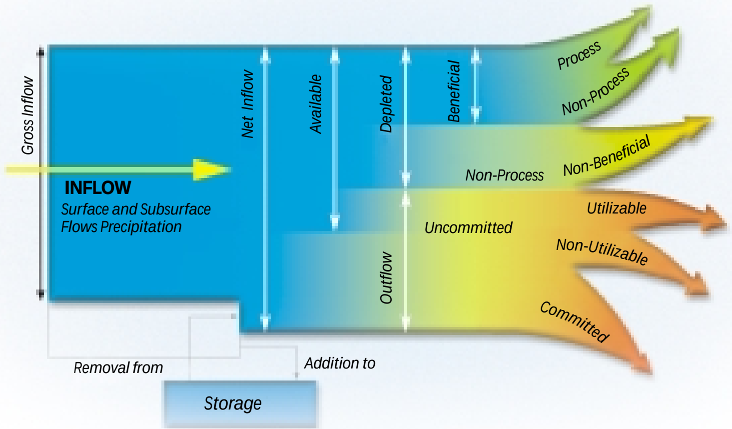
Water Accounting for Integrated Water Resources Management

IWMI's Water Accounting System provides a clear view of water resources in a river basin. It shows where water is going, how it's being used, and how much remains available for further use.



Policy makers, planners and resources managers can use this information to:

- Identify opportunities for saving water and increasing water productivity
- Conceptualize and test interventions in the context of multiple uses of water
- Develop effective strategies for allocating water among different users
- Assess the scope for the development of additional water resources

International Water Management Institute

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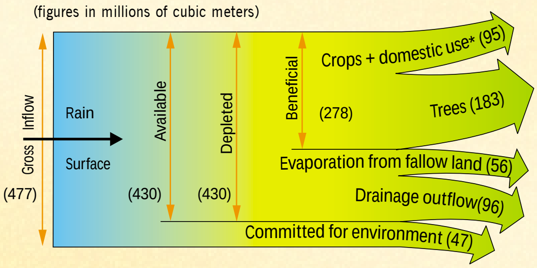
Water accounting for integrated water management in river basins

As more of the developing world's river basins become 'closed,' with all their available water used, it becomes increasingly important to plan water resources development, allocation, and management in the context of multiple uses of water. Policy makers and water resources planners can use water accounting to make decisions based on the actual amount of water available in a basin and with an understanding of the potential impacts on all users.

Multiple uses of water in a river basin

How is water being used? Water accounting clearly shows all users of water in a basin, including unplanned, and often unacknowledged users, such as trees. In the case of Kirindi Oya Subbasin, trees are revealed to be the largest user of water-consuming a surprising 43 percent of the total water available. Although trees are an important natural resource-improving biodiversity within irrigated areas and providing people with food, medicine, fuel wood, a pleasant environment and raw materials for handicrafts-they are rarely considered in water resources planning. Water accounting helps water managers take a more integrated approach that more accurately reflects the reality of water use.



Water accounting diagram for Kirindi Oya Subbasin, Sri Lanka

**The amount of water used for domestic purposes and most other income-generating activities is negligible when compared to the amount consumed by crops.*

Where can water be saved? In the Kirindi Oya, water saving strategies should focus on reducing the flow of irrigation drainage water to the sea. Currently, downstream irrigation tanks (holding-ponds) are filled directly from the main reservoir-reducing their ability to catch rainwater and drainage flows from upstream.

By changing this practice, so that upstream areas are irrigated first and downstream tanks are used to catch drainage, enough water could be saved in the reservoir for a second cropping season-96 million cubic meters in the year studied (1998).

Alternatively, drainage flows can be minimized by more closely matching the amount of irrigation water supplied to crops' actual needs. Finally, by reducing the evaporation from scrubland, fallow fields and surface water bodies another 56 million cubic meters could potentially have been saved.

How much water for natural ecosystems? 47 million cubic meters of water per year were designated as committed outflow to maintain the downstream Ramsar Convention wetland, Bundala National Park. But this is only a rough estimate of how much water this fragile ecosystem really requires. More research is needed to accurately quantify environmental water needs in many of the developing world's river basins.

