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Environmental Water Management - Advanced Technologies

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Introduction

- Various human activities consume or pollute a lot of water. At a global scale, most of the water use occurs in agricultural production but there are also substantial water volumes consumed and polluted in the industrial and domestic sectors.
- Water consumption and pollution can be associated with specific activities such as irrigation, bathing, washing, cleaning, cooling and processing.

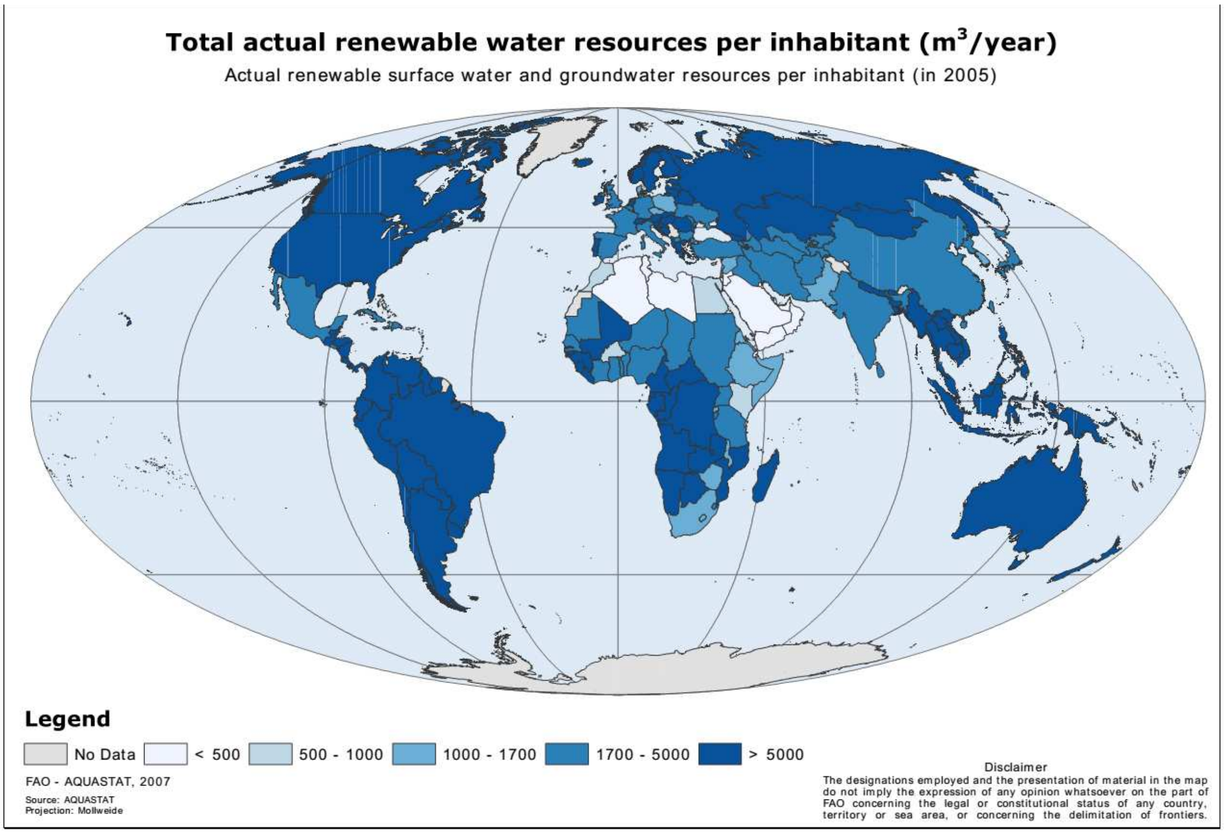


Figure 1. Total actual renewable water resources per inhabitant (m^3/year).

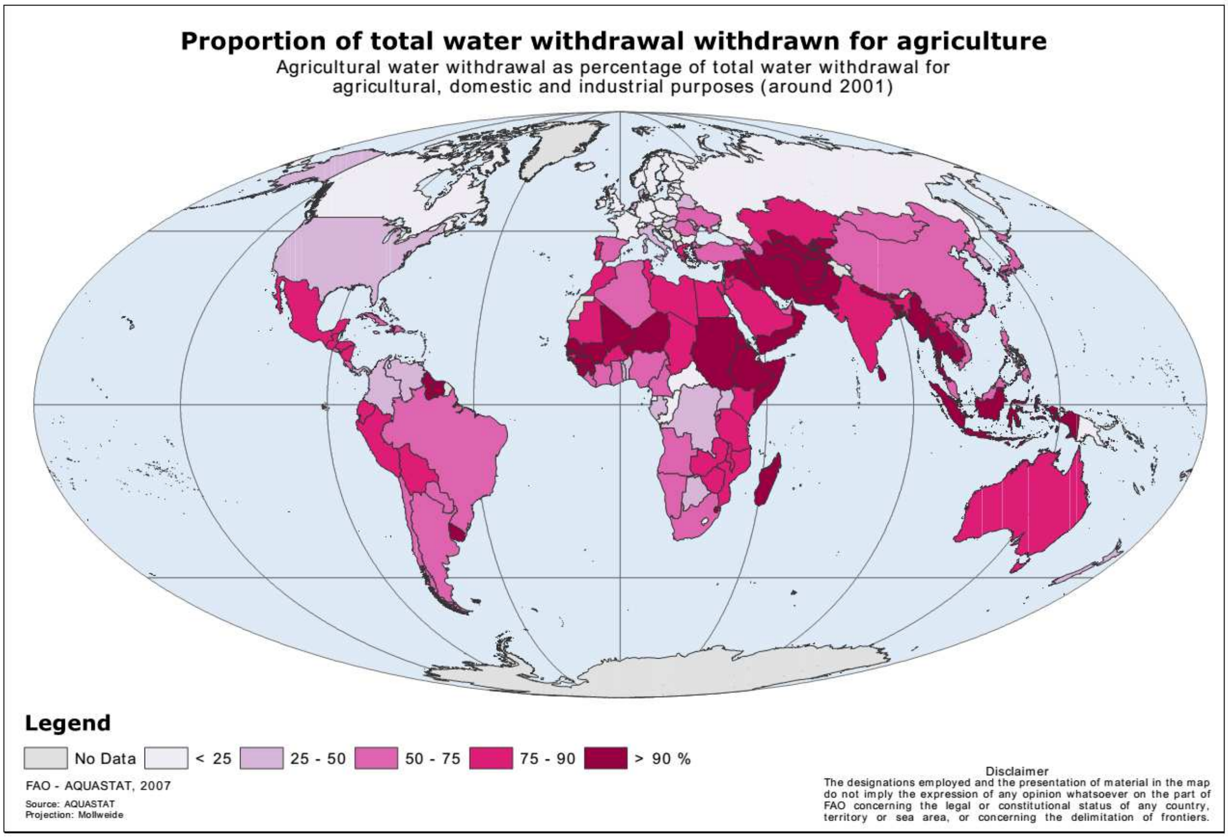
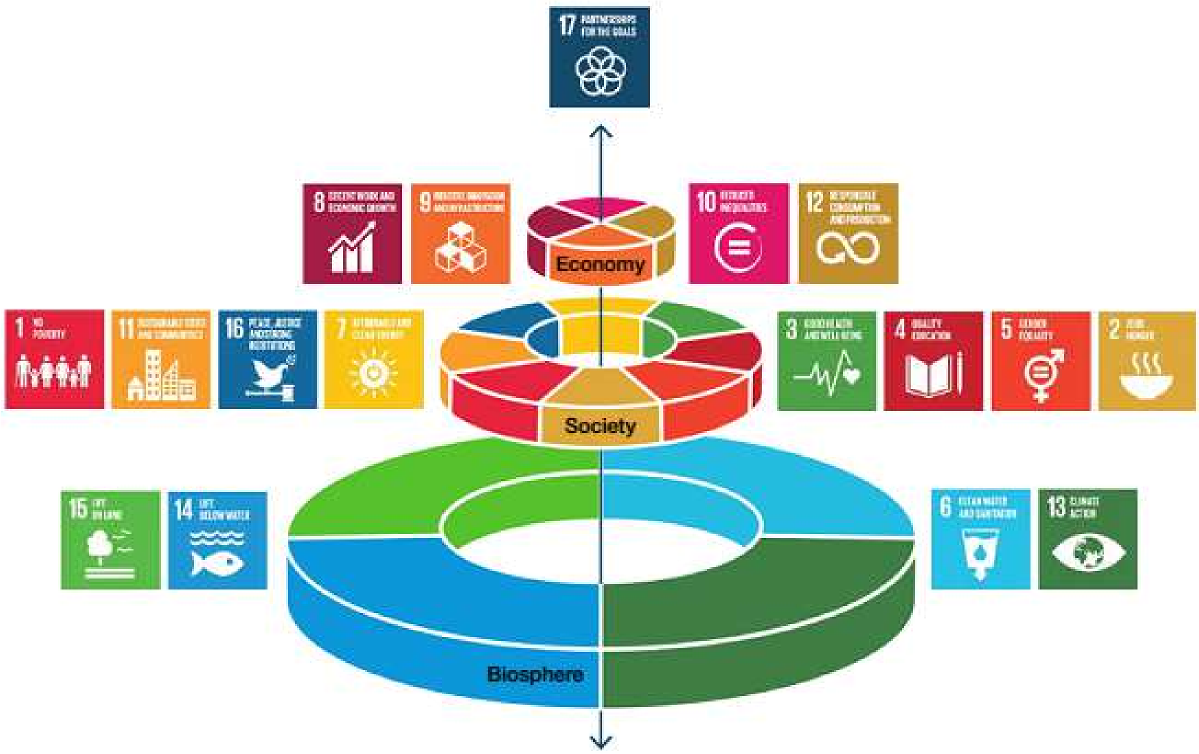


Figure 2. Propotion of total water withdrawal withdrawn for agriculture.

Sustainable Development Goals



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#6: Ensure access to water and sanitation for all

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TARGETS
INDICATORS

6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all

6.1.1 Proportion of population using safely managed drinking water services

6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations

6.2.1 Proportion of population using safely managed sanitation services, including a hand-washing facility with soap and water

6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally

6.3.1 Proportion of wastewater safely treated

6.3.2 Proportion of bodies of water with good ambient water quality

6.4.1 Change in water-use efficiency over time

6.4.2 Level of water stress: freshwater withdrawal as a proportion of available freshwater resources

6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate

6.5.1 Degree of integrated water resources management implementation (0-100)

6.5.2 Proportion of transboundary basin area with an operational arrangement for water cooperation

6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes

6.6.1 Change in the extent of water-related ecosystems over time

6.A By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies

6.A.1 Amount of water- and sanitation-related official development assistance that is part of a government-coordinated spending plan

6.B Support and strengthen the participation of local communities in improving water and sanitation management

6.B.1 Proportion of local administrative units with established and operational policies and procedures for participation of local communities in water and sanitation management

Wastewater Treatment and Reuse in Agriculture

Introduction

Non-conventional water (NCW) is water from a source not conventionally used for agricultural production, primarily **water that is of lower quality.** The two major sources are:

•wastewater, following its use for domestic, municipal and industrial purposes;
•saline water from groundwater, drainage and surface sources.

Within these sources there is a spectrum of quality and quantity. The extremes of the quality spectrum for wastewater would be undiluted untreated sewage at the low end and quaternary treatment at the high end.

- The safe use of NCW requires that human health is not impacted and that short and long term environmental quality is maintained at an acceptable level.
- The economic feasibility of using NCW in agriculture depends on many factors, such as the cost of treatment for safety, pumping costs, distribution costs, and competition from alternative uses such as landscaping and amenity.
- In some regions waste water is already a common water source as safer (cleaner) water sources are not available. In other countries NCW is becoming the major source of water for agriculture as conventional sources of good quality water decline or are diverted for other uses.

- Cities and towns generate a stream of water that has already been used, such as for domestic purposes. This stream of water represents a waste product which must be either disposed of safely or re-used downstream as a resource.
- Apart from its value as water, it may also contain nutrients which benefit agricultural production.
- There can however be a mismatch between its rate of production (which may be relatively constant) and the demand by agriculture which varies with the irrigated area and the time of year.

