Lecture 2

ROLE OF WATER RECLAMATION

Course: Water Reuse

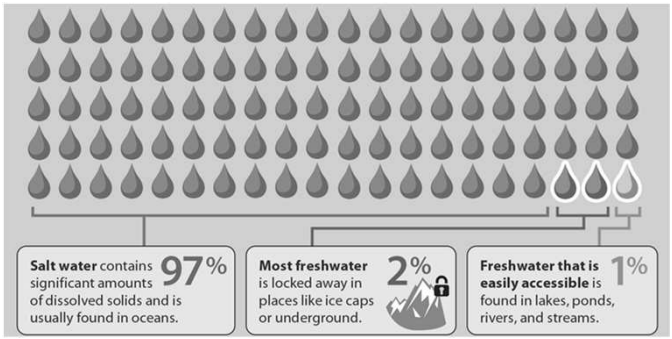
Dr. Alireza Bazargan

info@environ.ir

Asking important questions

- How long can existing water sources be sustained?
- Where will the next generation of water sources be found to meet growing needs?
- How will the conflict between environmental preservation and increasing demands be resolved?
- How can challenges of water, energy, food, and climate change be solved simultaneously (nexus thinking)?

Water scarcity



Water scarcity

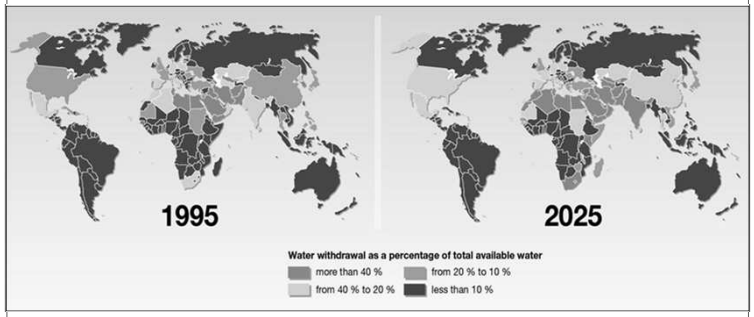
- **Water stress** starts when the per capita water available in a country drops below 1700 m^3/year or 4600 L/day. When the 1000 m^3/year or about 2700 L/day per person threshold is crossed, **water scarcity** is experienced. **Absolute water scarcity** is considered for countries with less 500 m^3/year/person or roughly 1400 L/day/person.

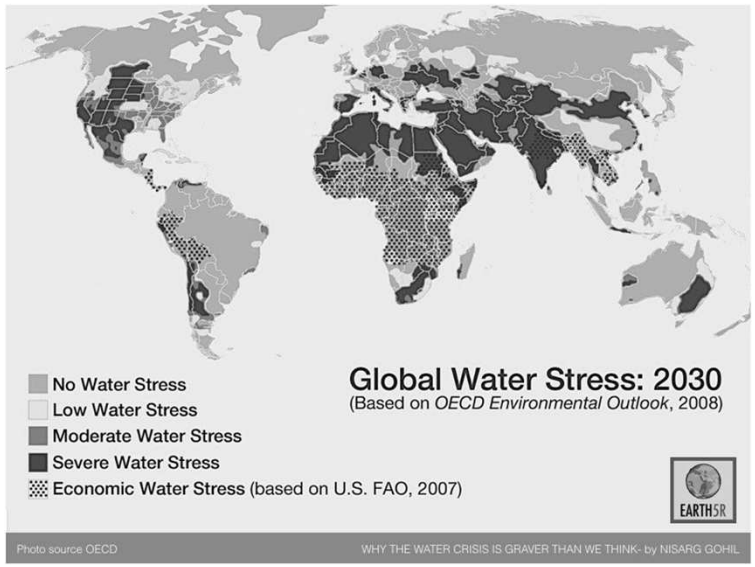
- **Renewable water** means it is replenished by rain, whereas non-renewable resources are bodies (deep aquifers) that have a negligible rate of recharge on our time-scale

Water scarcity

- If>25% renewable water withdrawn = **water stress**
- If>60% renewable water withdrawn = **physical water scarcity**
- If>75% renewable water withdrawn = **severe physical water scarcity**
- When countries withdraw more than 100 percent of their renewable freshwater resources this means that they use fossil non-renewable groundwater and/or non-conventional sources (such as desalination or reuse).
- Iran = 75% , UAE = Kuwait = 2000%

Water withdrawal





Urban populations

- In 1950, the only city with over 10 million inhabitants was New York
- Today we have about 40 such cities!

