

Water Resources and Water Balance for Sustainable Communities

5.1. Water Resources Management

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5.1. Water Resources Management

Water represents one of the most vital resources for life on Earth. It is essential for the survival of all forms of life and plays a wide range of roles and functions within ecosystems and human society. Water plays a crucial role in all aspects of human life, from drinking water consumption to personal hygiene. The human body is composed of approximately 70% water, and the lack of access to clean drinking water can have serious consequences, including the onset of severe diseases and mortality.

Water is necessary for agriculture and is used for irrigation to cultivate crops that feed the world's population. Without water, food production would be severely affected. For instance, did you know that producing 1 kg of chocolate requires approximately 17,000 liters of water, and producing a hamburger requires about 2,400 liters of water?

It is essential to note that approximately 2.4 billion people lack access to clean water sources or sewage/wastewater treatment services. Access to clean drinking water is a fundamental human right, and the absence of this access can have serious implications for the health and quality of life of these individuals. This underscores the ongoing importance of efforts to improve water resource management and ensure universal access to clean and safe water.

Water resource management refers to the process of planning, developing, using, monitoring, and protecting water resources to meet human needs and conserve the environment. This field covers a wide range of activities and responsibilities, including ensuring the supply of clean drinking water, wastewater management, the protection of aquatic ecosystems, flood prevention, and sustainable water resource management for the future. General concepts related to water resource management include:

1. **Water Cycle:** Water moves continuously through the hydrological cycle, which includes evaporation, condensation, precipitation, runoff, infiltration, and the return of water to groundwater or surface water sources. Understanding this cycle is fundamental for water resource management.
2. **Water Sources:** Water resources can come from surface water sources, such as rivers, lakes, seas, and oceans, or from groundwater sources, such as wells and springs.
3. **Water Uses:** Water is used for a variety of purposes, including human consumption (drinking water), agriculture, industry, energy production, recreation, and environmental protection.

4. **Water Treatment:** Water must be treated to be safe for human consumption. This process involves removing impurities/pollutants, disinfection, and water quality control.
5. **Wastewater:** After use, water becomes wastewater. This water must be collected, treated, and released back into the environment in a manner that minimizes its impact on ecosystems and meets water quality standards.
6. **Water Resource Management:** This involves planning and implementing strategies for the sustainable use of water resources, considering multiple requirements and priorities, including human consumption, agriculture, industry, and environmental protection.
7. **Conservation of Aquatic Ecosystems:** Protecting rivers, lakes, wetlands, and other aquatic ecosystems is crucial for maintaining biodiversity.
8. **Flood Management:** This involves assessing flood risk, implementing prevention measures, and preparing for flood events.
9. **Water Regulations and Strategies:** Many countries have specific legislation and policies related to water resources to ensure their proper management.
10. **Research and Innovation:** Continuous research and the development of innovative technologies are essential for improving water resource management and water treatment/purification.

Water resource management is a complex and interdisciplinary discipline that involves both technical and social aspects. It is essential to ensure the availability of water for current and future generations and to protect aquatic environments.

Sustainability Issues

Sustainability issues in integrated water resources management can include a range of aspects related to the sustainable use, conservation, and protection of water in a manner that preserves the environment. Among the key issues in this context are:

- **Increasing Water Demand:** Growing populations and economic development can lead to a significant increase in water demand for human consumption, agriculture, industry, and other purposes. Proper management of this growth is crucial to ensure water resource sustainability.

- **Water Pollution:** Water pollution caused by chemicals, industrial and agricultural waste, as well as biological contaminants, can affect water quality and have a negative impact on human health and ecosystems.
- **Droughts and Climate Change:** Climate change can lead to irregular precipitation patterns, more frequent droughts, and floods. These phenomena can affect water availability and put pressure on water resource management.
- **Efficient Water Resource Management:** Ensuring efficient water resource management, including equitable water distribution and responsible use, is essential for sustainability.
- **Conservation of Aquatic Ecosystems:** Protecting rivers, lakes, marshes, and deltas is crucial for maintaining biodiversity.
- **Management of Transboundary Waters:** Many river basins cross multiple countries, requiring efficient international cooperation to sustainably manage water resources.
- **Warning and Preparedness Systems:** Developing and implementing effective warning and preparedness systems for water-related crises, such as droughts, floods, and other extreme events, is essential.
- **Community Participation and Public Awareness:** Involving local communities and educating the public about responsible water management and its importance for sustainability are key factors in addressing water-related issues.

These are just some of the major issues that integrated water resource management faces in the context of sustainability. Addressing these issues requires ongoing efforts from governments, organizations, communities, and individuals to ensure sustainable water management and protect water resources for future generations.

The Water Usage Cycle describes the complete process through which water passes in human society, including raw water capture, treatment, distribution, consumption/use, wastewater collection, wastewater treatment, and options for disposal/recirculation/reuse.

Raw Water Abstraction: It begins with the collection of raw water from natural sources such as rivers, lakes, groundwater basins, and springs. This water is transported to treatment facilities to prepare it for human or industrial consumption.

Treatment: Raw water collected from natural sources may contain impurities such as sediments, bacteria, chemicals, or other pollutants. Treatment processes such as coagulation,

flocculation, sedimentation, filtration, and disinfection transform raw water into safe and quality drinking water.

Distribution: Treated water is distributed through water supply networks to consumers, such as households, industrial buildings, or agricultural users.

Consumption/Use: Consumers use water for various purposes, including providing drinking water, household use, agricultural irrigation, industrial use, and more.