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Use of this water requires consideration of:

- production;
- future availability;
- re-use safety/guidelines;
- present re-use status;
- governance/policies/legislation/monitoring and compliance;
- storage facilities;
- long-distance transportation networks and pumping requirements.

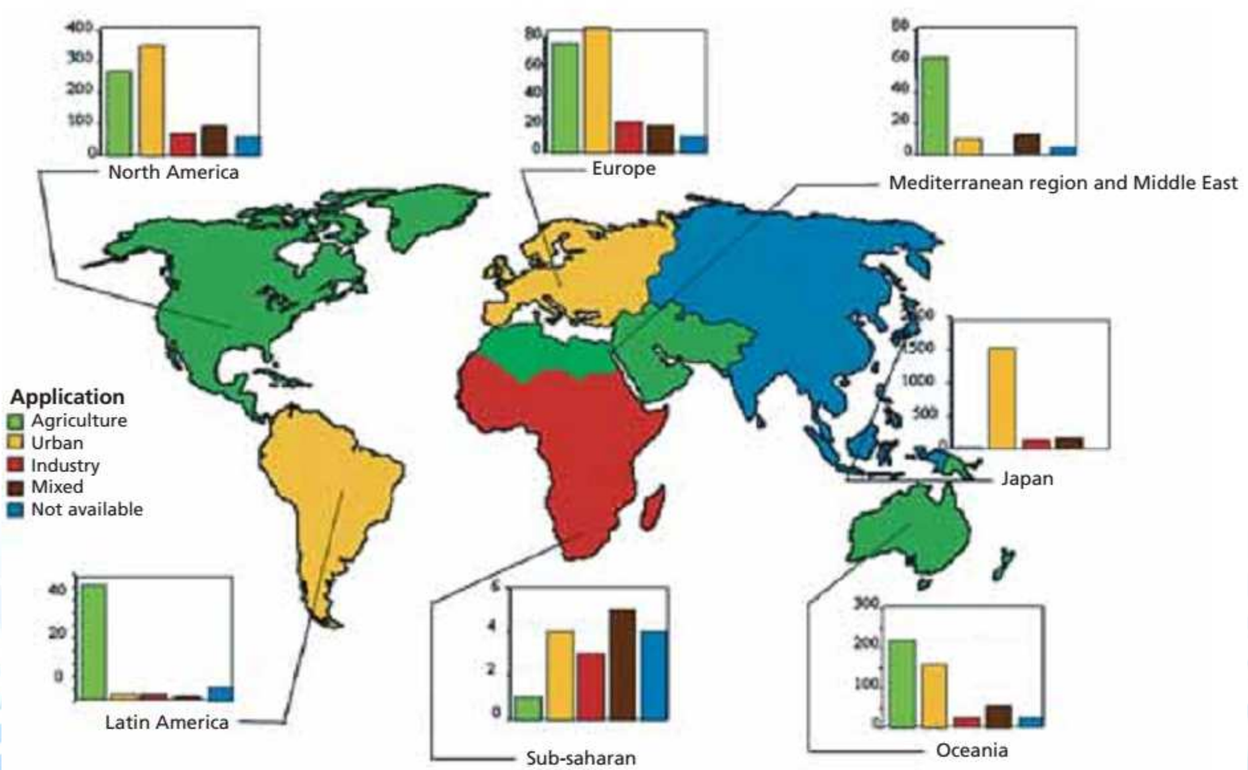


Figure 1. Municipal water reuse schemes across different regions of the world according to field of reuse application

Land-based Treatment Systems

- Land-based systems are considered to be one of the best wastewater treatment processes, especially for arid and semi-arid regions as they are capable of achieving comparable nutrient removal levels for a considerably low cost, provided land is available at reasonable prices.
- Additional benefits include recovery and reuse of wastewater and plant food nutrients for crop production.

- Waste stabilization ponds are a popular form of land-based treatment systems.
- A classical configuration of such a system comprises anaerobic, facultative, and maturation ponds.

Potential Impact of Wastewater Use in Agriculture

- ❑ Public health
- ❑ Crops
- ❑ Soil resources
- ❑ Groundwater resources
- ❑ Property values
- ❑ Ecological impacts
- ❑ Social impacts

Artificial Recharge

Introduction

- **Artificial recharge of groundwater** is the process of increasing the water amount that enters an aquifer through human effort. Many different techniques and purposes exist for causing artificial recharge. The water surplus of an area (mainly from surface water) is stored in the aquifers for later use.

Artificial recharge may be carried out for various purposes

- To prevent land subsidence caused by the groundwater drawdown due to overpumping, reducing the risk of damage to nearby structures.
- To avoid depletion of water resources when dewatering is carried out in aquifers used for water supply.
- To reduce environmental impacts on sensitive water-dependent features such as wetlands.
- To conserve the excess of surface water that would be wasted for future requirements.

❖ To improve the quality of groundwater (through dilution) in areas that the problem is qualitative and not quantitative.

❖ To prevent seawater intrusion.

❖ To control flooding.

❖ To use water for energy/power supply in areas of geothermal fields.

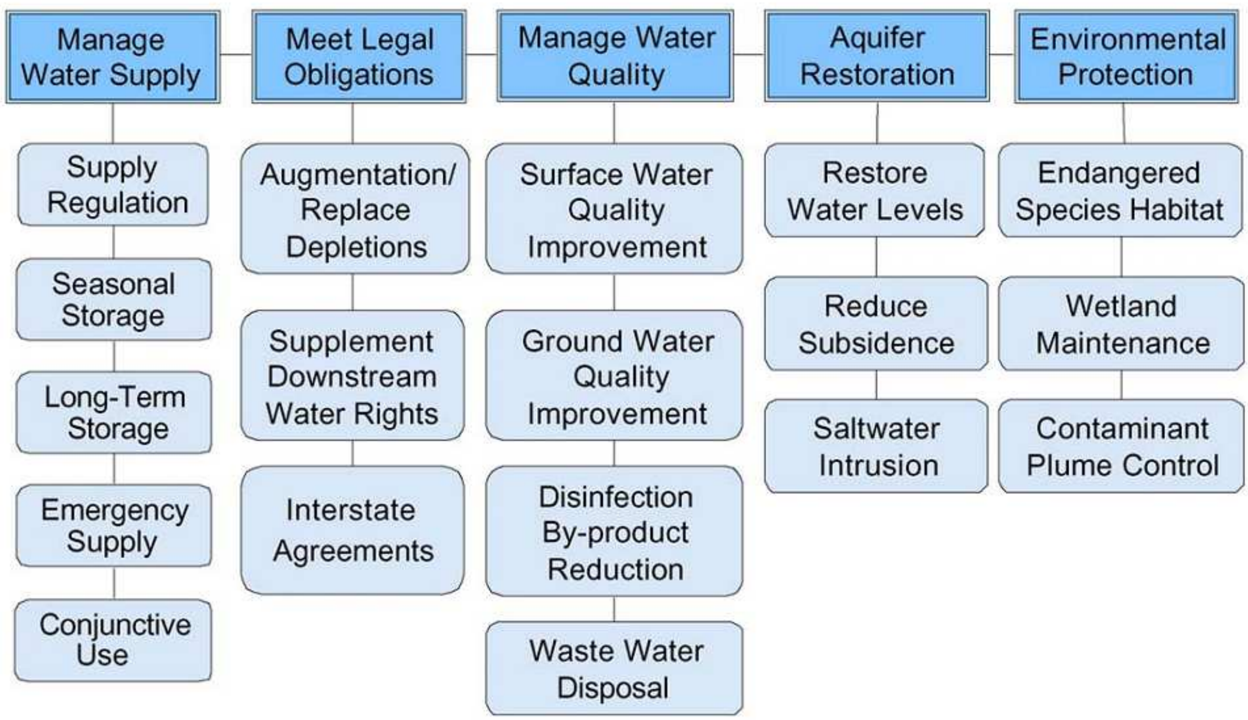


Figure 1. Objectives of artificial recharge.

Why do we implement artificial recharge?

- The **increase of population** leads to increased demands for water resources and the scenarios regarding the climate change are not very optimistic for the future.
- The **construction of dams** is not always feasible, due to the lack of suitable sites. The reasons might be hydrological, technical, environmental or even social and economic.

- The **rainfall distribution** in a country varies from one region to another. Therefore the availability of the surface water in some areas is low. The temporal distribution of the rainfall in the year is also a restricting factor for the use of surface water, since during the summer period that the water demands are high, the surface water is at the lowest level.

Artificial recharge is implemented in areas where

- A continuous water level drawdown is recorded.
- The discharge in wells or springs is inadequate especially during the dry months.
- The quality is poor and groundwater is the only available resource.

It is very important to ensure that the water that will be used for artificial recharge is of good quality. In any other case it should not be used because the risk to pollute the aquifers is extremely high. Otherwise the water should be appropriate treated.

In some cases waste water is used for recharge after treatment.

Advantages of artificial recharge

- The losses from evapotraspiration are negligible.
- The stored water is relatively protected from natural hazzards (e.g. landslide) and pollution.
- The availability of the water can cover a large area.

Disadvantages of artificial recharge

- ✓ The possible weakness to refill the recharge water.
- ✓ The demand of a large area for the operation and conservation of such a system compared to a system that provides surface water.
- ✓ The difficulty to remove salts from the water used for artificial recharge.
- ✓ The difficulty to prevent clogging phenomena.
- ✓ The weakness to deal with increased demands in a very short time since groundwater cannot be drained so quickly as surface water.

Prerequisites for artificial recharge

- ✓ The existence of surface water surplus.
- ✓ The quality of the water to be good and chemical compatible with the existing water in the aquifers.
- ✓ The geological-hydrogeological conditions must be appropriate (e.g. the permeability of the aquifers must be high, there must be a hydraulic connection between the aquifers e.t.c.).
- ✓ The cost for the construction and maintenance of the infrastructures must be viable.

Possible sources that can provide water for artificial recharge are:

- ❖ Surplus of surface water.
- ❖ Storm runoff or runoff from the melting of snow.
- ❖ Excess of water from aquedacts or facilities that are used for water transport.
- ❖ Urban waste or other kind of waste after treatment.

Artificial recharge techniques

a. Direct surface techniques

- Flooding
- Basins or percolation tanks
- Stream augmentation
- Ditch and furrow system
- Over irrigation

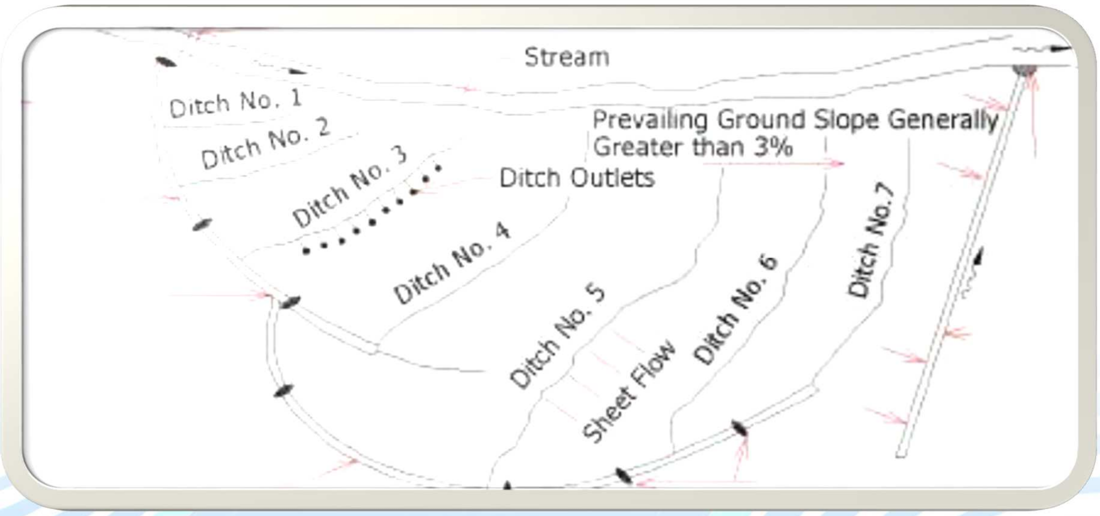
These methods are applicable in uncofined aquifers. Large areas are required. The recharge rate depends on the soil material properties. The water used must be free from suspended material

A1. Direct surface techniques: Flooding

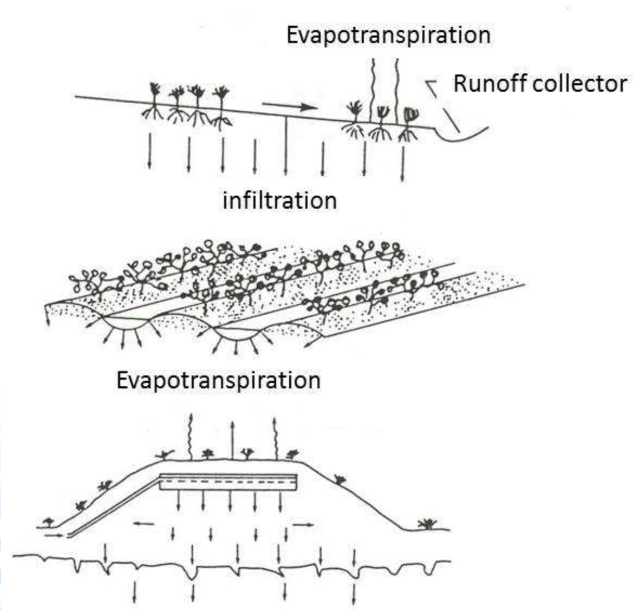
A2. Direct surface techniques: Basin and percolation tanks.

