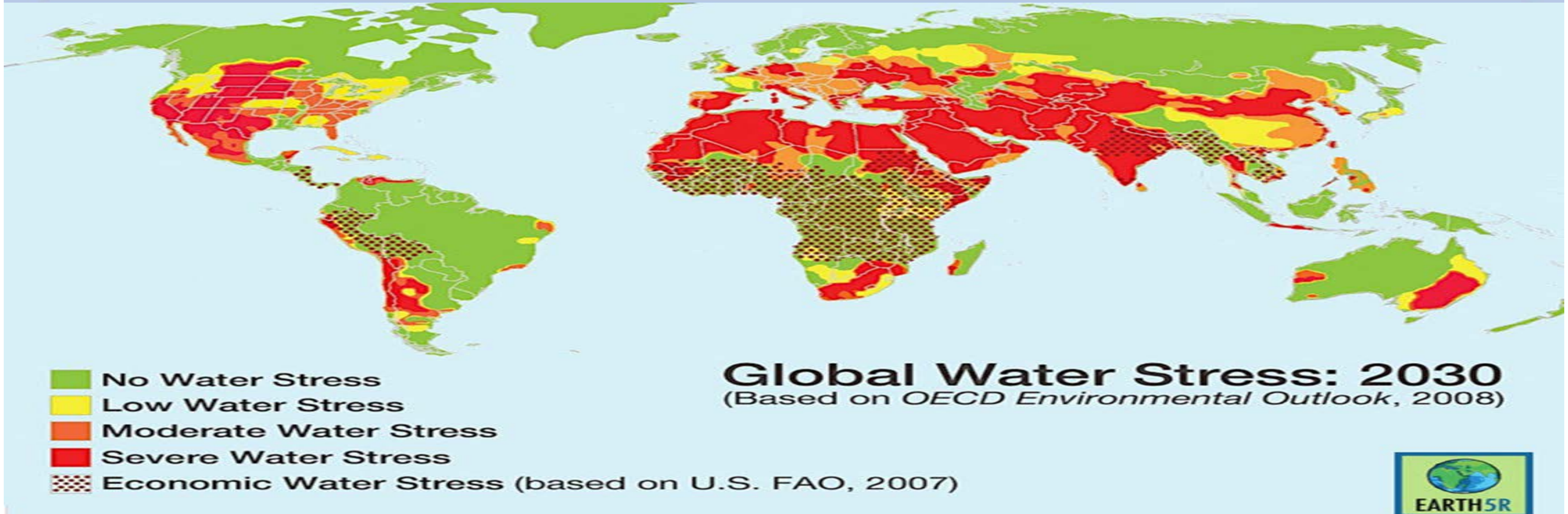
Renewable Internal Freshwater Resources

SN	Country	Total renewable water resources (km^3)	Date of Info
1	Brazil	8,233	2011
2	Russia	4,508	2011
3	United States	3,069	2011
4	Canada	2,902	2011
5	China	2,840	2011
6	Colombia	2,132	2011
—	EU	2,057	2011
7	Indonesia	2,019	2011
8	Peru	1,913	2011
9	India	1,911	2011
10	Congo, D R	1,283	2011
11	Venezuela	1,233	2011
12	Bangladesh	1,227	2011