Increasing the productivity of water

One of the most valuable applications for water accounting is in identifying opportunities for saving water and increasing its productive use. By showing where water is being used and providing a framework for assessing its productivity, water accounting helps :

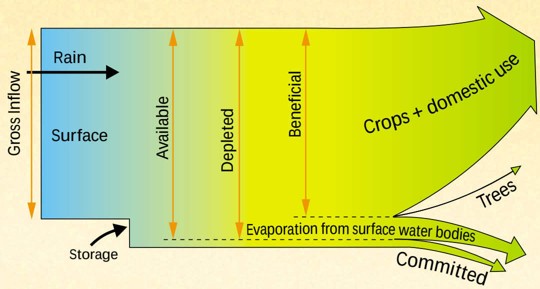
- Pinpoint areas where water can be transferred from lower- to higher-value uses
- Evaluate the scope for improving productivity of water and target interventions
- Identify opportunities to reduce non-beneficial evaporation, pollution, or the flow of water into 'sinks' (deep aquifers or other areas where it can't be recovered)

Avoiding conflicts: A common language for talking about water

Being able to clearly communicate how water is being used and the rationale for allocation can help avoid or minimize conflicts over water. This is especially important in cases where the competition for water is intense and giving more water to one user necessarily means taking it away from another. The IWMI Water Accounting System provides a common language to understand and describe the use and productivity of water.

Managing water in 'closed' basins

In 'closed' basins, such as Chishtian, almost all available water is used for producing crops and there is little non-beneficial depletion. The only remaining alternative for these basins is to focus on gaining more productivity from the water used—through improved management practices or reallocation of water from lower- to higher-value uses.



Water Accounting Diagram for Chistian Subbasin, Pakistan

Water accounting definitions

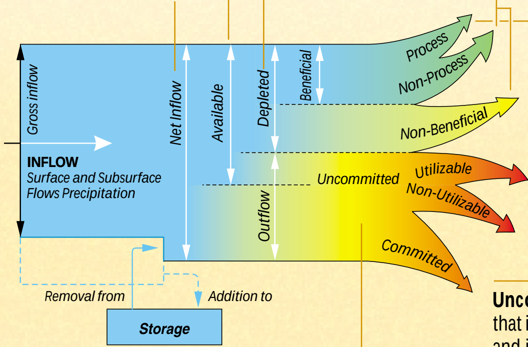
Water depletion is a use or removal of water from a water basin that renders it unavailable for further use.

Available water represents the amount of water available for use. Available water includes process and non-process depletion, plus utilizable outflows.

Net inflow is the gross inflow plus any changes in storage.

Non-process depletion occurs when water is depleted, but not by a human-intended process. *Non-process depletion* can be either *beneficial*, or *non-beneficial*-for example, evaporation from fallow land would generally be classified as non-beneficial, while evaporation from forests would generally be considered beneficial. *Classification as beneficial or non-beneficial requires a value judgement and is a good entry point for discussions with stakeholders.*

Process depletion is that amount of water diverted for use that is depleted to produce a human-intended product.



Gross inflow is the total amount of water flowing into the river basin or defined area from precipitation, rivers and subsurface sources (groundwater).

Committed water is that part of outflow from the basin or defined domain that is committed to other uses such as downstream environmental requirements or downstream water rights.

Uncommitted outflow is water that is not depleted, nor committed and is therefore available for a use within the domain, but flows out of the basin due to lack of storage or sufficient operational measures. Uncommitted outflow can be classified as *utilizable* or *non-utilizable*. Outflow is utilizable if it could be used by improved management of existing facilities.

How water accounting works

Water accounting uses a 'water balance' approach to quantify the amount of water entering a system (through precipitation and river and groundwater flows) and the amount leaving a system (through evaporation, plant transpiration and river and groundwater flows). The amounts depleted within the basin are then classified according to use, whether or not the use is intended and whether or not it is beneficial.

The amount of unused water flowing out of the system is classified according to whether or not it is committed for downstream use. Non-committed outflows are further subdivided into water that is currently utilizable and water that is not utilizable without additional infrastructure.

Once water is categorized, water accounting indicators refine the picture

Depleted Fraction indicators reveal how much scope remains for water resources to be developed, how close they are to being fully committed, and how sustainable the system is. For example, the depleted fraction *(amount of water depleted divided by gross inflow)* for Pakistan's Chishtian subbasin was 1.09—meaning more water is being depleted than is flowing into the system. This indicates groundwater overdraft and therefore unsustainable water use.

Beneficial Utilization *relates the amount of water depleted by all beneficial processes to the amount of water available for use.* This indicator offers a more accurate view of basin efficiency than traditional indicators, because it takes into consideration the water consumed by valuable natural ecosystems as well as the water consumed by human activities (such as agriculture). For example, according to the classical definition, Kirindi Oya subbasin has an efficiency of 22 percent (counting only water used by crops), but its beneficial utilization is actually much higher—65 percent (counting water consumed by crops and beneficial natural vegetation).