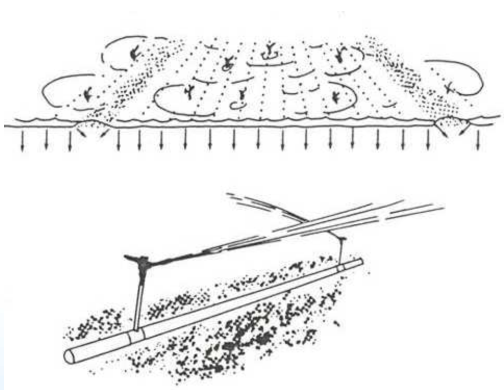
A3. Direct surface techniques: Stream augmentation.

A4. Direct surface techniques: Ditch and furrows



A5. Direct surface techniques: Irrigation.





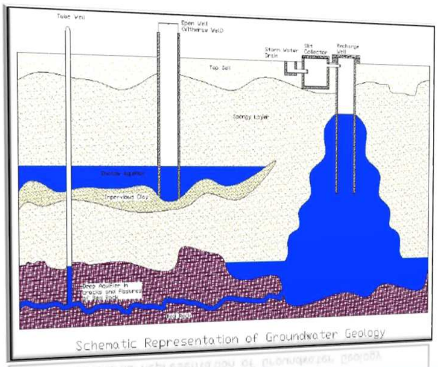
Artificial recharge techniques

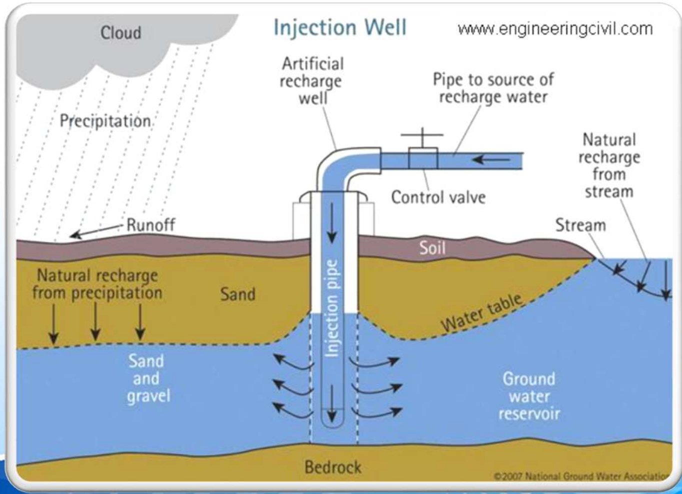
b. Direct sub surface techniques

- Injection wells or recharge wells
- Recharge pits and shafts
- Dug well recharge
- Natural openings, cavity fillings.

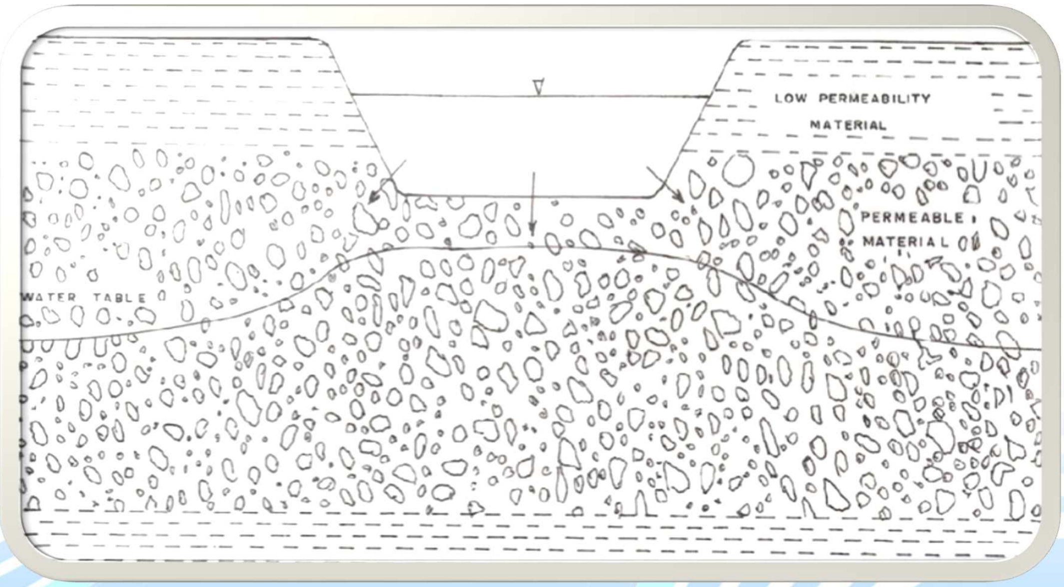
In these techniques the recharge is applied directly to the aquifers usually through wells, boreholes e.t.c.

B1. Direct sub surface techniques: Recharge and injection wells.

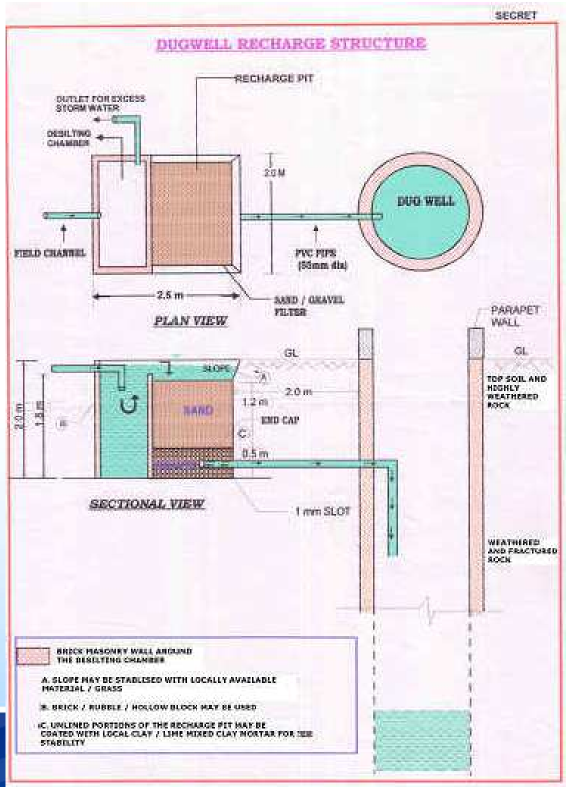




B2. Direct sub surface techniques: Pits and shafts



B3. Direct sub surface techniques: Dug well.



B4. Direct sub surface techniques: Natural openings.

- Recharge is achieved through natural openings from the fracturing or dissolution of limestones or other rock formations
- It is a cheap method but it's implementation requires very specific soil and geological conditions

Artificial recharge techniques

c. Indirect Techniques

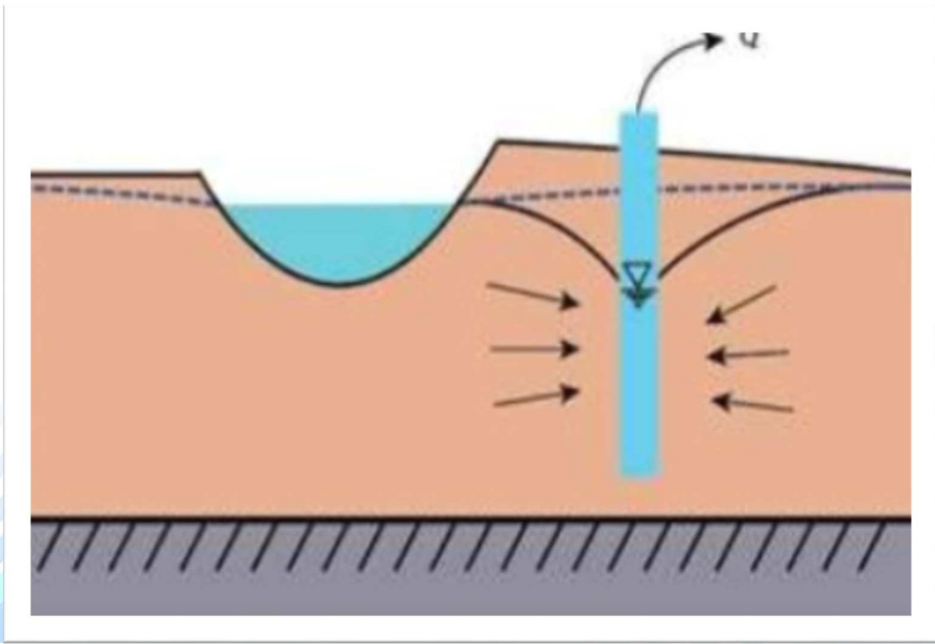
- Induced recharge from surface water source.
- Aquifer modification.
- Incidental recharge

d. Combination surface –sub-surface techniques

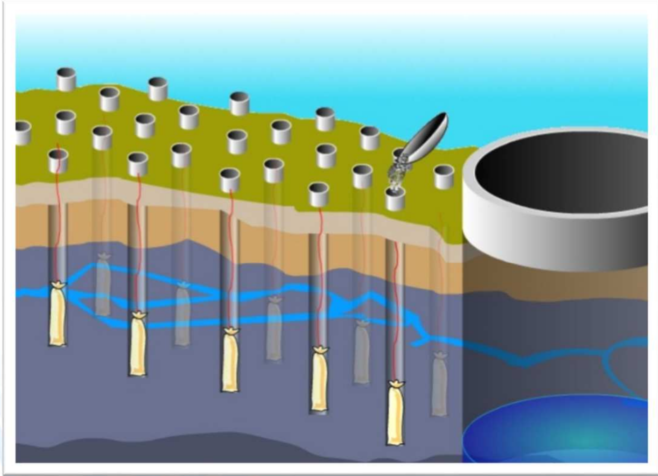
- Basin or percolation tanks with pit shaft or wells.

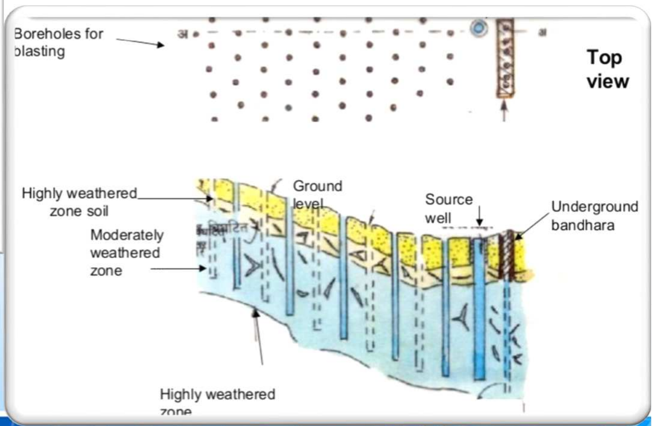
In induced recharge a cone of depression is created after pumping. The surface water replenish the abstracted groundwater causing recharge of the aquifer.