Rank	City, Country	Population in 2016 (thousands)
1	Tokyo, Japan	38 140
2	Delhi, India	26 454
3	Shanghai, China	24 484
4	Mumbai (Bombay), India	21 357
5	São Paulo, Brazil	21 297
6	Beijing, China	21 240
7	Ciudad de México (Mexico City), Mexico	21 157
8	Kinki M.M.A. (Osaka), Japan	20 337
9	Al-Qahirah (Cairo), Egypt	19 128
10	New York-Newark, USA	18 604

Irrigation

- About 65% of the total global water used by humans
- ***Consumptive use*** is the portion of withdrawn water that is evaporated, transpired, incorporated into products or crops, consumed by humans or livestock, or otherwise removed from the immediate water environment (permanently gone).
- Depending on the technology and management, consumptive use associated with irrigation (agriculture and landscaping) can range from 30 to 90 percent of the total water withdrawn.

Modern thinking

- The principle of sustainability, a cornerstone in the Brundtland Commission's report entitled *Our Common Future* (1987) is defined as: "Humanity has the ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs."
- Water recycling (water reclamation) is defined as treating wastewater to make it suitable for beneficial use, which would otherwise be discharged.

Demand management

Typical single family home water use, with and without water conservation[a]

	Typical single family home water use			
	Without water conservation		With water conservation	
Water uses	L/capita·d[b]	Percent	L/capita·d[b]	Percent
Toilets	76.1	27.7	36.3	19.3
Clothes washers	57.2	20.9	40.1	21.4
Showers	47.7	17.3	37.9	20.1
Faucets	42.0	15.3	40.9	21.9
Leaks	37.9	13.8	18.9	13.8
Other domestic	5.7	2.1	5.7	3.1
Baths	4.5	1.6	4.5	2.4
Dish washers	3.8	1.3	3.8	2.0
Total	274.4	100	187.8	100

[a]Adapted from AWWA Research Foundation (1999).
[b]L/capita·d, liters per capita per day.

Reclamation rationale

Rationale for water reclamation and reuse

- Water is a limited resource. Increasingly, society no longer has the luxury of using water only once
- Acknowledge that water recycling is already happening and do it more and better
- The quality of reclaimed water is appropriate for many nonpotable applications such as irrigation and industrial cooling and cleaning water, thus providing a supplemental water source that can result in more effective and efficient use of water
- To meet the goal of water resource sustainability it is necessary to ensure that water is used efficiently
- Water reclamation and reuse allows for more efficient use of energy and resources by tailoring treatment requirements to serve the end-users of the water
- Water reuse allows for protection of the environment by reducing the volume of treated effluent discharged to receiving waters

Potential benefits

Potential benefits of water reclamation and reuse

- Conservation of fresh water supplies
- Management of nutrients that may lead to environmental degradation
- Improved protection of sensitive aquatic environments by reducing effluent discharges
- Economic advantages by reducing the need for supplemental water sources and associated infrastructure. Reclaimed water is available near urban development where water supply reliability is most crucial and water is priced the highest
- Nutrients in reclaimed water may offset the need for supplemental fertilizers, thereby conserving resources. Reclaimed water originating from treated effluent contains nutrients; if this water is used to irrigate agricultural land, less fertilizer is required for crop growth. By reducing nutrient (and resulting pollution) flows into waterways, tourism and fishing industries are also helped

Driving factors

Factors driving further implementation of water reclamation and reuse

- Proximity: Reclaimed water is readily available in the vicinity of the urban environment, where water resources are most needed and are highly priced
- Dependability: Reclaimed water provides a reliable water source, even in drought years, as production of urban wastewater remains nearly constant
- Versatility: Technically and economically proven wastewater treatment processes are available now that can provide water for nonpotable applications and can produce water of a quality that meets drinking water requirements
- Safety: Nonpotable water reuse systems have been in operation for over four decades with no documented adverse public health impacts in the United States or other developed countries
- Competing demands for water resources: Increasing pressure on existing water resources due to population growth and increased agricultural demand
- Fiscal responsibility: Growing recognition among water and wastewater managers of the economic and environmental benefits of using reclaimed water
- Public interest: Increasing awareness of the environmental impacts associated with overuse of water supplies, and community enthusiasm for the concept of water reclamation and reuse

Driving factors (cont.)