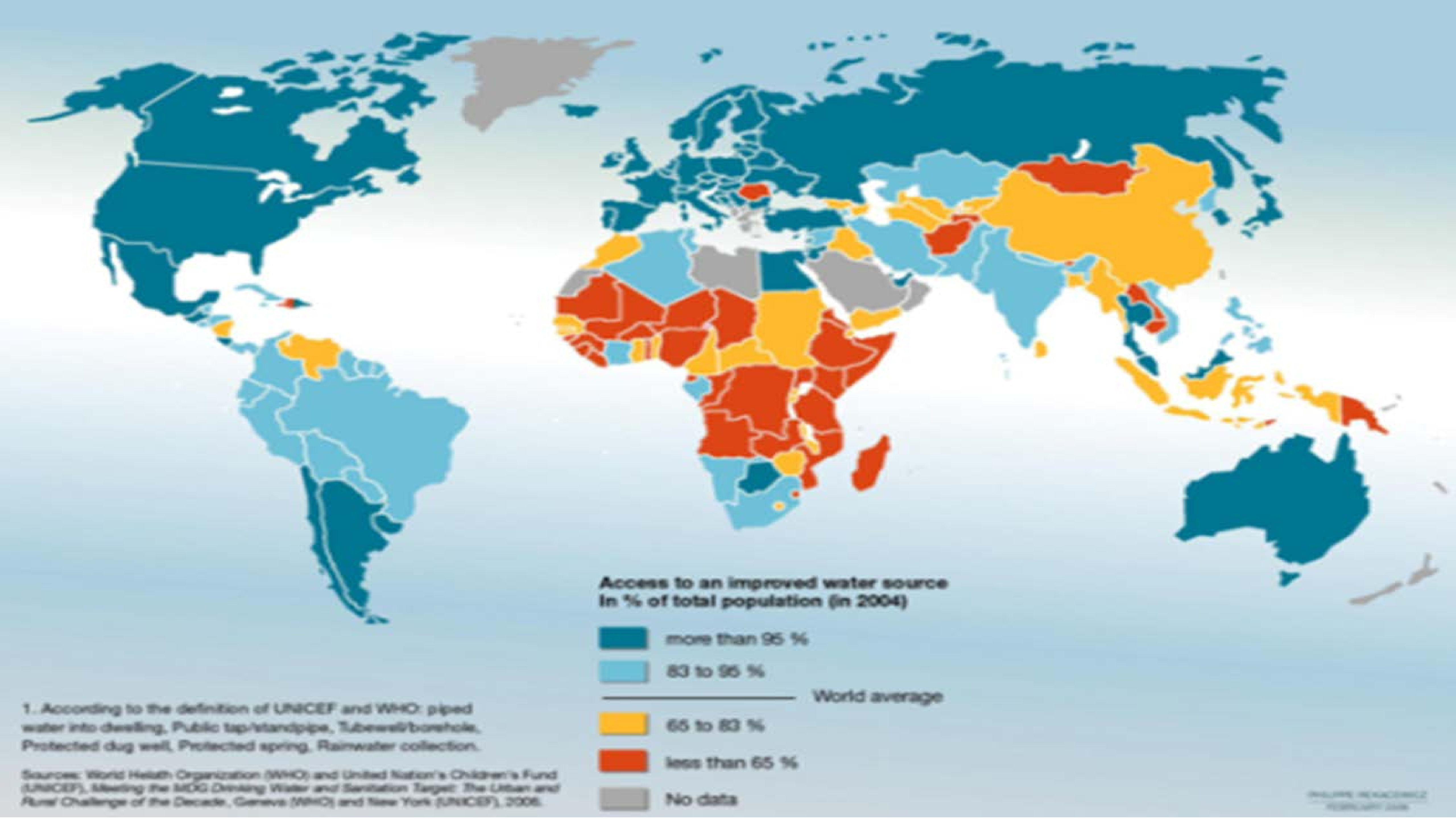


Atmospheric run-off
Sewage treatment plant
Cropland
Untreated sewage
Feedlot
Fertilizer run-off
Treated sewage
Animal wastes
Dead algae
Algae
Nutrients
Nutrients
Fish
Dead fish, insects, worms, and other animals
Insects, worms, microscopic animals, fungi, and bacteria
Oxygen
Dead microscopic organisms
Dead plants
Organic materials, insects, worms, shellfish, bacteria, and fungi



Little or no water scarcity
Physical water scarcity
Not estimated
Economic water scarcity
Approaching physical water scarcity
Source: International Water Management Institute



No Water Stress
Low Water Stress
Moderate Water Stress
Severe Water Stress
Economic Water Stress (based on U.S. FAO, 2007)
Global Water Stress: 2030
(Based on OECD Environmental Outlook, 2008)
EARTH5R



Access to an improved water source
in % of total population (in 2004)
more than 95 %
83 to 95 %
World average
65 to 83 %
less than 65 %
No data
1. According to the definition of UNICEF and WHO: piped water into dwelling, Public tap/standpipe, Tubewell/borehole, Protected dug well, Protected spring, Rainwater collection.
Sources: World Health Organization (WHO) and United Nation's Children's Fund (UNICEF), *Meeting the MDG Drinking Water and Sanitation Target: The Urban and Rural Challenge of the Decade*, Geneva (WHO) and New York (UNICEF), 2006.

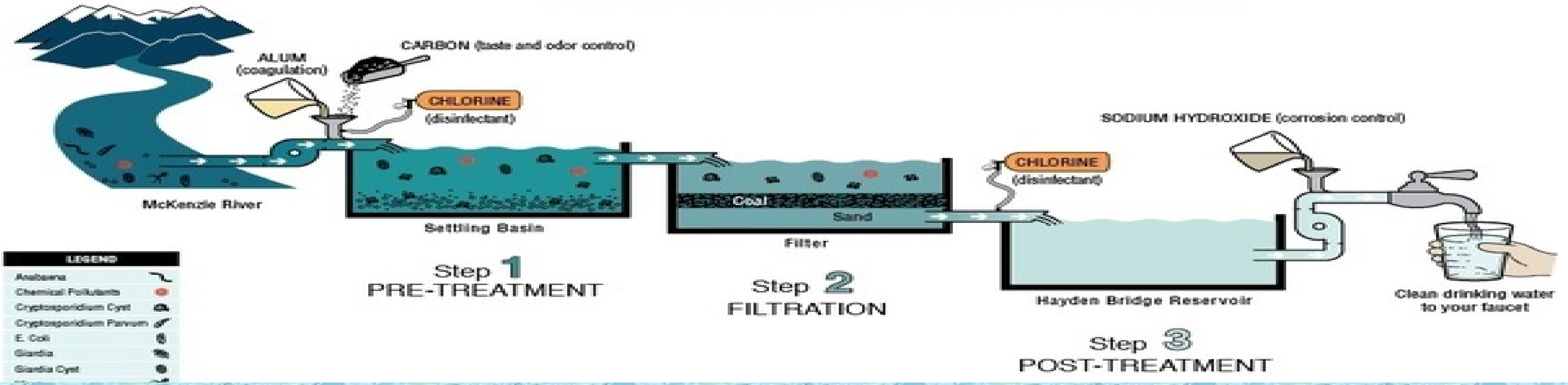
Water Contaminants and Characteristics

Viruses & Bacteria	Microbial contaminants, such as viruses and bacteria, which may come from sewage treatment plants, septic systems, agricultural livestock operations and wildlife
Salts & Minerals	Inorganic contaminants, such as salts and metals, which can be naturally occurring or result from urban storm water runoff, industrial or domestic wastewater discharges, oil and gas
Pesticides	Pesticides and herbicides, which may come from a variety of sources such as agriculture, urban storm water runoff, and residential uses.
Organic Chemicals	Organic chemical contaminants, including synthetic and volatile organic chemicals, which are byproducts of industrial processes and petroleum production, and can also come from gas stations, urban storm water runoff, and septic systems.
Radioactive Elements	Radioactive contaminants, which can be naturally occurring or be the result of oil and gas production and mining activities