C1. Indirect techniques. Induced recharge from surface water source



C2. Indirect techniques. Aquifer modification (bore blasting technique)





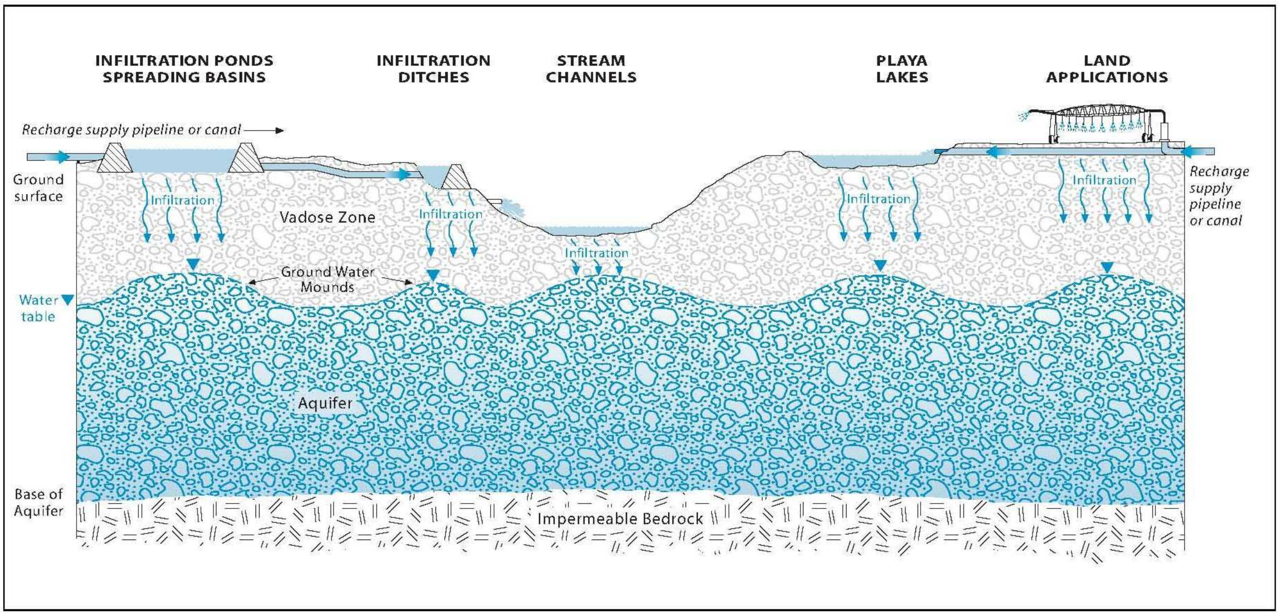


Figure 2. Examples of surface infiltration technologies.

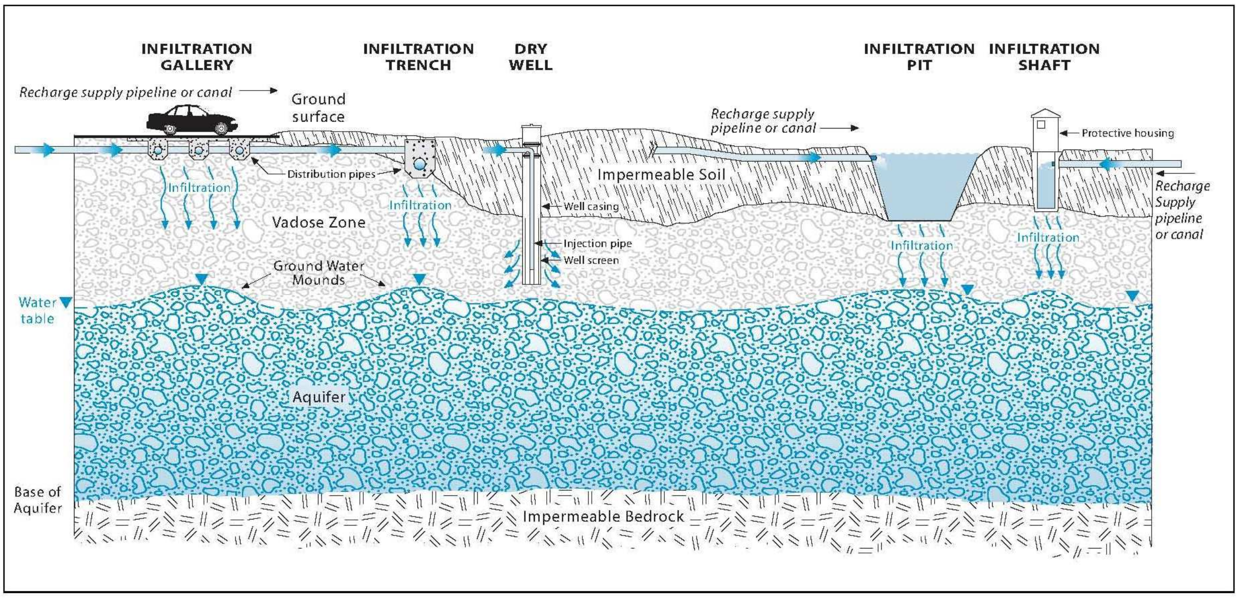


Figure 3. Examples of subsurface infiltration technologies.

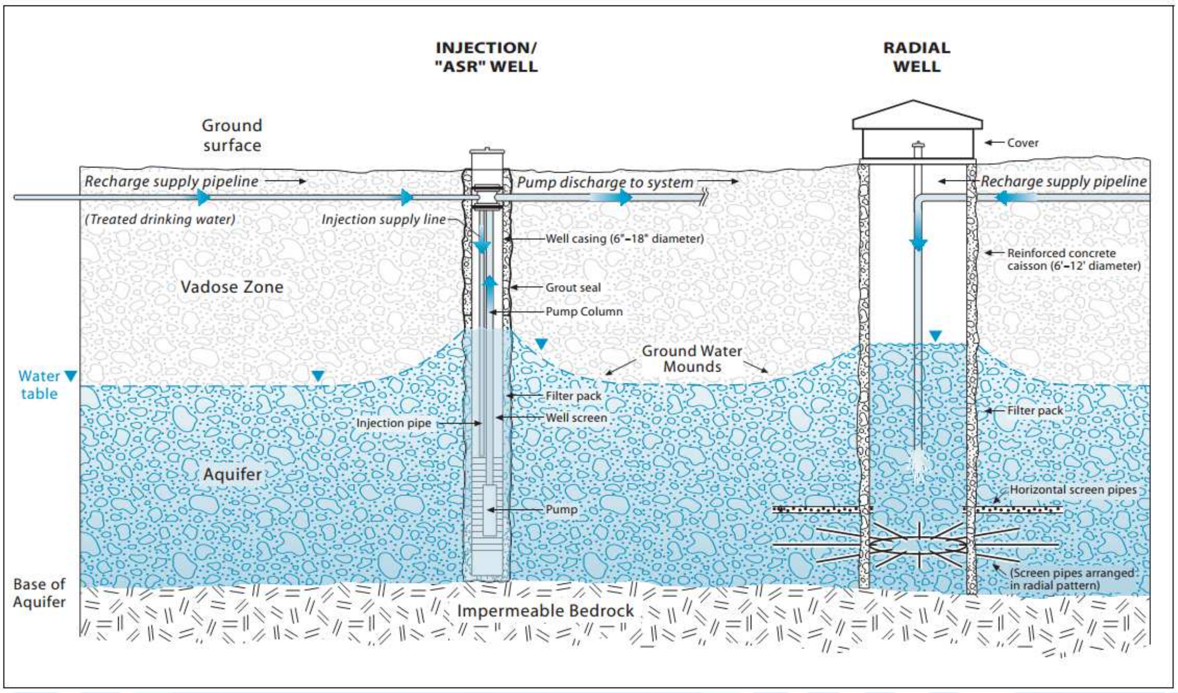


Figure 4. Direct injection in an unconfined aquifer.

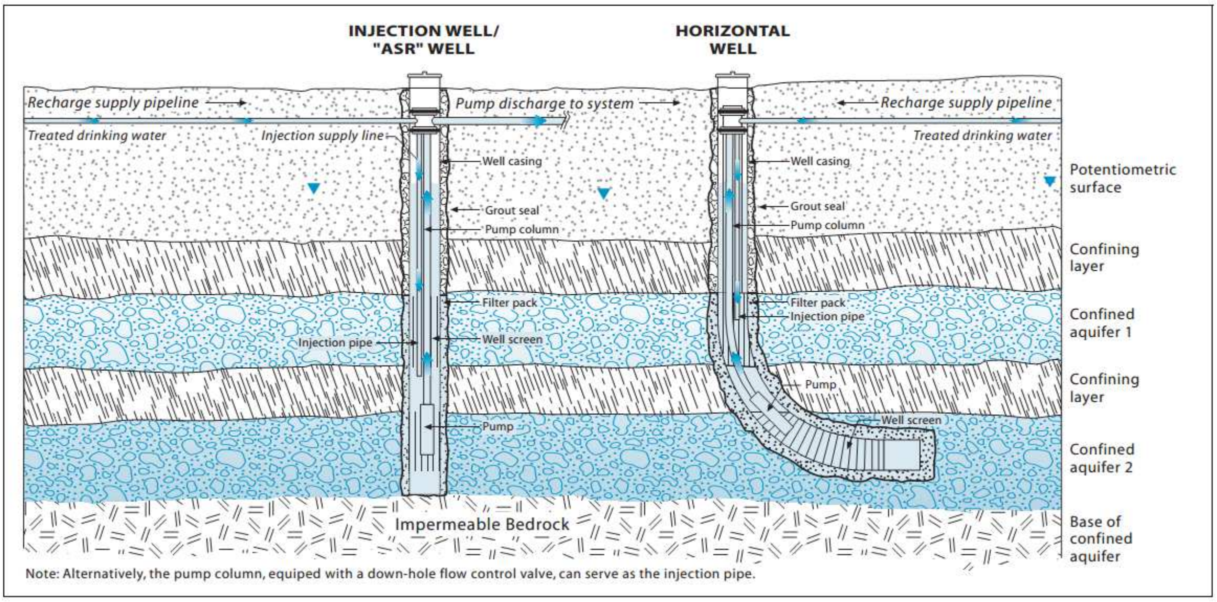


Figure 5. Direct injection in a confined aquifer.

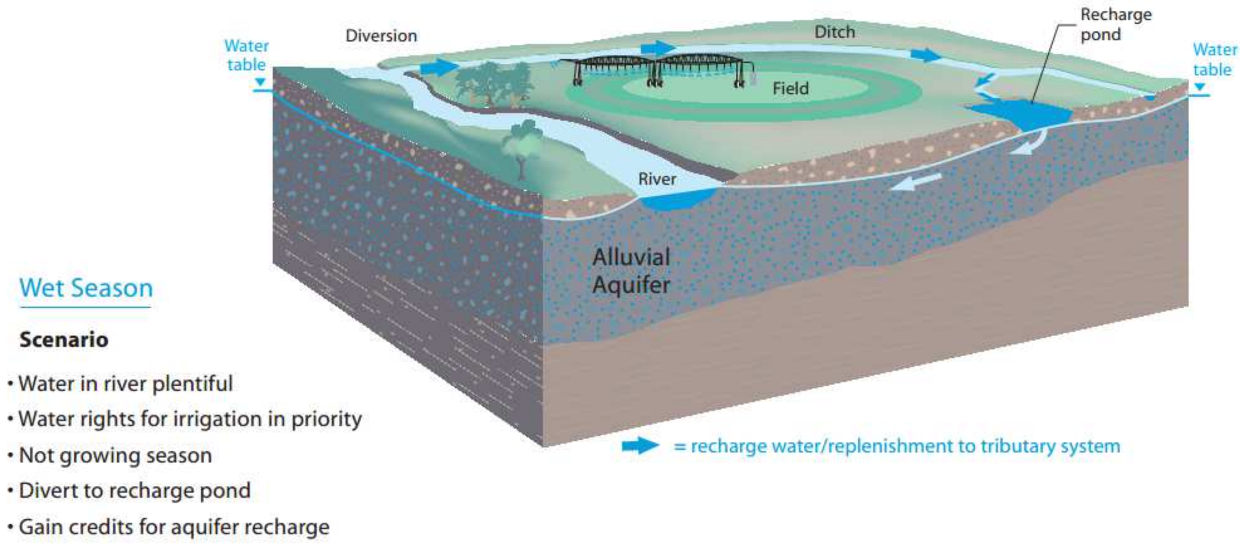


Figure 6a. Artificial recharge as augmentation for tributary ground water.