Productivity of Water quantifies the value derived from the water used. In agriculture, it can be expressed as the *yield (in kilograms) produced per cubic meter of water consumed by crops*. More generally, it can be expressed as *the economic value of production per unit of water consumed.* These productivity values can also be related to the amount of water available, depleted or diverted.

Water accounting in action: Indonesia, India, Pakistan, Sri Lanka, China, Nepal, Philippines

In South Asia, water accounting was used in four basins to identify opportunities for saving water and improving productivity—Bhakra and Chishtian in the semiarid regions of India and Pakistan, and Kirindi Oya and Huruluwewa in the more humid region of Sri Lanka.

In Indonesia, the Philippines, Sri Lanka, China and Nepal, national partners are carrying out water accounting as a key component of a five-country study. The goal of the study is to find ways for water-sector institutions to effectively deal with water scarcity, pollution and other challenges of basin management.

In China, in collaboration with the International Rice Research Institute and Wuhan University of Electrical and Hydraulic Engineering water accounting has been used to determine whether the on-farm water management practice of alternate wetting and drying in paddy rice translates into water savings at the basin level.

More water for food, livelihoods and nature

Water planners have two basic options for increasing the amount of water available for beneficial use without building additional infrastructure.

- Reduce non-beneficial depletion.
- Produce more crop per unit of water beneficially depleted.

Improving the productivity of water and reducing waste are appealing options compared to developing new storage and diversion facilities, which often carry high financial, social and ecological costs. Water accounting gives planners and policy makers a clear view of their options and the scientific information necessary to effectively plan development and management efforts.

Four ways of improving the productivity of basin water resources

1. Increasing the productivity per unit of water consumed

Changing crop varieties. Developing new crop varieties can provide increased yields for each unit of water consumed, or the same yields with fewer units of water consumed.

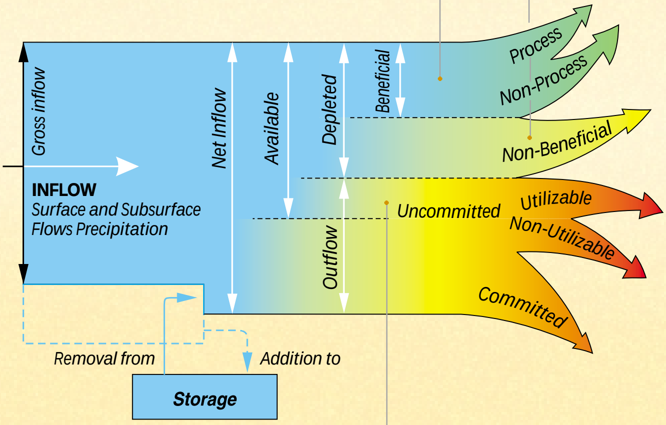
Crop substitution. Switching from high- to less-water-consuming crops, or switching to crops with higher economic or physical productivity per unit of water consumed.

Deficit, supplemental, or precision irrigation. With sufficient water control, higher productivity can be achieved using irrigation strategies that increase the returns per unit of water consumed.

3. Reducing non-beneficial depletion

Non-beneficial depletion can be reduced by decreasing....

- evaporation from water applied to irrigated fields through specific irrigation technologies such as drip irrigation, or agronomic practices such as mulching, or changing crop planting dates to match periods of less-evaporative demand.
- evaporation from fallow land, decreasing area of free water surfaces, decreasing less beneficial vegetation, and controlling weeds.
- water flows to sinks (ocean or deep aquifers) and by reusing return flows, or by interventions that reduce deep percolation or surface runoff that flows to sinks.
- flows through saline soils, or through saline groundwater to reduce pollution caused by the movement of salts into irrigation return flows.
- preventing saline or otherwise polluted water from reentering the system by shunting it directly to sinks.



2. Tapping uncommitted outflows

Improving the management of existing facilities to obtain more beneficial use from existing water supplies. A number of policy, design, management, and institutional interventions may allow for an expansion of irrigated area, increased cropping intensity, or increased yields within the service areas.

Adding storage facilities and releasing water during drier periods. Storage takes many forms including impoundment in reservoirs, groundwater aquifers, and in small tanks and ponds on farmers' fields.

Reuse of return flows through gravity and pump diversions to increase irrigated area.

4. Reallocating water between uses

Reallocation of water:

- ***between sectors**-from lower- to higher-value uses.*
- ***between upstream and downstream uses***

Reallocation can have serious legal, equity, and other social considerations that must be addressed.

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