Factors driving further implementation of water reclamation and reuse

- Environmental and economic impacts of traditional water resources approaches: Greater recognition of the environmental and economic costs of water storage facilities such as dams and reservoirs
- Proven track record: The growing numbers of successful water reclamation and reuse projects throughout the world
- A more accurate cost of water: The introduction of new water charging arrangements (such as full cost pricing) that more accurately reflect the full cost of delivering water to consumers, and the growing use of these charging arrangements
- More stringent water quality standards: Increased costs associated with upgrading wastewater treatment facilities to meet higher water quality requirements for effluent disposal
- Necessity and opportunity: Motivating factors for development of water reclamation and reuse projects such as droughts, water shortages, prevention of seawater intrusion and restrictions on wastewater effluent discharges, plus economic, political, and technical conditions favorable to water reclamation and reuse

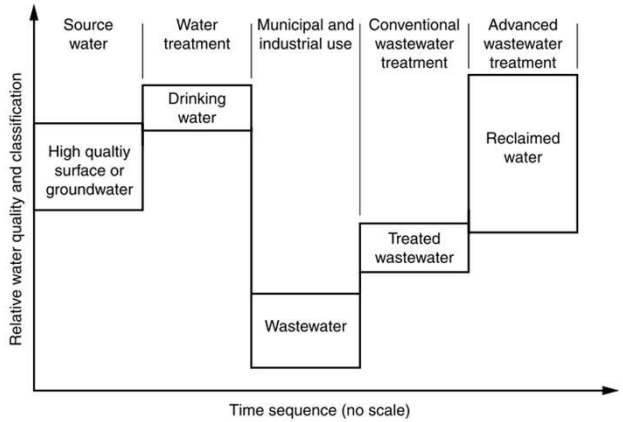
Water source

- Many cities have surface water in protected upstream watersheds (high quality). In less desirable situations, water is drawn from rivers with discharges upstream.
- Some cities are fortunate and have groundwater sources (generally of high quality because they are protected from many environmental influences).
- Municipal wastewater typically contains a variety of biological and chemical constituents from a variety of sources including households, schools, offices, hospitals, and commercial and industrial facilities.

Water reuse

- The majority of water reuse projects are for nonpotable applications such as agricultural and landscape irrigation and industrial uses
- Water reclamation and reuse are usually challenging options, technically and economically, because the source of water is normally of low quality.
- Extensive treatment is commonly applied, and a separate distribution system may be required, potentially making this option expensive

Conceptual comparison



Management

- Prioritize the use of water based on availability and quality. Preferentially, the emphasis is on preserving the highest quality water sources for drinking water supplies by using an alternative source such as reclaimed water for applications that have less significant health risks such as irrigating croplands.
- Water requirements for irrigation applications tend to vary seasonally whereas industrial water needs are more constant. So if reclaimed water is used in agriculture, storage and distribution facilities are required.

Management

- In most developing countries where wastewater is used for irrigation, it is used without adequate treatment. This can lead to diseases.
- Protection of public health, and provision of additional water supply can be conflicting goals
- Under these conditions, guidelines are required:
  - https://cfpub.epa.gov/si/si_public_record_report.cfm?dirEntryId=253411
  - http://abedi-koupai.iut.ac.ir/sites/abedi-koupai.iut.ac.ir/files//files_course/wastewater_applications-code535.pdf

Management

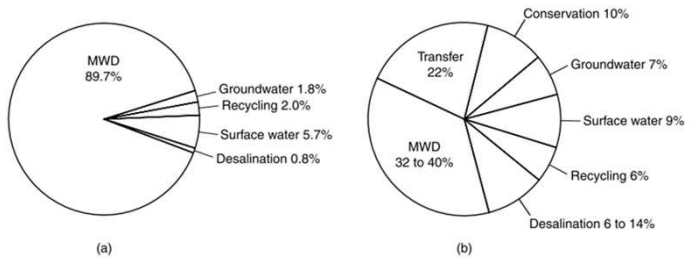


Figure 2-6

Comparison of regional water supply sources for San Diego County, CA the years 2002 and 2020 (a) 2002 and (b) 2020. The principal source of water is from the Metropolitan Water District (MWD) of Southern Californa (Adapted from San Diego County Water Authority, 2002).

San Diego Water Authority