Sefficiency (Sustainable efficiency) and Reallocation of Water Using Agricultural and Urban Scenarios

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Why Efficiency

"With 90% of the global economic activity dependent on water, protection of this key resource is highly relevant to Juncker’s top priority to boost jobs growth, and investment."  WssTP, 2015

“Efficiency is thus not a goal in itself. It is not something we want for its own sake, but rather because it helps us attain more of the things we value.”  Stone (2002)

Concept vs Computation
Flawed Indicators

CE = (ET – PP) \( \frac{b}{(VA - \Delta S)} \) (or similar ones)

CE = Classical Efficiency (%)

Much used: UN, China, EU, USA, ...

WP = \( \frac{\text{yield}}{ET} \) (or similar ones)

WP = Water Productivity (kg / lit)

Much used: ...

Reasons

i. Lack of generalized application of Usefulness Criterion

ii. Mixing up of hydrology and agronomy

iii. Incompleteness of water flow considerations

iv. Objectives and scale mismatches

Reasons

i. It is not derived systemically according to a universal principle or a foundational framework

ii. See youtube Wichelns 2013

iii. See Haie 2015
Water Security: a working definition (UN-Water 2013)

“The capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for [the following benefits]

- sustaining livelihoods
- human well-being
- socio-economic development
- protection against water-borne pollution
- protection against water-related disasters
- preserving ecosystems

in a climate of peace and political stability.”
Sefficiency and Water Security

Development

Resource use
- water quantity as a resource
- water quality as a resource

Impact
- water quantity loss
- water quality loss (pollution)

(Haie, 2015)
UN-WWAP (2012) defines governance as "Decisions that grant power, or verify performance.”

Most important performance indicator is **efficiency**.

Organisation for Economic Co-operation and Development (OECD)

Principles on Water Governance:

- **Efficiency** of water governance
- Effectiveness of water governance
- Trust and engagement in water governance

Gurria, Angel: Secretary General, OECD, 7th World Water Forum, Korea, 13 April 2015

True knowledge is power.
UNDP: water governance assessment framework: three main components
1) power, as analysed from the perspective of stakeholders, institutions and interests
2) principles, in particular transparency, accountability and
3) performance, including efficiency and effectiveness of government in delivering and achieving its goals

"to assess performance, which is an umbrella term referring to the capability of an initiative
-to be effective (achieve the desired result),
-to be efficient (produce the result with as little input as possible), and
-to comply with process criteria (conduct the right activities and steps in the process that are needed for achieving the desired result)."

Equity ← Performance → Efficiency

Jacobson et al. 2013
Requirements for efficiency indicators

Systemic
Comprehensive
Levels

Quantity
Quality
Benefits

Climate Change

Stakeholder

Cartoon is published in the Journal Nature; from Luiz Gylvan Meira Filho (2013)
The Law of Conservation of Mass
or
Water Balance

Water Use System (WUS)
WaT = Water path Type

<table>
<thead>
<tr>
<th>WaT</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ET</td>
<td>Evapotranspiration</td>
</tr>
<tr>
<td>NR</td>
<td>Non-Reusable</td>
</tr>
<tr>
<td>OS</td>
<td>Water from Other Sources</td>
</tr>
<tr>
<td>PP</td>
<td>Total Precipitation</td>
</tr>
<tr>
<td>RF</td>
<td>Return Flows</td>
</tr>
<tr>
<td>RP</td>
<td>Potential Return (not to the main source)</td>
</tr>
<tr>
<td>VA</td>
<td>Abstracted/Applied water from the main source</td>
</tr>
<tr>
<td>VD</td>
<td>Volume of water Downstream after RF</td>
</tr>
<tr>
<td>VU</td>
<td>Volume of water Upstream before VA</td>
</tr>
<tr>
<td>V1</td>
<td>Volume of water at section 1 (VU or VA)</td>
</tr>
<tr>
<td>V2</td>
<td>Volume of water at section 2 (VD or RF)</td>
</tr>
</tbody>
</table>
**Water Quality**

Water Crisis even without climate change!

Nobre, C (2011)
Usefulness Criterion

\[ X_q = W_q X \times X \]
\[ X_b = W_b X \times X \]
\[ X_S = W_S X \times X \]
\[ W_S X = W_q X \times W_b X \]

\( W_q = \) quality weight
\( W_b = \) beneficial weight
\( W_S = \) usefulness weight
\( X = \) one of the Water path Types (WaTs)
Efficiency (%) defined:
ratio of useful outflow to its corresponding total flow

Applying Usefulness Criterion to the combined Water Balance equation would give $Sefficiency$.

Mathematical proof in Haie & Keller (2012)
Macro, Meso, and Micro-Efficiency (3ME) levels

Macro-Efficiency (MacroE):
indicates the impact of a WUS on a basin, e.g., the major river where water was abstracted.

Meso-Efficiency (MesoE): indicates, for example, the impact of return flows generated by a WUS.

Micro-Efficiency (MicroE): indicates the useful outflow generated by a WUS for itself.

Haie and Keller (2012 or 2014)
Haie & Keller 2014

Sefficiency, Water in Agriculture and Methods / Technologies

- RFA (Rainfed Agriculture) no irrigation
- SIT (Traditional Surface Irrigation)
- SIP (Precision, leveled, surged, etc. Surface Irrigation)
- DIM (Marketed Drip Irrigation)
  “marketed” means performing as promoted or advertised
- DIR (Real Drip Irrigation) constitutes most of the field drip systems
- SPI (Sprinkler Irrigation)

Haie & Keller 2014
Relevant publications about Sefficiency


Thank you!

More info: search Google for naimhaie5