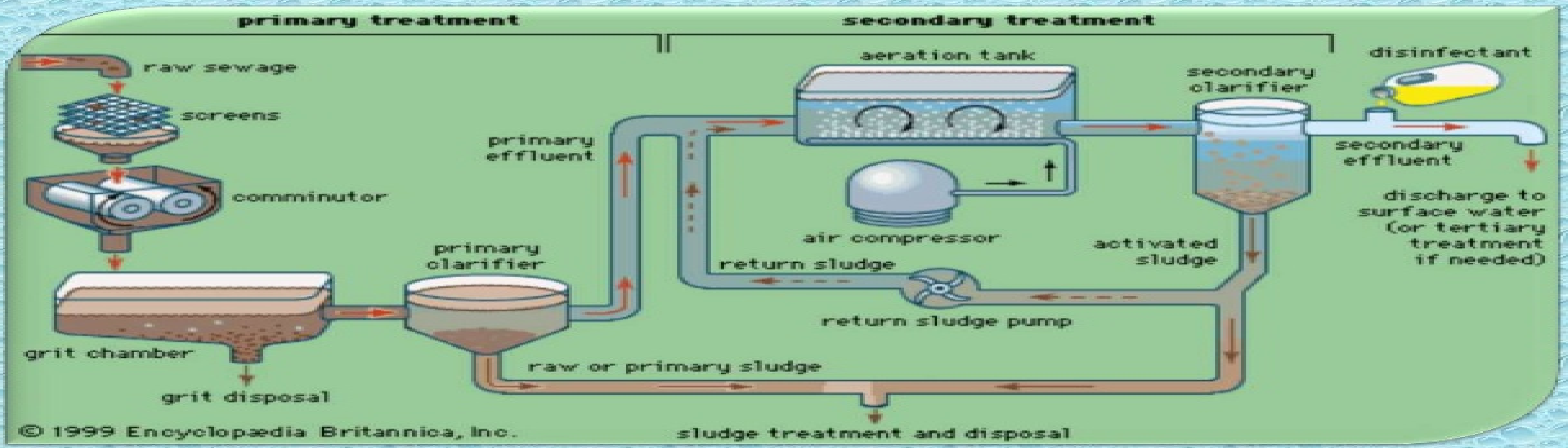
Other characteristics; taste, odor, color, corrosivity, temperature, etc.

The treatment process need to be designed specifically for the available water and the variability of its quality.

EWEB Water Filtration Process



Waste Water Treatment Process



Water availability and quality is specific to location, climate, geology
and
the potential for access to imported water from other locations
and
dependent on legal, regulatory, jurisdictional and environmental factors.

World drought frequency, duration, and severity for 1951–2010

Jonathan Spinoni,* Gustavo Naumann, Hugo Carrao, Paulo Barbosa and Jurgen Vogt
Papers published in Hydrology and Earth System Sciences Discussions are under
open-access review for the journal Hydrology and Earth System Sciences

Intensity-Duration-Frequency and spatial analysis of droughts using the Standardized Precipitation Index

M. Mohseni Saravi1 , A. A. Safdari1 , and A. Malekian2 1 Faculty of Natural Resources,
University of Tehran, Karaj, Iran 2 International Research Center for Coexistence
with Desert, University of Tehran, Tehran, Iran

Trends and Variability in Droughts in the Pacific Islands and Northeast Australia

Simon McGree*School of Science, RMIT University, and Climate and Oceans Support
Program in the Pacific, Climate Information Services, Environment and Research Division,
Bureau of Meteorology, Melbourne, Victoria, Australia*
Sergei Schreider*School of Science, RMIT University, Melbourne, Victoria, Australia*
Yuriy Kuleshov*School of Science, RMIT University, Melbourne, and School of Mathematics
and Statistics, The University of Melbourne, Parkville, and Faculty of Sciences,
Engineering and Technology, Swinburne University of Technology, Melbourne,
and Climate Information Services, Environment and Research Division, Bureau of Meteorology, Melbourne, Victoria, Australia*

Water Hierarchy Level	Items to Consider
Eliminate	Educate your staff to avoid using water where appropriate. Consider if the water using activity is actually required?
Alternative Water Use (See Section 2.0)	Eliminate the inappropriate use of mains (potable) water. Can you hygienically use an alternative water source in the activity?
Reduce	Consider options to improve water efficiency. Can existing fittings be upgraded to improve water efficiency?
Reuse	Can water efficiency be increased through its reuse? Consider if the reused water needs to be treated prior to reuse?
Recycle	Can water be recycled for use in another water using activity?
Disposal	Always dispose of water in a legal and environmentally responsible manner to avoid flooding, pollution or inconvenience to others.

5 countries with cutting-edge water technology

From desalination to smart metering, these global leaders are ushering in a future of clean water.Techniques vary depending on each country's particular needs and strengths, but they usually involve one or more of three methods: desalination, water conservation and water recycling. Here are five countries that are leading the way to the future of water technology.

Saudi Arabia

Saudi Arabia has long been a leader in desalination. In fact, it's the largest producer of desalinated water in the world. Most recently, it's taken desalination technology to the next level by introducing desalination powered by renewable, **solar energy** – a resource that's plentiful in this desert nation. It's home to the world's largest solar photovoltaic (PV) desalination plant in the city of Al Khafji. By 2019, Saudi Arabia wants all **desalination** plants to be powered by **solar technology**.

Israel

Israel has always been a leader in **water conservation technology** because of its desert location. But today that necessity has grown into an economic incentive. The country recycles 85 percent of wastewater. By 2020, it estimates that 50 percent of its agricultural needs will be met with recycled water. Additionally, with more than 300 water technology companies specializing in desalination, it earns $2 billion annually by exporting its water to other countries

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Greece

Geothermal renewable energy is plentiful on the island of Milos in Greece because of its location on the Aegean Volcanic Arc. Magma trapped beneath the Earth's surface heats the surrounding rocks and the water trapped within the rocks creating geothermal resevoirs. The hot water created is piped through underground wells where it becomes hot steam, which spins turbines and generates energy. Geothermal energy is used to convert sea water and brackish water by heating up water to form water vapor that is condensed into drinking water and water for irrigation. It's a source of abundant energy that's inexpensive and doesn't depend on fossil fuels. That's why the country's new **geothermal desalination** project is an ideal fit. The plant will provide desalinated water at a low cost to residents of the island.

