Evaluating the ecosystem services linked to water in agricultural ecosystems
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1. Green and Blue water: ecosystem services for farmers and society

Soils contribute significantly to ecosystem services (ES) to the whole society (e.g. global climate regulation, water quality regulation) and to farmers (e.g. biological regulations, nutrients provision to crop plants). As porous media, they especially store water and control its flows, whether these are transpired by plants for their biomass production or evaporated toward the atmosphere (Green water), or infiltrated or runoffed to groundwater or surface water (Blue water). In agricultural contexts, these processes are linked to both ES "soil capacity to store and return water" to (i) the farmer and (ii) the whole society. Assessing these two ES in an agricultural context is delicate, insofar as the contribution of humans – here the farmer through their agricultural practices including tillage, irrigation, fertilization, etc. – affect their level of provision. In the context of the French National Ecosystem Assessment (the EFESE program), we have developed biophysical indicators to value water flows in soil-plan system for cropped systems over the whole French territory.

2. Defining ecosystem services and their biophysical indicators

<p>| Green Water Fluxes | Transpired water by plants + Evaporated water from the soil |</p>
<table>
<thead>
<tr>
<th>Ecosystem service for farmers</th>
<th>Not useful for farmers</th>
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<tbody>
<tr>
<td>ES: Storing and returning water to crop plants</td>
<td>Benefit = Reducing the quantity of water brought by irrigation</td>
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<tr>
<td>Biophysical Indicator: quantity of water transpired by the cash crop between its seeding and its harvest</td>
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| Blue Water Fluxes | Free water in lakes, rivers, etc. |
| Ecosystem service for the whole society | |
| ES: Storing and returning Blue water | Benefit = available water for several uses |
| Biophysical Indicator: annual water yield, i.e. difference between the amount of water brought by rainfall and irrigation, and the amount of water evaporotranspired over a year |

3. Evaluating ES indicators by crop modelling

- Soil data: European Geographical Soil Database at 1:1 000 000
- Climate data: French Meteorological data over 30 years at the 8x8 km resolution
- Pedoclimatic units
  - ~30,000
  - (including ~30,000 units with crops)

4. Transpiration and Water yield at the French national scale

- Annual mean transpiration of French crops: 150 mm
- Spatial structuration linked to climate pattern
- Effect of Soil Available Water Content (AWC): low transpiration for low AWC but large variability for high AWC
- In irrigated areas: ES contribute to transpiration from 2 to 75 % (100 % for rainfed crops)

- Mean annual Water Yield over 30 years for French crops: 315 mm
- Spatial structuration linked to climate pattern
- Effect of Soil Available Water Content (AWC): decreasing water yield with AWC but large variability for high AWC
- Insignificant effect of intermediate crops on annual water yield