Dry Season, Alternative A

Scenario

- Water in river limited
- Water rights for field out of priority
- Growing season
- Divert water to field for irrigation
- Claim credits for previous wet season recharge

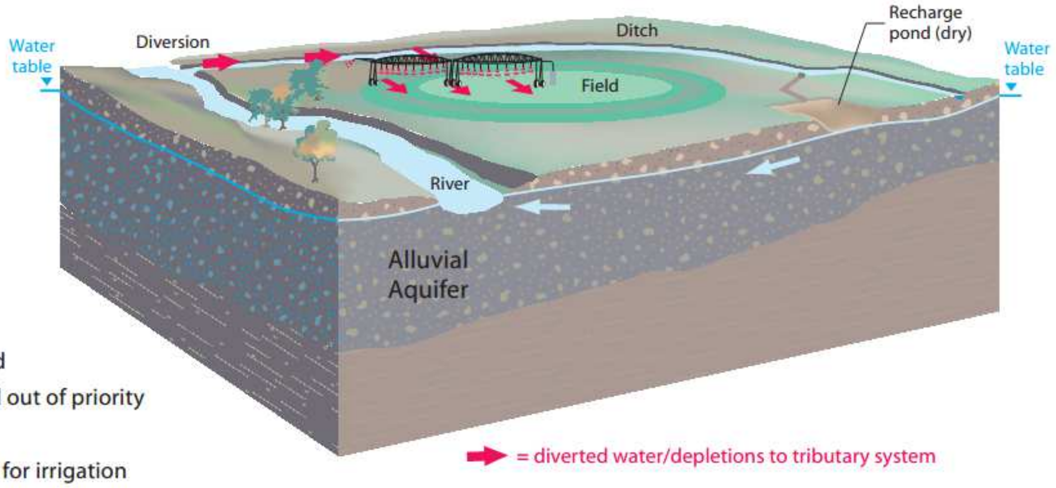


Figure 6b. Artificial recharge as augmentation for tributary ground water.

Dry Season, Alternative B

Scenario

- Water in river limited
- Water rights for field out of priority
- Growing season
- Pump water from aquifer for irrigation
- Claim credits for recharge

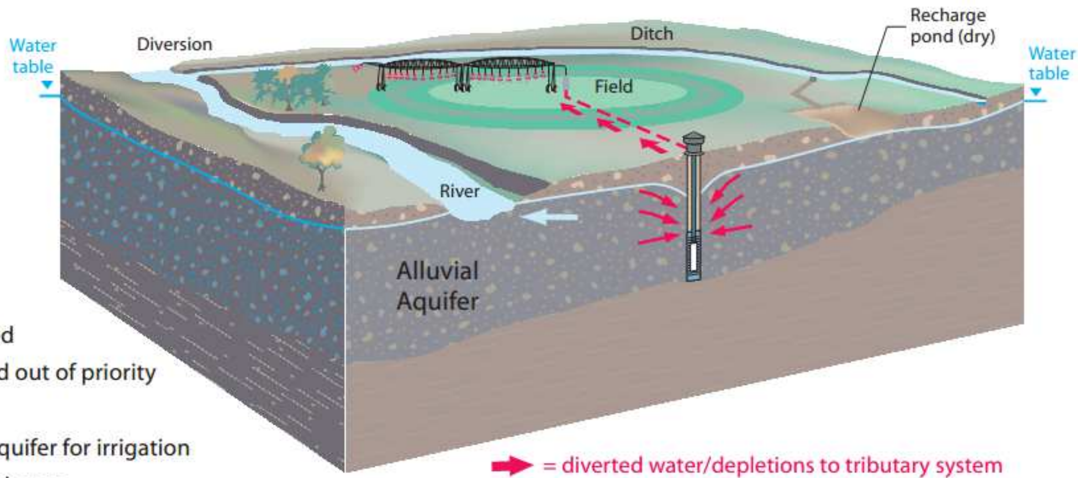


Figure 6c. Artificial recharge as augmentation for tributary ground water.

The selection of the most appropriate method depends on

- Geological, morphological and hydrogeological conditions of the wider area.
- The availability of the land where the implementation of artificial recharge will take place.
- Origin, availability and quality characteristics of recharge water.
- Existence or possibility for constructuion of infrastructures and the cost for operation and maintenance.
- Economical and legal issues and criteria.

Water Footprint

Life Cycle Assessment

Introduction

- ❑ Water is an essential natural resource.
- ❑ The issue of water and its management has become increasingly central to the global debate on sustainable development.
- ❑ This interest has been driven by:
  - ❖ growing water demand,
  - ❖ increasing water scarcity in many areas and/or
  - ❖ degradation of water quality.

This drives the need for a better understanding of water related impacts as a basis for improved water management at:

- ➢ **local,**
- ➢ **regional,**
- ➢ **national and**
- ➢ **global levels**

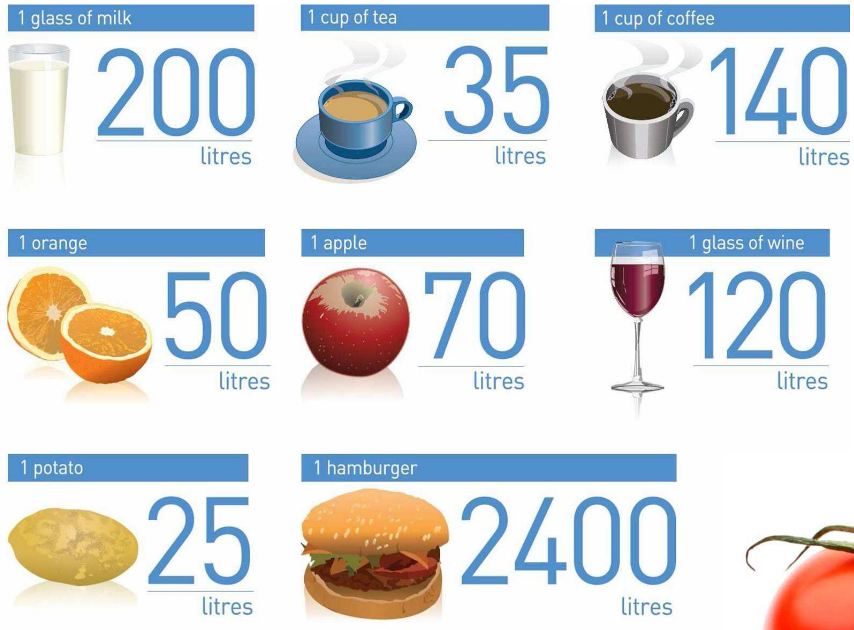
- Various human activities consume or pollute a lot of water. At a global scale, most of the water use occurs in **agricultural production** but there are also substantial water volumes consumed and polluted in the industrial and domestic sectors.
- Water consumption and pollution can be associated with specific activities such as irrigation, bathing, washing, cleaning , cooling and processing.

- It is therefore desirable to have appropriate assessment techniques in water resources management that can be used in an internationally consistent manner.
- Hoekstra and Chapagain have shown that ***visualizing the hidden water use behind products*** can help in understanding the ***global character of fresh water*** and in quantifying the effects of consumption and trade on water resources use.
- The improved understanding can form a basis for ***a better management of the globe's freshwater resources.***

- The idea of considering water use along supply chains has gained interest after the introduction of the **WATER FOOTPRINT** concept.
- The water footprint is an indicator of freshwater use that looks not only at direct water use of a consumer or producer, but also at the indirect water use.

Virtual Water

- The ***virtual water*** is the water "embodied" in a product, not in real sense but in virtual sense. It refers to the water needed for the production of the product.
- The virtual water concept has two major types of practical use:
  - ***Virtual Water Trade***
  - ***Water Footprint***



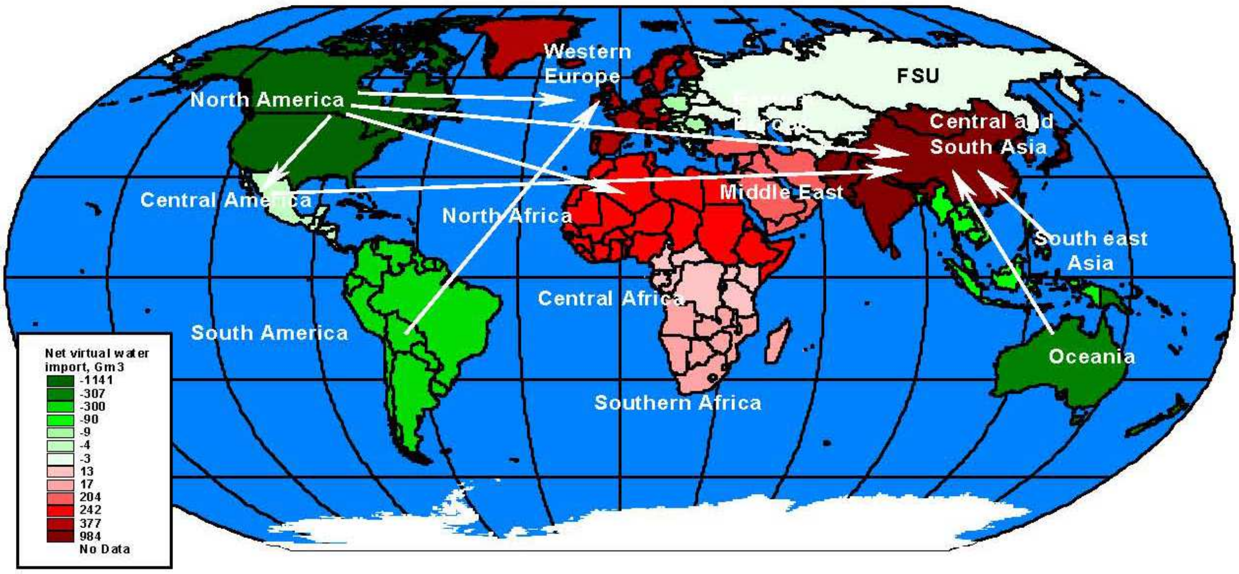
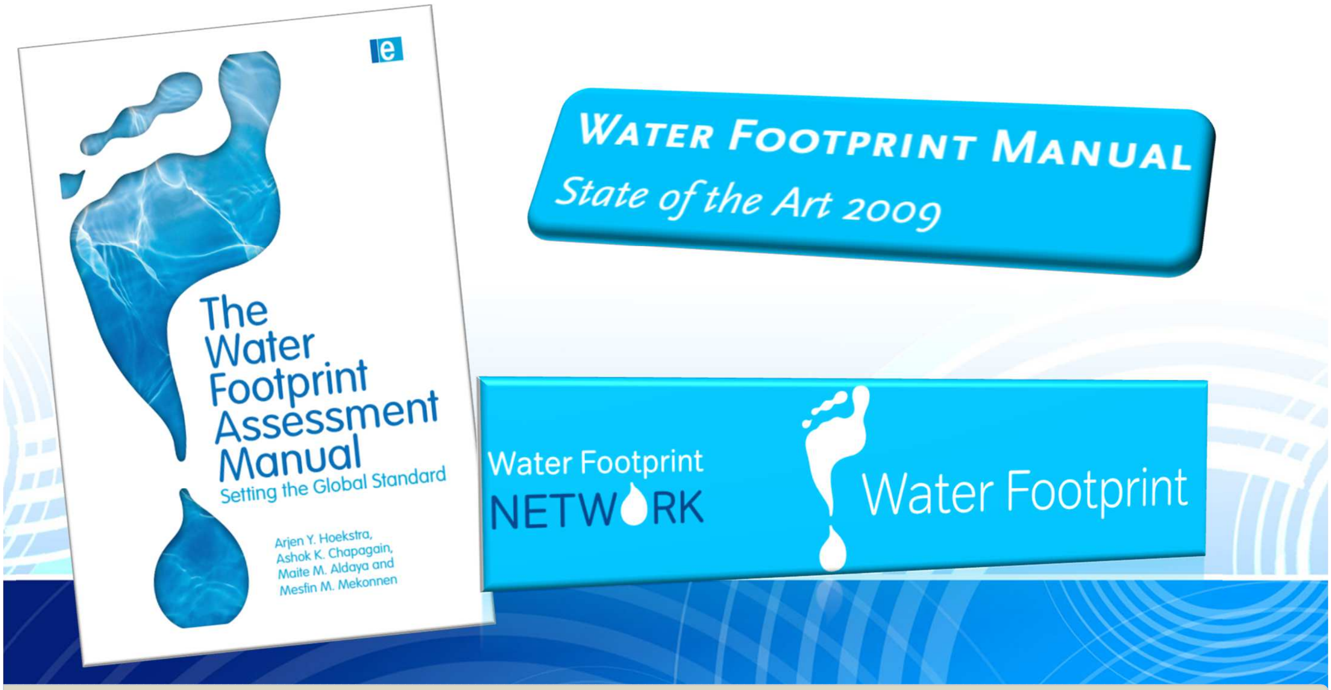