United Kingdom

United Kingdom is a leader in smart water metering technology, enabling residents to monitor their water usage online. Smart meters provide users with more detailed information about how water is being used and in what quantities. It allows households to get a better hold on their water usage each month and encourages residents to install water efficient appliances and other water-saving technologies in their homes. It also helps customers pinpoint leaks that cause increased usage. By 2030, Thames Water, a leading U.K. provider, wants smart water meters installed in every home it serves.

United States

In the U.S., California has been besieged by historic droughts, which have been the stimulus to build the **largest desalination plant** in the Western Hemisphere. Once completed, the plant will pump 50 million gallons of seawater per day through a 10-mile water delivery pipeline, one of the most advanced plants in the world. The plant, located in Southern California, will be completed in 2016.

Saudi Arabia buying up farmland in US Southwest

Saudi land purchases in California and Arizona fuel debate over water rights

Why Are Saudis Buying Up Farmland in Drought-Stricken Western U.S.?

Saudi Hay Farm In Arizona Tests State's Supply Of Groundwater

Arizona officials enraged over farmland purchases by Saudi Arabia to grow hay

Saudi Arabia is buying US land to feed its cows

U.S. water rights at stake as Saudis buy up land in California

Andy Sacks | Getty Images Harvesting alfalfa crop - Saudi Arabia grows alfalfa hay in both states for shipment back to its domestic dairy herds. In another real-life example of the world's interconnected economy, the Saudis increasingly look to produce animal feed overseas in order to save water in their own territory, most of which is desert. Privately held Fondomonte California on Sunday announced that it bought 1,790 acres of farmland in Blythe, California — an agricultural town along the Colorado River — for nearly $32 million. Two years ago, Fondomont's parent company, Saudi food giant Almarai, purchased another 10,000 acres of farmland about 50 miles away in Vicksburg, Arizona, for around $48 million.

"They will continue to come over here and buy properties where they can grow good-quality alfalfa hay and ship it back to the Middle East. It makes logical sense for them to do that because they're not going to be able to grow it in Saudi Arabia, especially for milk production."-Joseph Dutra,

A Little-Known Company Is Quietly MakingMassive Water Deals

By Ry Rivard, May 7, 2019 Voice Of San Diego

Los Angeles-based Renewable Resources Group has helped to sell 33,000 acres of land to the Metropolitan Water District of Southern California in the past years. Now,it may be working on another deal that could rearrange the distribution of water in California forever.

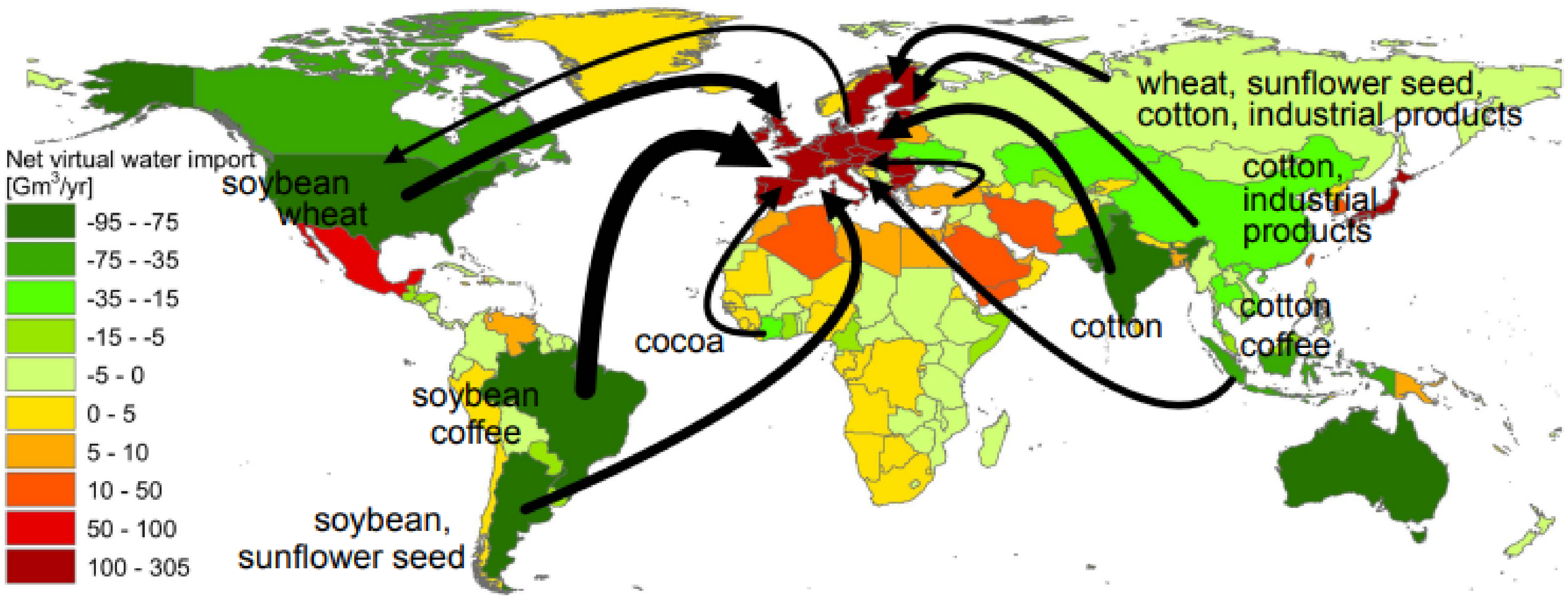
In 2011, Harvard University and a small private company began buying up rights to the Colorado River. Within a year, they owned nearly 13,000 acres near the small Riverside County farming community of Blythe.

Now, investors may want to make money by marketing land with water.

The Imperial Valley has more rights to water from the Colorado River than entire states.

