Aqueous Productivity: an enhanced indicator for agricultural water management in the monsoonal tropics and dry lands

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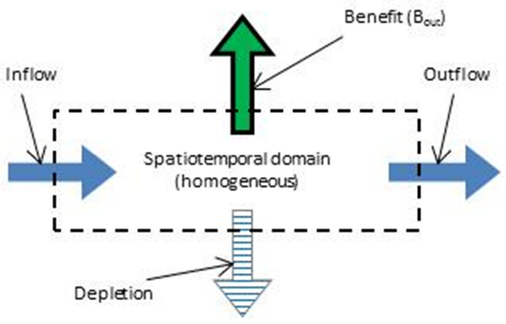
Water scarcity can seriously limit crop and livestock production in dry and monsoonal climates in the developing world. **Indicators** that convey information about the **productivity of water** can support **water management decisions** and strategy, particularly in contexts that are under-supported by analysis or data availability.

One prominent indicator: 'Water Productivity'

Def: ratio of net benefits from crop, forestry, fishery, livestock, and mixed ag systems to the amount of water required to produce those benefits



In WP, benefits from a production process are compared to water flows crossing domain boundaries

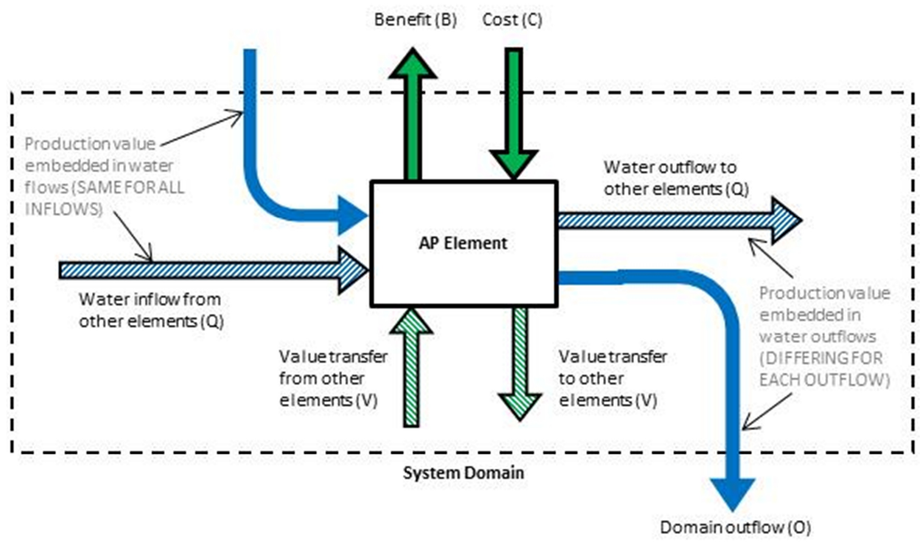
$$\mathrm{WP} = \frac{B_{out}}{V}$$

where:
B_{out} is net benefit
V is volume of water used, e.g. depletion or net inflow

WP is simple and intuitive, BUT has significant limitations:

- **Highly scale-dependent (value changes with domain boundary definition)**
- **Ill-suited to systems with multiple uses, high water re-use, and non-depleting uses (difficulty in obtaining a meaningful V)**

… vs. an enhanced alternative: 'Aqueous Productivity'



Enforcement of (1) water and value balances on each system element, and (2) assignment of equivalent AP values on all inflows into each element produces a system of linear equations that can be solved for AP values (ε) for all water flows:

$$\boldsymbol{\varepsilon} = [V_{out} - V_{in} + B - C + G][I + Q_{in} - Q^T]^{-1}$$

In AP:

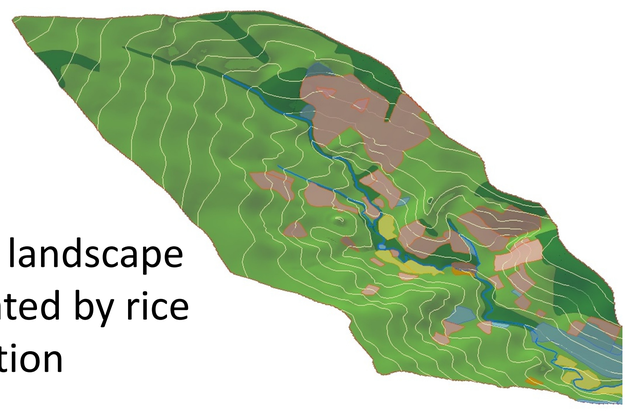
- Productive value is conceptualized as being 'embedded' or 'dissolved' in water flows.
- Elements within a system domain extract (or infuse) productive value from associated water flows.
- AP values at any point thus represent the aggregate productive value of that water for all 'downstream' uses.

The result: The AP method links water uses within a system and seamlessly integrates consumptive and non-consumptive uses of water, thereby providing a 'truer' estimate of the productivity of water.

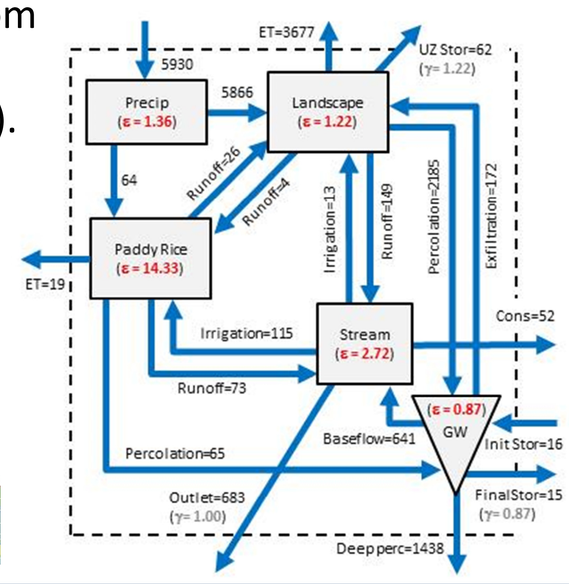
For more information:
Ritzema, R.S. (2014). Aqueous Productivity: An enhanced productivity indicator for water. Journal of Hydrology, 517(0): 628-642.

An AP example: a 3.5 km² upper catchment in Lao PDR

AP values (ε in USD/1000m³) calculated from estimated production benefit and hydrologic modeling results (volumes in 1000m³).



Upland landscape dominated by rice production



Highlights:

- **Indicators can support ag water management in contexts that are under-supported by analysis or data.**
- **'Water productivity' (WP), the ratio of benefits from both agricultural and non-agricultural uses to the amount of water required to produce them, is one such indicator. However, while intuitive and appealing, WP is problematic when implemented in certain contexts.**
- **'Aqueous productivity' is an alternative indicator that addresses some inherent limitations in the WP approach and enhances productivity estimates for water in integrated hydrologic systems.**

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