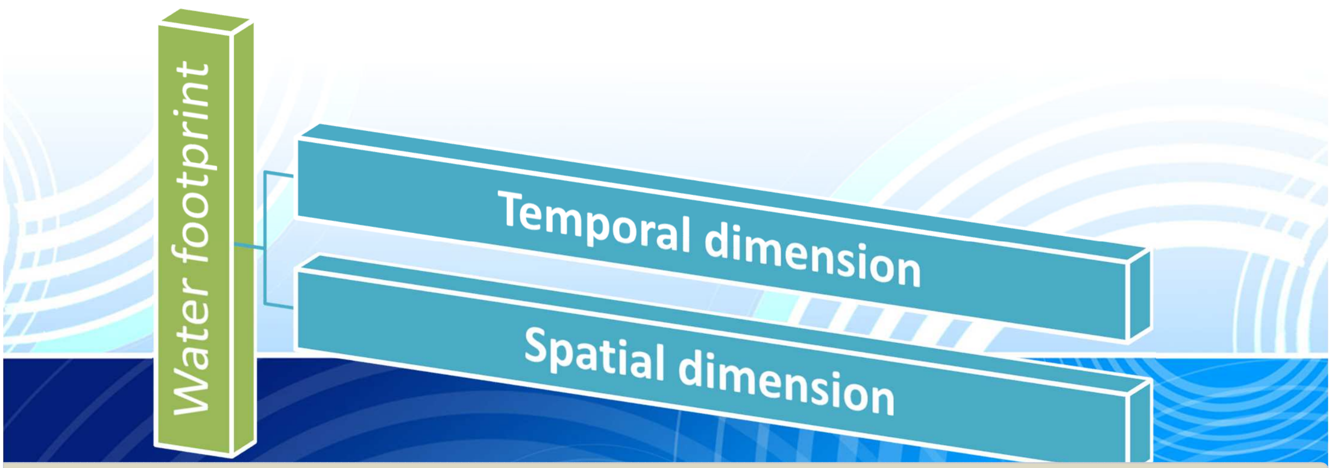
Figure 1. Virtual water trade balances of thirteen world region for the period 1995-1999.

The Water Footprint Assessment



Water Footprint

- **Water Footprint (WF)** is a multidimensional indicator of fresh water use that looks not only at *direct use* of a consumer or product but also the *indirect use*. Except the volume of water use the WF making explicit the type of water use (rainwater, surface or groundwater, pollution of water) and the location and timing of water use.



- Water footprint of a product
- Water footprint of a consumer
- Water footprint of a community
- Water footprint of national consumption
- Water footprint of a business
- Water footprint within a geographically delineated area

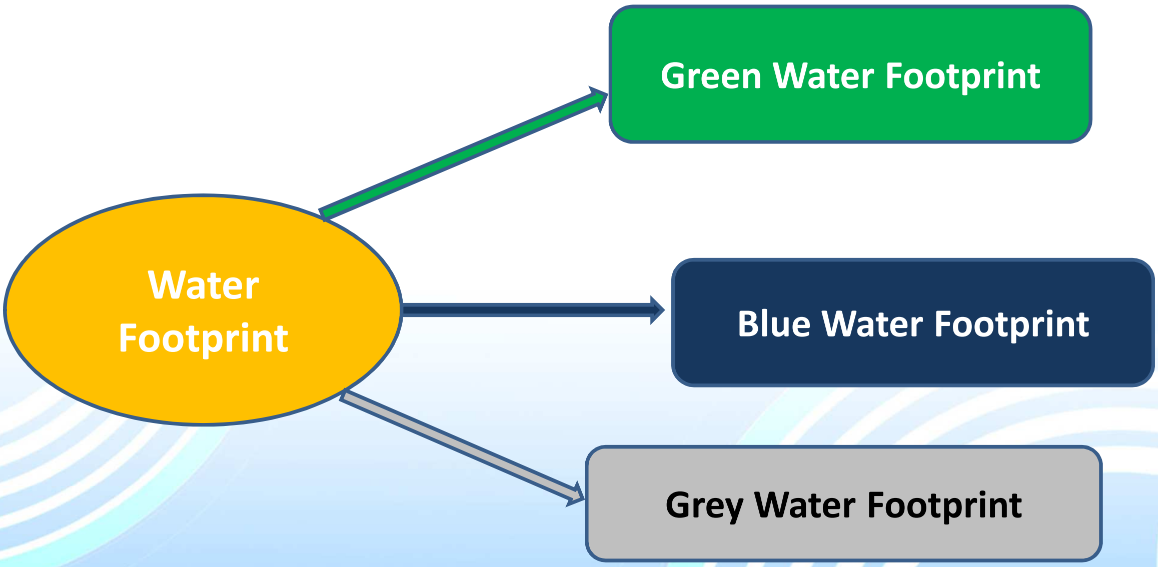
- The water footprint of a **product** is the sum of the water footprints of the process steps taken to produce the product (considering the whole production and supply chain).
- The water footprint of a **consumer** is the sum of the water footprints of all products consumed by the consumer.
- The water footprint of a **community** is the sum of the water footprints of its members.

- The water footprint of **national consumption** is the sum of the water footprints of its inhabitants.
- The water footprint of a **business** is the sum of the water footprints of the final products that the business produces.
- The water footprint within a **geographically delinea-ted area** (for example, a municipality, catchment or river basin) is the sum of the process water footprints of all processes taking place in the area.

- **Water Footprint** of ***a product*** is the volume of fresh water used to produce the product, measured ***over the full supply chain***.

Water Footprint Components

Water Footprint is the sum of three components:



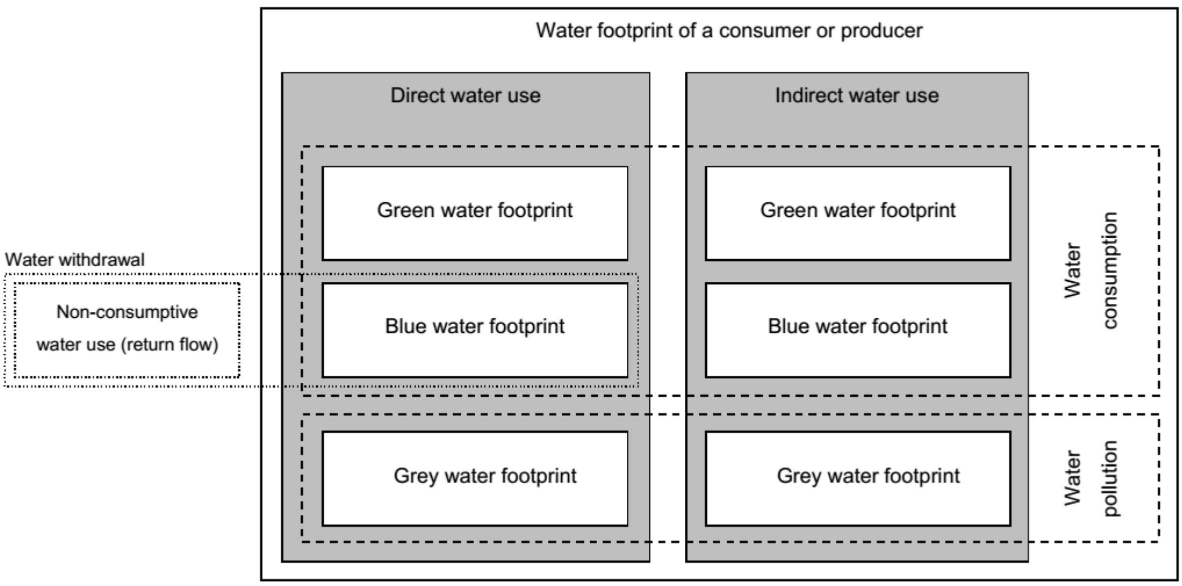


Figure 2. Schematic representation of the components of a water footprint.

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<u>Blue water:</u> consumption of blue water resources (surface and groundwater) along the supply chain of a product.

<u>Green water:</u> consumption of green water resources (rainwater stored in the soil as soil moisture)

Grey water: refers to the volume of polluted water, quantified as the volume of water to dilute pollutants, necessary to keep the quality of the water remains above agreed levels of quality

As an indicator of 'water use', the *water footprint differs from the classical measure of 'water withdrawal'* in three respects:

❖ it is not restricted to blue water use, but also includes green and grey water.

❖ it is not restricted to direct water use, but also includes indirect water use.

❖ it does not include blue water use insofar this water is returned to where it came from.

Water Footprint Assessment

A full water footprint assessment consists of four phases.

Phase 1
- Setting goals and scope

Phase 2
- Water footprint accounting

Phase 3
- Water footprint sustainability assessment

Phase 4
- Water footprint response formulation

Goals and Scope of Water Footprint Assessment

Goals

- ❑ Water footprint studies may have various purposes and applied in different contexts.
- ❑ Each purpose requires its own scope of analysis and will allow for different choices when making assumptions. A checklist for defining the goal of water footprint assessment is given in the next figure.
- ❑ The list is not exhaustive but rather shows a number of different options.

- General
- Process water footprint assessment
- Product water footprint assessment
- Consumer or community water footprint assessment
- Assessment of water footprint within a geographically delineated area
- National water footprint assessment (within a nation and of national consumption)
- Business water footprint assessment

Water Footprint Sustainability Assessment

- The question of the sustainability of water footprints can be considered from a number of distinct points of view.
- From the geographical viewpoint, one can ask: Is the total water footprint within a certain geographic area sustainable?
- This will not be the case when, for example, environmental flow requirements or ambient water quality standards in a catchment area are compromised or when the water allocation within a catchment area is regarded as unfair or inefficient.

- When considering a specific water-using process, one can ask: Is the water footprint of this process sustainable? ***The answer depends on two criteria.***
- First, the water footprint of a process is unsustainable when the process is situated in a certain period of the year in a certain catchment or river basin in which the overall water footprint is unsustainable.
- Second, the water footprint of a process is unsustainable in itself – independent of the geographic context – when either the green, blue or grey water footprint of the process can be reduced or avoided altogether (at acceptable societal cost).