Virtual water

- Virtual-water content of a product is the freshwater ‘embodied’ in the product.
- Refers to the volume of water consumed or polluted for producing the product, measured over its full production chain.
- If a nation exports/imports such a product, it exports/imports water in virtual form.



Over 40% of the water footprint of European consumers is outside of Europe

WATER USE AND WATER RATES 2018

Imperial Irrigation District

https://www.iid.com/water/about-iid-water

WATER USE	
IID Total Consumptive Use in acre-feet as reported by USBR for 2016	2,504,258 AF
2016 Intentionally Created Surplus	70,077 AF
2016 Underrun	62,497 AF

WATER RATES	
Agriculture	$20/AF
Municipal	$20/AF
Industrial	$85/AF
Pipe Service Charge	
Tier 1 - pipe with 2" or less diameter, and service to small parcels from an open ditch	$250/acct/yr
Tier 2 - pipe over 2" diameter and not exceeding 6" (more than 2 acres)	$100/acct/yr

Metropolitan Water District of Southern California

http://www.mwdh2o.com/WhoWeAre/Management/Financial-Information

Water Rate Table

Effective January 1st	2018	2019	2020
Tier 1 Supply Rate ($/AF)	$209	$209	$208
Tier 2 Supply Rate ($/AF)	$295	$295	$295
System Access Rate ($/AF)	$259	$326	$346
Water Stewardship Rate ($/AF)	$55	$69	$65
System Power Rate ($/AF)	$132	$127	$136
Full Service Untreated Volumetric Cost ($/AF)			
Tier 1	$695	$731	$755
Tier 2	$781	$817	$842
Treatment Surcharge ($/AF)	$320	$319	$323
Full Service Treated Volumetric Cost($/AF)			
Tier 1	$1,015	$1,050	$1,078
Tier 2	$1,101	$1,136	$1,165
Readiness-to-Serve Charge ($M)	$140	$133	$136
Capacity Charge ($/cfs)	$8,700	$8,600	$8,800

Wholesale Water Supply Assessment - Revised 8/22/2016

Demands for Metropolitan Water Supply

	2017	2018	2019
Total Member Agency Wholesale Requests	1,750,490	1,718,154	1,725,949
Total Water Demand	**1,750,490**	**1,718,154**	**1,725,949**

Metropolitan Water Supply Sources

	2017	2018	2019
Total State Water Project Supplies	736,960	105,280	421,120
Total Colorado River Aqueduct Supplies	719,065	771,295	733,180
*Structural Conservation since 2013-2014**	*62,451*	*58,422*	*52,320*
Total Storage: Take/(Put)	294,465	841,579	571,649
Total Water Supply	**1,750,490**	**1,718,154**	**1,725,949**

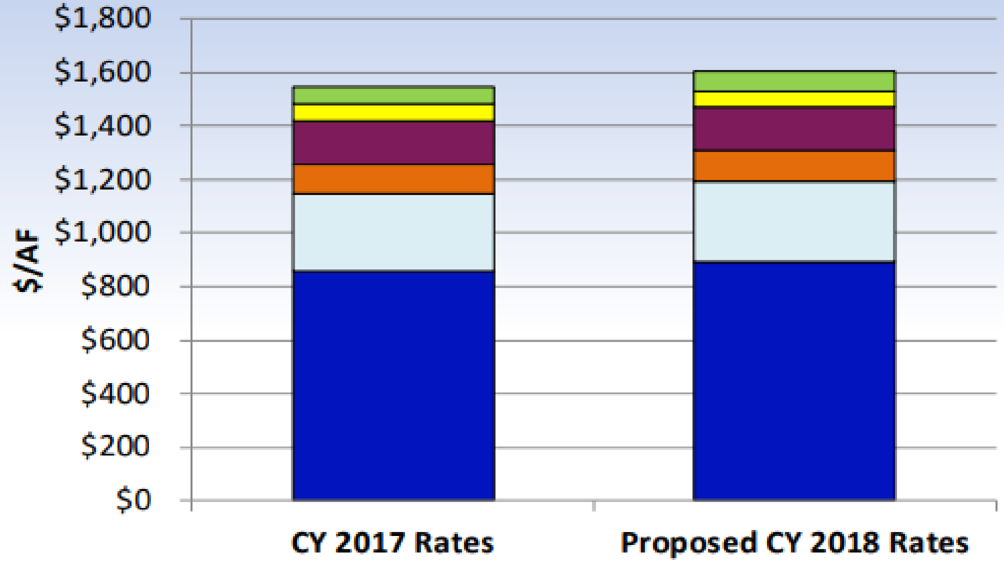
Water Supply and Demand Balance

	2017	2018	2019
Total Water Demand	1,750,490	1,718,154	1,725,949
Total Water Supply	1,750,490	1,718,154	1,725,949
Water Balance: Surplus/(Shortage)	0	0	0
Reduction to Wholesale Water Requests	**0%**	**0%**	**0%**

*Structural conservation savings are excluded from this assessment per SWRCB memo 6/22/2016