Collection and Transport of Wastewater: Used water, which contains impurities and pollutants after consumption, is collected from sources (households, industry, agriculture) and transported to wastewater treatment facilities.

Wastewater Treatment: Wastewater undergoes treatment processes at wastewater treatment facilities, where impurities are removed, chemicals neutralized, and the treated water is made safe for disposal or recirculation.

Disposal/Recirculation/Reuse: Treated wastewater can be released back into the environment or reintroduced into the water usage cycle, depending on its quality. Discharge may occur into rivers or lakes, while water can be recirculated or reused for various non-potable purposes such as agricultural irrigation or industrial use.

Water quality undergoes several qualitative changes at different stages of its collection from natural sources, treatment, and respective discharge, recirculation, or reuse.

Water is abstracted from natural sources such as rivers, lakes, groundwater basins, and springs and is treated for potable use. After use, the water is considered wastewater as it contains various pollutants. Major signs of global water pollution include the presence of plastics in seas and oceans, chemically polluted water, loss of aquatic biodiversity, increased heavy metal concentrations in fish, depleting drinking water reserves, and inadequately treated or untreated wastewater.

Water Resources and Their Distribution

Water covers approximately 71% of the Earth's surface, but it is important to note that 97% of the water existing globally cannot be used for human consumption, as it is salty and found in oceans and seas. Only 3% of the total water volume is freshwater. Of the entire freshwater volume, approximately 68% is in the form of glaciers and ice caps, approximately 30% is found as

groundwater, and only 1% is in the form of surface water, including rivers (2%), lakes (87%), and wetlands (11%).

Access to Water Resources

Regarding access to water resources, it is essential to mention that approximately 2.4 billion people live in areas with a water deficit, and around 500 million are approaching this situation.

Over 1.6 billion people face challenges related to the quality and quantity of water supplied due to economic difficulties.

Europe is considered to have sufficient water resources available, but water deficits and drought are becoming increasingly common and widespread phenomena.

At least 11% of the population and 17% of Europe's territory are affected by water deficits. Romania is a country with relatively limited water resources, ranking 9th in the European Union. On a European level, the average water consumption is around 4,000 m³ per person per year, while at the national level, the average water consumption is about 2,660 m³ per person per year. Eight out of ten people without access to essential water services live in rural areas.

Water Resources in Romania

In Romania, the following water resources are available: sources of fresh water with a potential of 125 billion cubic meters, including 40 billion cubic meters in inland rivers and 85 billion cubic meters represented by the Danube River. Groundwater has an annual potential of 9.6 billion cubic meters.

The evolution of water consumption in Romania from 2014 to 2021 is depicted in the table below, showing an increase in the volume of water extracted and, naturally, an increase in the water exploitation index.

The values of the water exploitation index (%) from 2014 to 2021 are below 20%, indicating that Romania's water resources are under low exploitation pressure.

Natural sources water Pollution represents an alteration of its physical, chemical, biological, bacteriological, and radioactive qualities, beyond an established permissible limit, caused directly or indirectly by human activities. Polluted waters become unsuitable for regular use such as drinking, industrial, recreational, and agricultural purposes.

Surface water pollution occurs due to:

- **Concentrated or organized pollution sources** represented by treated municipal wastewater, industrial wastewater with continuous or intermittent discharge, and varying degrees of treatment.
- **Dispersed pollution sources** originating from precipitation, waste deposits, agricultural lands where fertilizers or pesticides have been applied, infiltrations, and effluents from livestock farms.

Water, like energy, is an essential component of all human activities.

Water uses

The main uses of water sources are: obtaining drinking and industrial water, irrigating agricultural land, generating energy (hydropower), recreation, public services, sanitation, and social development.

After use, water is considered wastewater because it contains various pollutants. Among the primary signs of global water pollution, we can mention: the presence of plastic in seas and oceans, water contaminated with various chemicals, the disappearance of aquatic biodiversity, increasing concentrations of heavy metals in fish, the loss of drinking water reserves, and inadequately treated or untreated wastewater.

Wastewater pollution can be attributed to the following types of pollutants that can affect water quality and human health:

- Bacteria, viruses, and parasites
- Biogenic organic compounds (biodegradable)
- Toxic pollutants
- Inorganic compounds
- Large solids, suspended solids, and colloids
- Petroleum substances
- Detergents, fats, and oils
- Radioactive substances
- Warm water

Collected wastewater is adequately treated globally in only 44% of cases. Around 25% of the total volume of collected wastewater is treated properly, 37% is inadequately treated, and roughly

37% remains untreated and is discharged without control. Wastewater has a significant impact on natural receptors, depending on the flow of wastewater and the type and concentration of pollutants present in poorly treated wastewater.

Inadequate wastewater treatment can lead to:

- Eutrophication of surface waters due to the nutrients (nitrogen and phosphorus compounds) present in wastewater.
- The possibility of waterborne diseases due to microorganisms in wastewater.
- The production of malodorous gases due to the decomposition of organic compounds present in wastewater.
- The presence of toxic pollutants harmful to all living organisms, making self-purification impossible.

Education, awareness, and community involvement are essential aspects of promoting intelligent and sustainable water management. Creating a "water-smart society" involves achieving key objectives related to the responsible use of water. In this regard, we can mention the following aspects:

Developing education programs about the importance of water resources, efficient water use, and its environmental impact.

Raising public awareness about water sources, water quality, and measures to protect water resources.

Involving local communities in decision-making processes regarding the use of water resources in their area.

Organizing events and community initiatives to increase awareness and engagement.