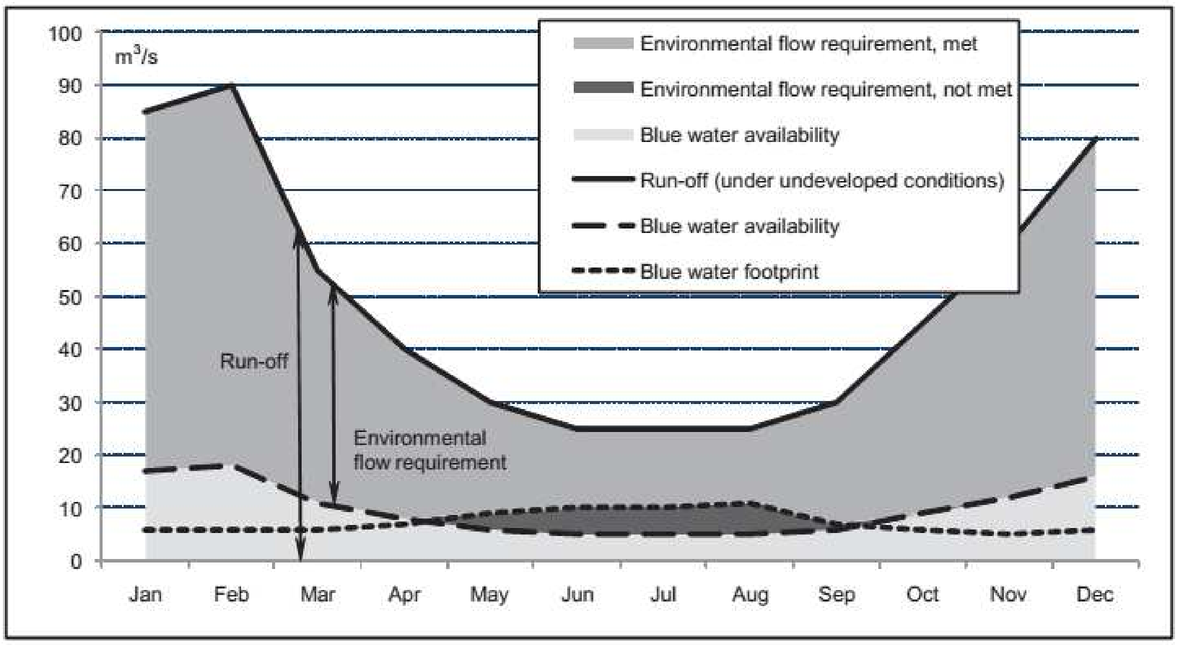
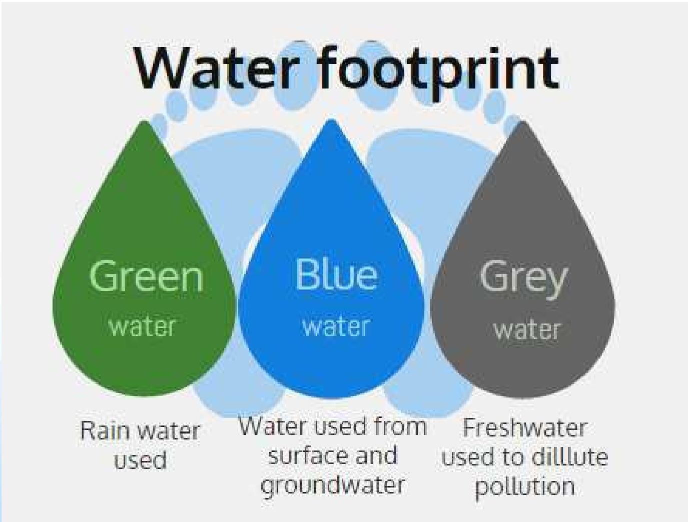


Figure 3. The blue water footprint over a year compared to the blue water availability, where the latter is equal to run-off (under undeveloped conditions) minus environmental flow requirements.

Water Footprint in Agriculture



Water Footprint in Agriculture

- When a product includes ingredients that originate from agriculture, those ingredients often give a major contribution to the overall water footprint of the product.
- In the global water footprint the major consumption is the agricultural products (86%).
- Wheat is the largest share in the total volume of water used for global crop production.

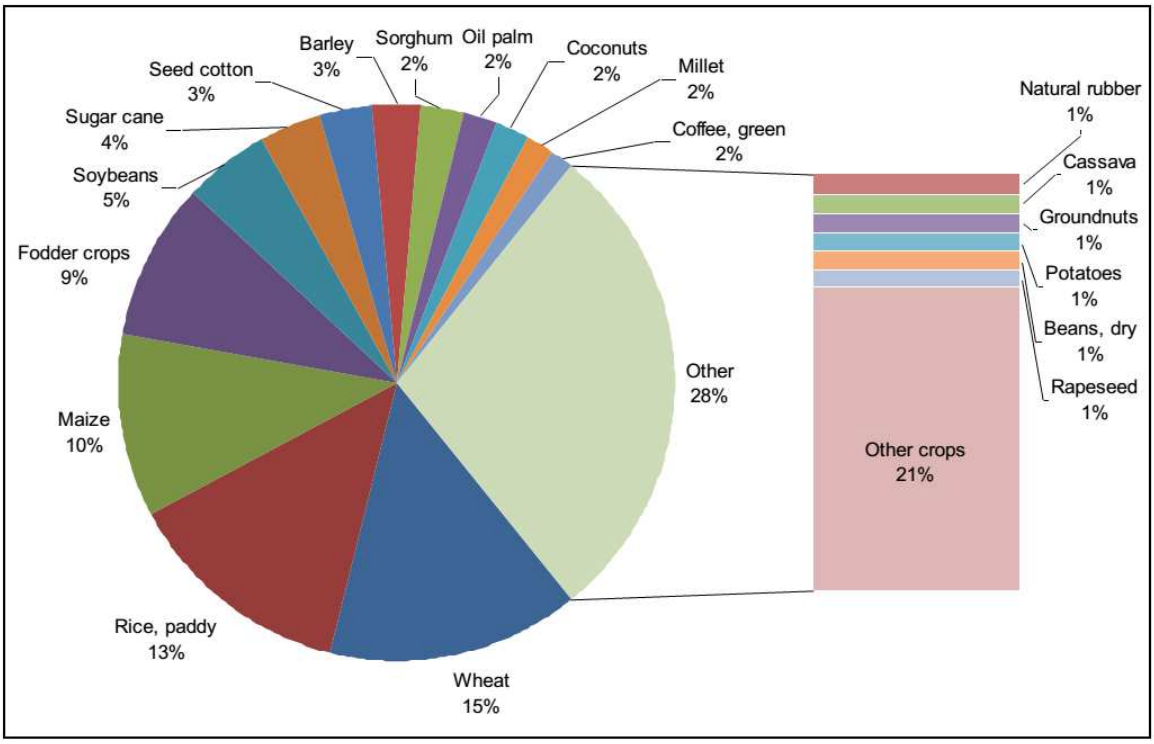


Figure 4. Contribution of different crops to the total water footprint of crop production for the period 1996-2005.

Calculation of Water Footprint of a crop

- The agricultural sector is the major water consuming and the products have a significant water footprint.
- The total WF of a crop is the sum of three components:

$$WF_{crop} = WF_{green} + WF_{blue} + WF_{grey} \qquad [volume/mass]$$

Water footprint in agriculture express per unit of product as m^3/ton which is equivalent to litre/kg.

- **Green component:** Green component in crop water use (CWU_{green}, m^3/ton) divided by the crop yield (Y, ton/ha).

$$WF_{green} = \frac{CWU_{green}}{Y} \qquad [m^3/ton]$$

- **Blue component:** Blue component in crop water use (CWU_{blue}, m^3/ton) divided by the crop yield (Y, ton/ha).

$$WF_{blue} = \frac{CWU_{blue}}{Y} \qquad [m^3/ton]$$

- **Grey component:** Grey component is calculated as the chemical application rate per hectare (AR, kg/ha) times the leaching fraction (α) divided by the maximum acceptable concentration (c_{max}, kg/m^3) minus the natural concentration for the pollutant considered (c_{nat}, kg/m^3) and then divided by the crop yield (Y, ton/ha).

$$WF_{grey} = \frac{(\alpha \cdot AR)/(c_{max} - c_{nat})}{Y} \qquad [m^3/ton]$$

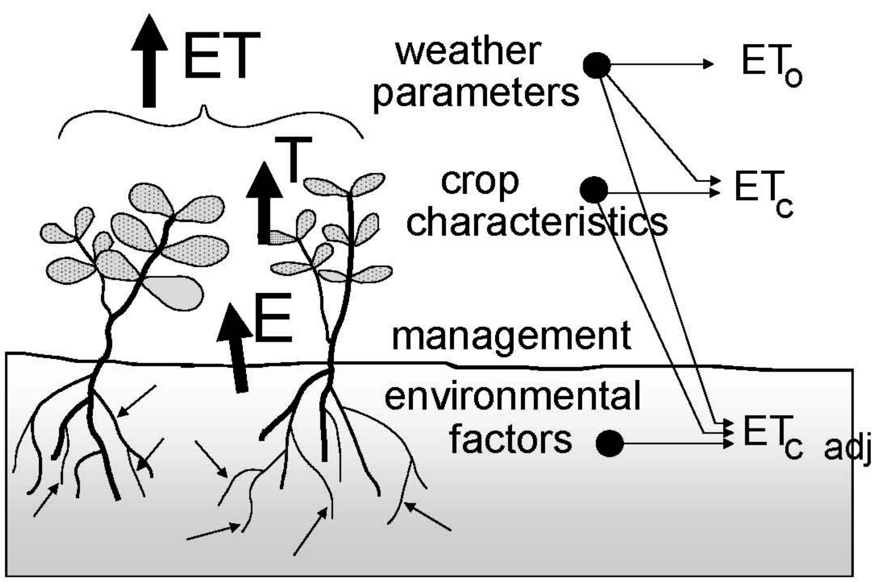
The pollutants generally consist of fertilizers (nitrogen, phosphorus and so on), pesticides and insecticides.

- The green and blue components in crop water use are calculated by accumulation of daily evapotranspiration:

$$CWU_{green} = 10 \cdot \sum_{d=1}^{lgp} ET_{green}$$

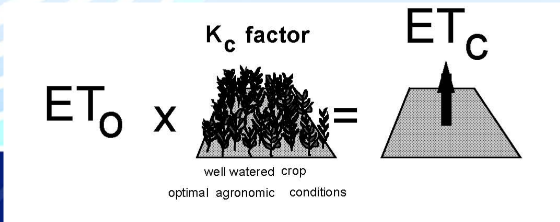
$$CWU_{blue} = 10 \cdot \sum_{d=1}^{lgp} ET_{blue}$$

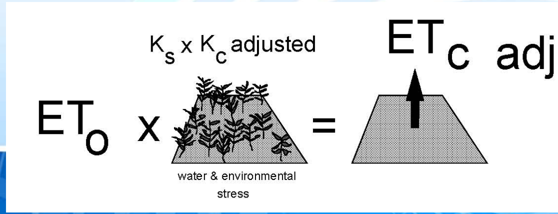
- Evapotranspiration (ET) is estimated by the equations with data of climate, soil properties and crop characteristics.



Two different options to calculate crop evapotranspiration

Optimal conditions in which ET_c (CWR) is covered from P_e, SM, GW or IR and $ET_a=ET_c$ and $Y_a=Y_m$	Actual conditions in which ET_c (CWR) is covered from P_e, SM, GW or IR and $ET_c adj<=ET_c$ and $Y_a<=Y_m$





- Optimal conditions: The green and blue components are calculated by equations:

$$ET_{green} = \min(ET_c, Pe)$$
$$ET_{blue} = \max(0, ET_c - Pe - SM - GW)$$

- Actual conditions: The green and blue components are calculated by equations:

$$ET_{green} = \min(ET_c, Pe)$$
$$ET_{blue} = \max(0, IR)$$

International Standard ISO14046

Environmental Management – Water Footprint - Principles, requirements and guidelines

Introduction

- This International Standard specifies principles, requirements and guidelines related to water footprint assessment of products, processes and organizations based on **life cycle assessment (LCA).**
- This International Standard provides principles, requirements and guidelines for conducting and reporting a water footprint assessment as a stand-alone assessment, or as part of a more comprehensive environmental assessment.
- The result of a water footprint assessment is a single value or a profile of impact indicator results.

This International Standard is expected to benefit organizations, governments and other interested parties worldwide by providing:

- transparency,
- consistency,
- reproducibility and
- credibility

for assessing and reporting the water footprint of:

- products,
- processes or
- organizations.

A water footprint assessment conducted according to this International Standard:

- is based on a life cycle assessment (according to ISO 14044);
- is modular (i.e. the water footprint of different life cycle stages can be summed to represent the water footprint);
- identifies potential environmental impacts related to water;
- includes relevant geographical and temporal dimensions;
- identifies quantity of water use and changes in water quality;
- utilizes hydrological knowledge.

A water footprint assessment can assist in:

- assessing the magnitude of potential environmental impacts related to water;
- identifying opportunities to reduce water related potential environmental impacts associated with products at various stages in their life cycle as well as processes and organizations;
- strategic risk management related to water;

- facilitating water efficiency and optimization of water management at product, process and organizational levels;
- informing decision-makers in industry, government or non-governmental organizations of their potential environmental impacts related to water;
- providing consistent and reliable information, based on scientific evidence for reporting water footprint results.