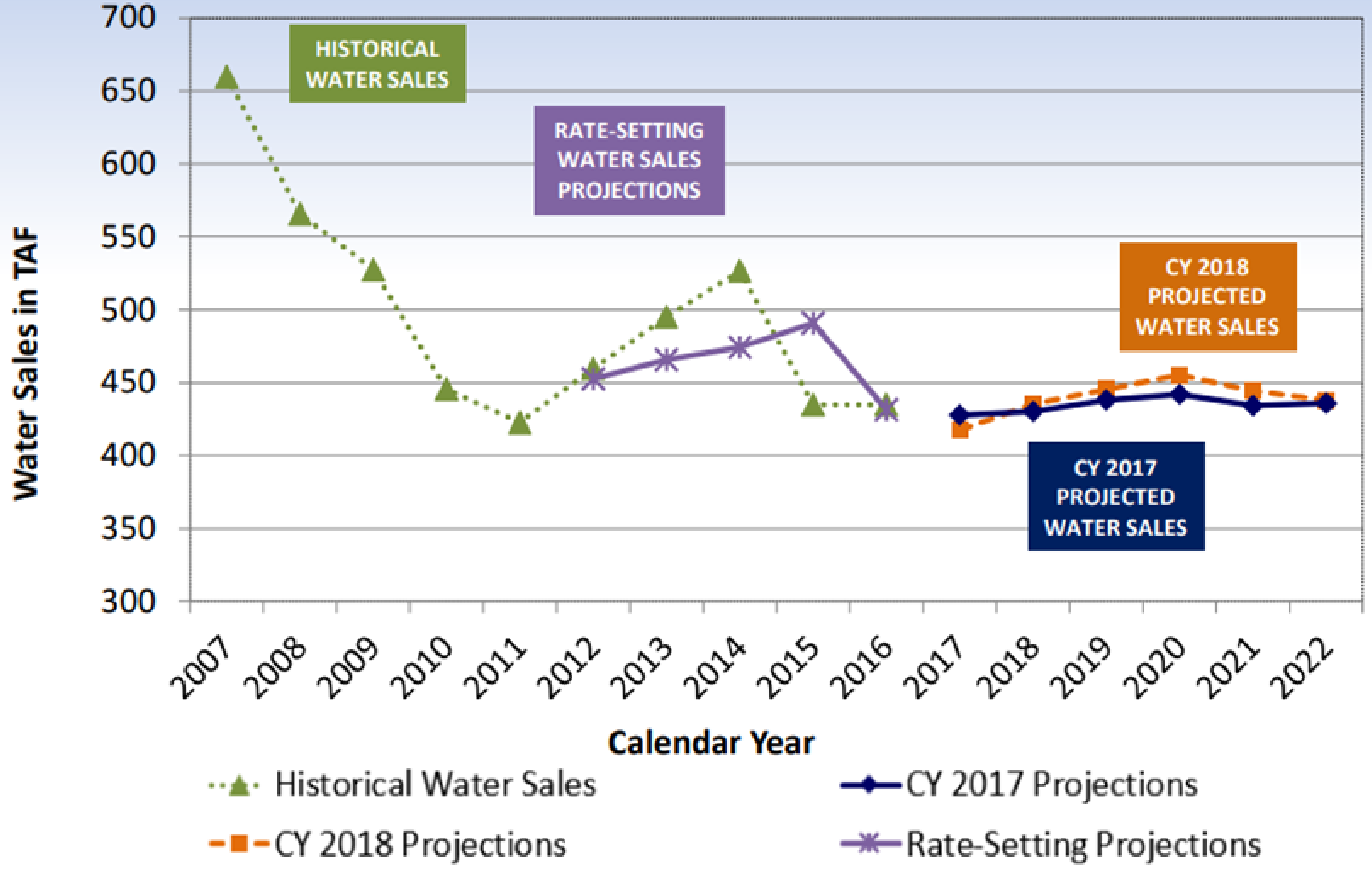
San Diego County Water Authority Water Rates and Uses 2018

Proposed CY 2018 Total Cost of Water Breakdown*



Water Rates and Charges ($/AF)	CY 2017 Rates	Proposed CY 2018 Rates	Proposed CY 2018 Change in Rate	Proposed Year/Year Change
Melded Supply Rate	$855	$894	$39	4.6%
Melded Treatment Rate	290	300	10	3.4%
Transportation	110	115	5	4.5%
Storage[1]	167	162	(5)	-3.0%
Customer Service[1]	61	61	0	0.0%
Supply Reliability Charge[1]	63	71	8	12.7%
Treated Water Cost*	**$1,546**	**$1,603**	**$57**	**3.7%**
Untreated Water Cost*	**$1,256**	**$1,303**	**$47**	**3.7%**

Water Sales*



- Projections account for long-term impacts of water use regulations, near-term increased levels of local supplies and local supply development

City of San Diego Water Rates and Water Use https://www.sandiego.gov/water/rates/rates

Water rates effective August 1, 2017

Single-Family Domestic Customers:

Each HCF equals 748.05 gallons, Each Acre Foot equals 325,851 gallons

The monthly charges for a typical single-family domestic customer are: Base fee: $24.22

0 - 4 HCF: $4.842/HCF, 5-12 HCF: $5.423/HCF, 13-18 HCF: $7.748/HCF.

Each HCF used after the initial 18 HCF is billed at $10.895 per HCF.

Other Domestic Customers - **$5.860/HCF or $2,552.62/AF or $0.007834/gallon**

Commercial and Industrial Customers- **$5.718/HCF or $2,490.76/AF or $0.007644/gallon**