Methodological Framework

A water footprint assessment according to this International Standard shall include the four phases of life cycle assessment:

a) **goal and scope definition,**

b) **water footprint inventory analysis,**

c) **water footprint impact assessment,**

d) **interpretation of the results.**

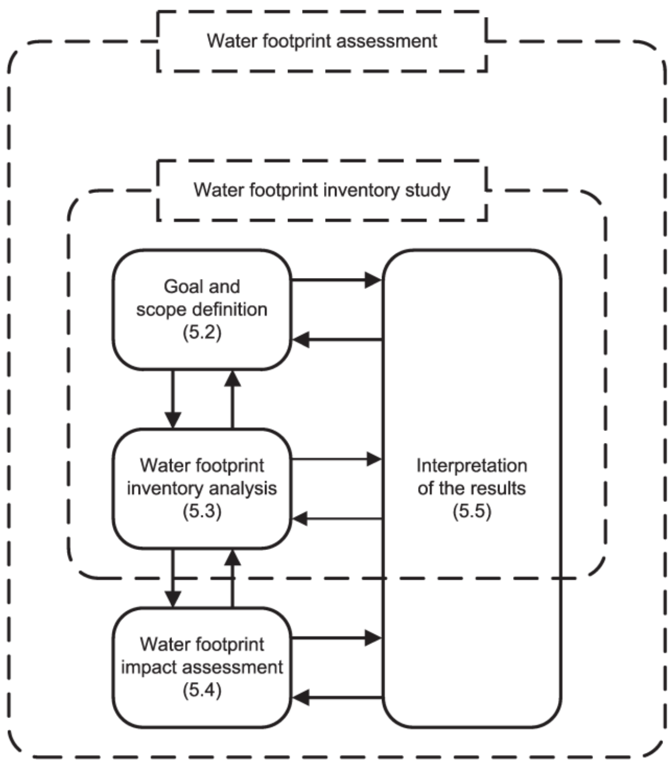


Figure 5. Phases of a water footprint assessment.

A water footprint inventory study according to this International Standard shall include the three following phases of life cycle assessment:

— goal and scope definition,

— water footprint inventory analysis and

— interpretation of the results

Goal and Scope definition

In defining the goal of a water footprint assessment, the following items shall be stated:

- the intended application,
- the reasons for carrying out the study,
- the intended audience, i.e. to whom the results of the study are intended to be reported,
- whether the study is a stand-alone assessment or part of a life cycle assessment, and
- whether the study is part of a life cycle assessment where a comparative assertion is intended

In defining **the scope of the study**, the following items shall be considered and clearly described, taking into account the requirements and guidance given in the relevant clauses:

- system under study, system boundary and organizational boundary where relevant,
- functional unit,
- temporal and geographical coverage and resolution of the study,
- data and data quality requirements,
- cut-off criteria,

- allocation procedures,
- assumptions, value choices and optional elements,
- water footprint impact assessment methodology and selected impact categories
- whether the results of the water footprint assessment will include one impact indicator result (and specifying which one), a water footprint profile and/or a water footprint after weighting,
- whether the water footprint assessment is comprehensive,

- which cause effect chains and potential environmental impacts are covered by the water footprint assessment and identify the foreseen consequences of the excluded potential environmental impacts,
- uncertainties and limitations,
- justification for exclusions from the study,
- baseline conditions with which the current conditions caused by the activities are being compared if applicable.

The goal and scope definition phase shall include the identification of:

- unit processes requiring a detailed assessment based on primary data, because of a significant expected contribution to the results, and
- unit processes for which the inventory may be based on secondary data or estimated data, as they are of low significance or if they are difficult to obtain as primary data.

Water Footprint Inventory Analysis

Inventory calculations shall follow the procedures as described in ISO 14044:

- Calculating data.
- Validation of data.
- Relating data to unit processes, reference flows and functional unit evaluation.
- Aggregate the inputs and outputs.
- Refining the system boundaries.

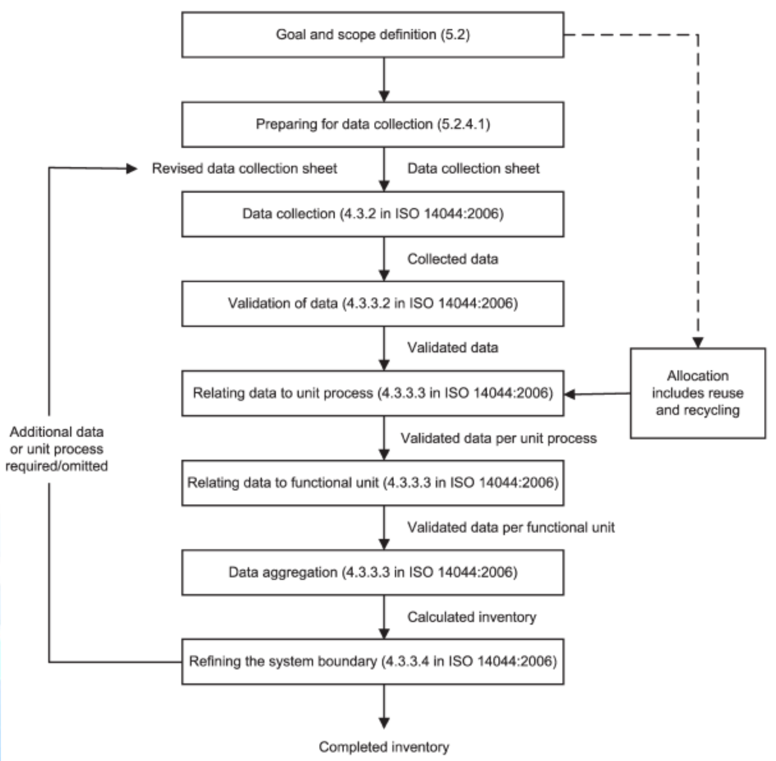


Figure 6. Procedures for water footprint inventory analysis.

The water footprint inventory shall include inputs and outputs from each unit process being part of the system to be studied. Any discrepancies in the inventory balance shall be explained.

Information **on each elementary flow** should generally include, where relevant:

- quantities of water used,
- resource types of water used,
- water quality parameters and/or characteristics,
- forms of water use,
- geographical location of water used or affected,
- temporal aspects of water use,
- emissions to air, water and soil that impact water quality

Water inputs or water outputs of different resource types, different quality, different form, different location with different environmental condition indicators, or different timing shall not be aggregated in the inventory phase. Aggregation may be performed at the impact assessment phase.

Water Footprint Impact Assessment

- The water footprint impact assessment shall be compliant with ISO 14044.
- This International Standard provides further requirements and guidelines for assessing potential environmental impacts related to water.

- Impacts related to water can be represented by one or more parameters which quantify the potential environmental impacts of a product system, process or organization related to water, including:
  - the water footprint indicator result (e.g. water scarcity footprint), related to one single impact category (e.g. water scarcity)
  - the water footprint profile which comprises several indicator results.

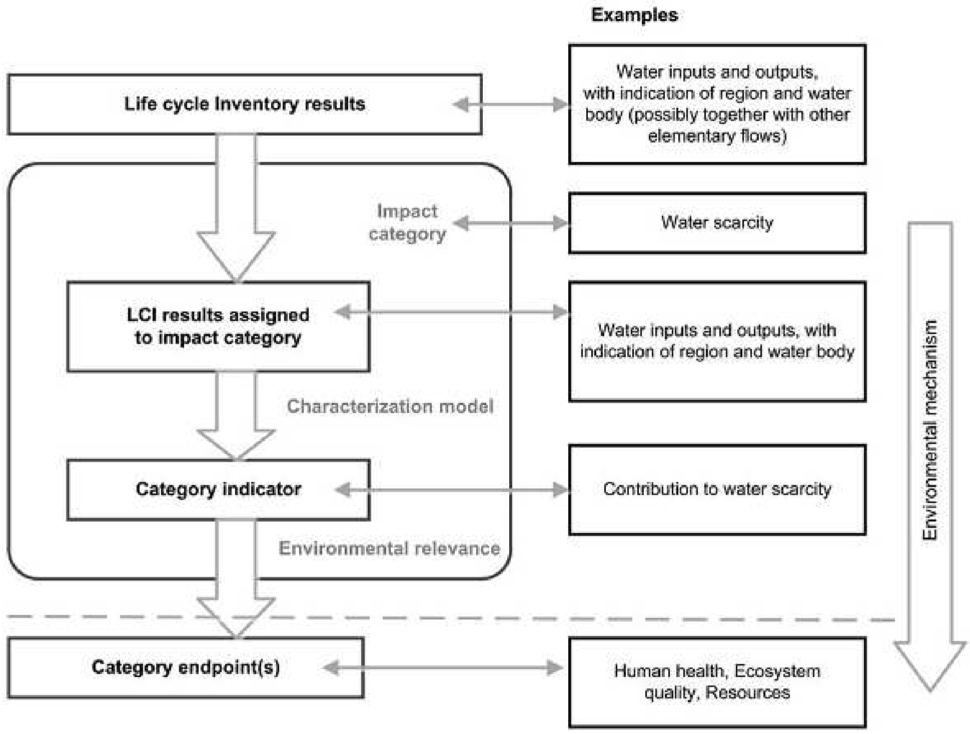


Figure 7. Concept of category indicators illustrated for an impact category addressing water scarcity.

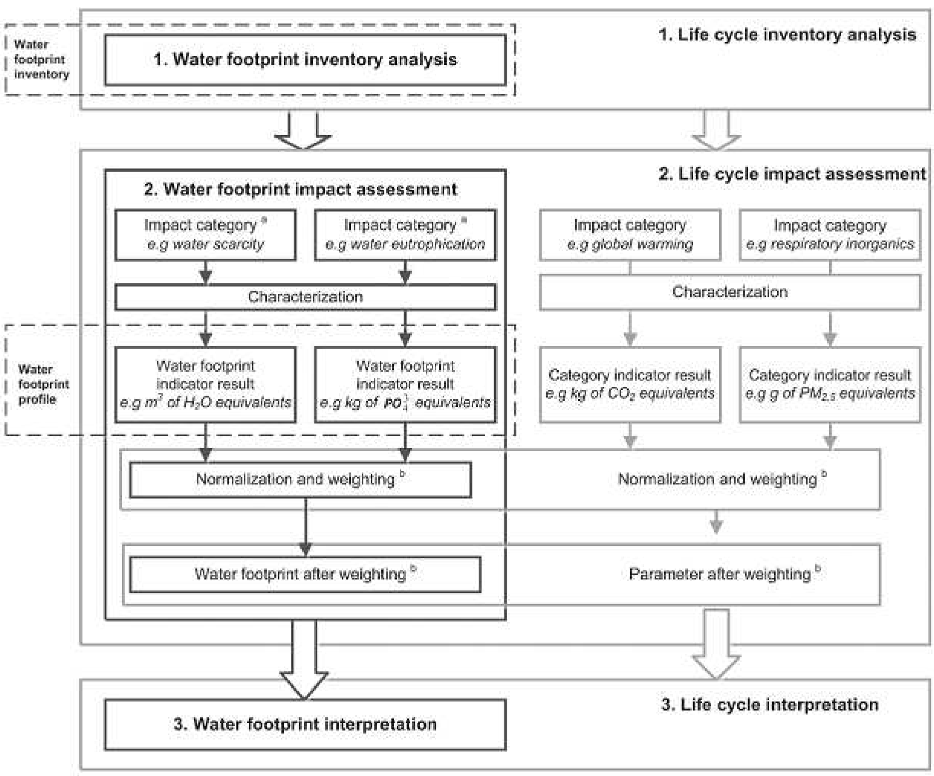


Figure 8. Concept of water footprint as a stand-alone assessment or part of a life cycle assessment.

Environmental Water Management – Advanced Technologies, April 3, 2019 , Tbilisi, Georgia

Interpretation of the Results

The interpretation phase of a water footprint assessment shall include the following:

- identification of the significant issues based on the results of the water footprint assessment,
- evaluation that considers completeness, sensitivity and consistency checks,
- consideration of geographical and temporal aspect,
- conclusions of the water footprint assessment,
- limitations of the water footprint assessment,
- qualitative and/or quantitative assessment of uncertainty, for example through the application of Monte-Carlo simulation,
- consideration of sensitivity analysis to provide ranges around the reported results.

Conclusions

- The water footprint:
  - shows human appropriation of the world's limited freshwater
  - provides a basis for discussing water allocation and issues that relate to **sustainable**, **equitable** and **efficient** water use
  - can help the dialogue between consumers, producers and governments about how to share responsibility for reducing it where most necessary.

Thank you for Your attention

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