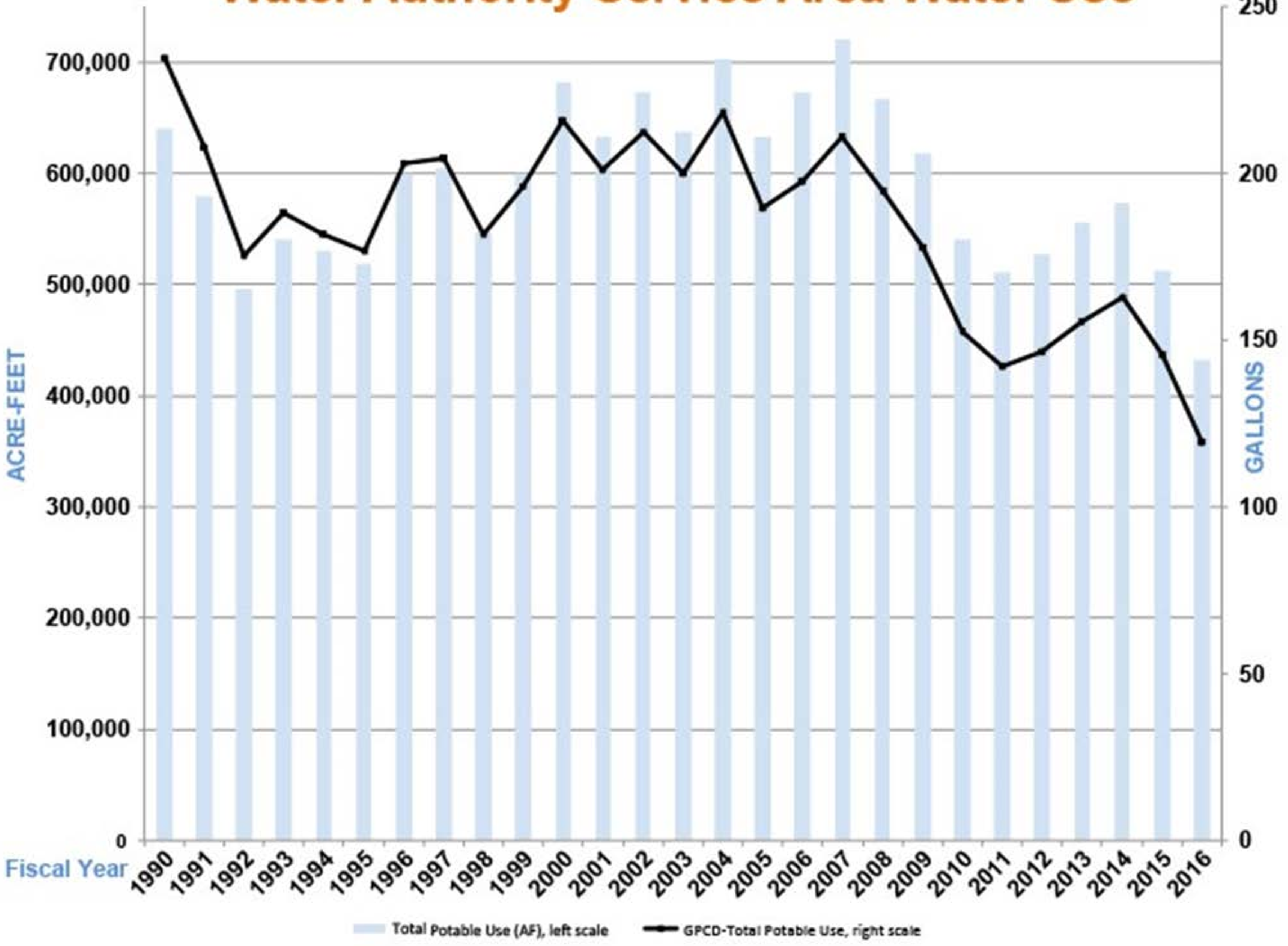
Temporary Construction - $6.607/HCF

Irrigation Customers- $6.496 per HCF

City of San Diego FY2017 Water Use

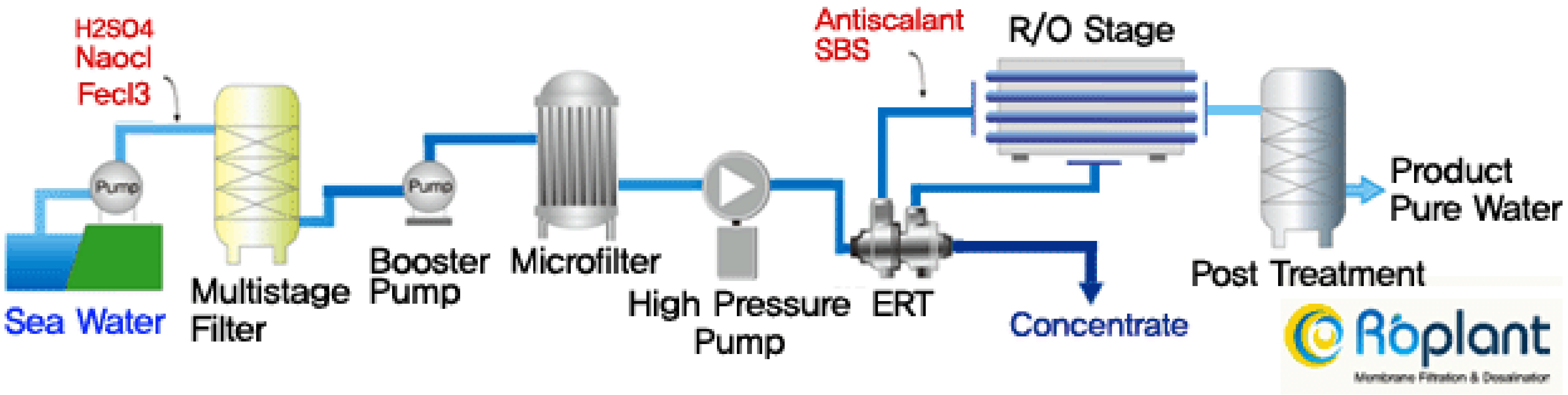
18,386.7 AF Local + 153,495.6 AF CWA = 171,882.3 AF Total Annual

Water Authority Service Area Water Use

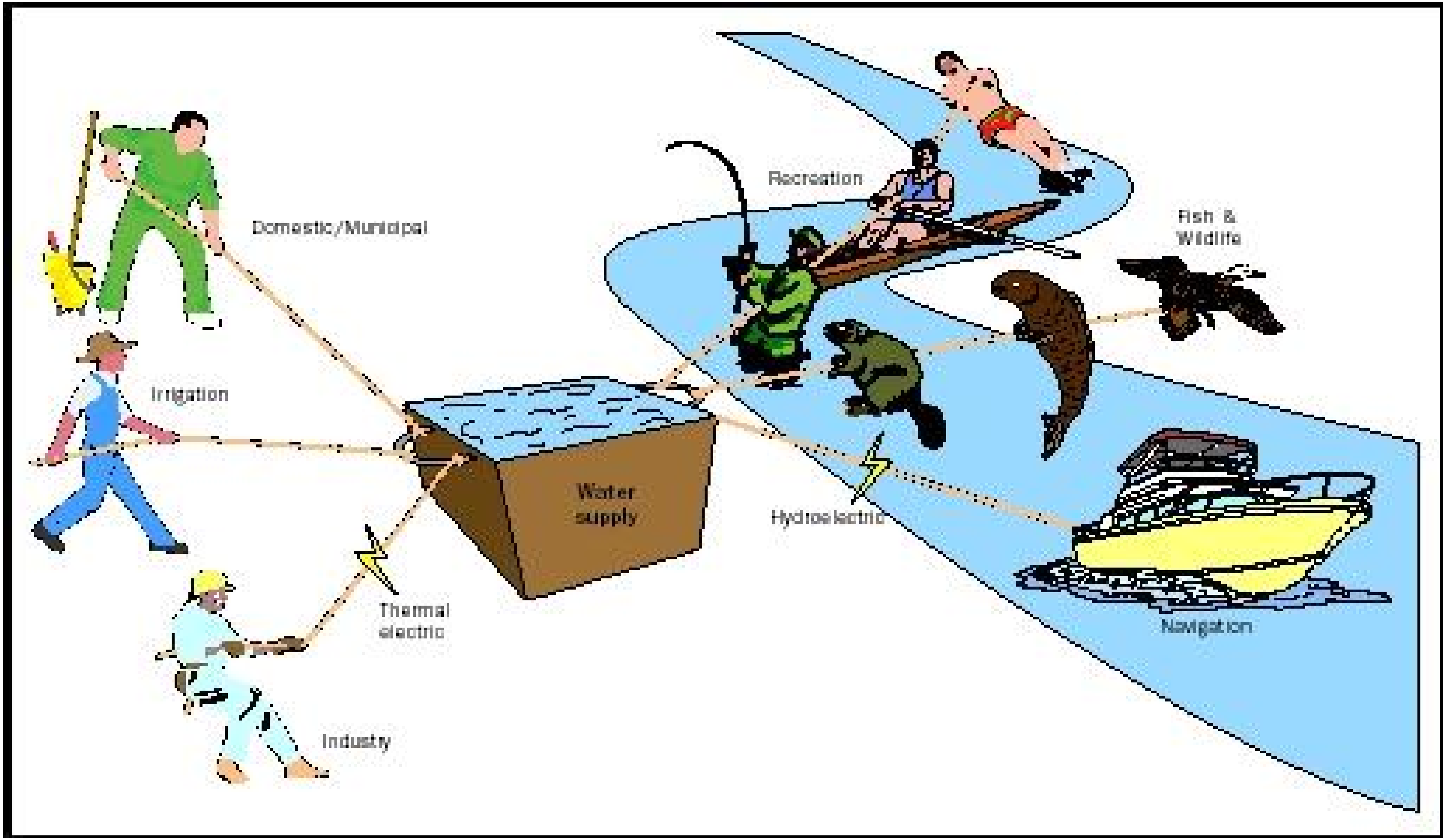


County Rank by Gross Value of Agricultural Production, 2015-2016 [1]

County	Rank Without Timber					Timber Value	Rank With Timber				
	2015		2016		Percent Change		2015		2016		Percent Change
	$1,000	Rank	$1,000	Rank		$1,000	$1,000	Rank	$1,000	Rank	
Kern	6,880,495	2	7,187,938	1	4.5	62	6,880,658	2	7,188,000	1	4.5
Tulare	6,980,772	1	6,369,926	2	-8.8	194	6,980,978	1	6,370,120	2	-8.8
Fresno	6,680,287	3	6,182,541	3	-7.5	1,382	6,680,953	3	6,183,923	3	-7.4
Monterey	4,705,143	4	4,256,073	4	-9.5	0	4,705,143	4	4,256,073	4	-9.5
Merced	3,589,900	6	3,447,830	5	-4.0	10	3,589,909	6	3,447,840	5	-4.0
Stanislaus	3,879,333	5	3,261,412	6	-15.9	0	3,879,333	5	3,261,412	6	-15.9
San Joaquin	2,732,900	7	2,337,899	7	-14.5	0	2,732,900	7	2,337,899	7	-14.5
Ventura	2,198,555	8	2,110,187	8	-4.0	12	2,198,571	8	2,110,199	8	-4.0
Imperial	1,875,158	11	2,063,215	9	10.0	0	1,875,158	11	2,063,215	9	10.0
Kings	2,021,052	9	2,002,192	10	-0.9	0	2,021,052	9	2,002,192	10	-0.9
Madera	2,016,726	10	1,819,093	11	-9.8	396	2,017,447	10	1,819,489	11	-9.8
San Diego	1,701,762	12	1,746,619	12	2.6	14	1,701,778	12	1,746,633	12	2.6
Santa Barbara	1,479,093	13	1,426,662	13	-3.5	0	1,479,093	13	1,426,662	13	-3.5
Riverside	1,301,552	14	1,275,776	14	-2.0	0	1,301,552	14	1,275,776	14	-2.0
San Luis Obispo	828,173	16	914,724	15	10.5	7	828,180	16	914,731	15	10.5
Sonoma	766,272	17	898,129	16	17.2	3,417	770,876	18	901,546	16	17.0
Colusa	901,809	15	791,663	17	-12.2	0	901,809	15	791,663	17	-12.2
Glenn	748,988	19	748,513	18	-0.1	9	748,988	19	748,522	18	-0.1
Napa	553,347	22	737,298	19	33.2	3	553,347	22	737,301	19	33.2
Butte	759,835	18	697,419	20	-8.2	8,518	773,552	17	705,937	20	-8.7
Yolo	664,738	20	662,392	21	-0.4	0	664,738	20	662,392	21	-0.4



〈Revers Osmosis Desalination Process〉



Too Much – Just Right – Too Little ------------------------- Who is Right or Who's Rights