Water saving and plural uses in agriculture: water resources potential for Climate Change mitigation in irrigation management

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Abstract

Agriculture is one of the largest "user" of water resources (WR) required for irrigation. According to the leading principles of the European Water Framework Directive (WFD) 60/2000 and Climate Change (CC) policies, innovative approaches and methodologies are essential to obtain lower volumes and promote plural uses of water in agriculture, resulting also in energy savings and increasing of renewable energy production (and thus lower CO_2 emissions).

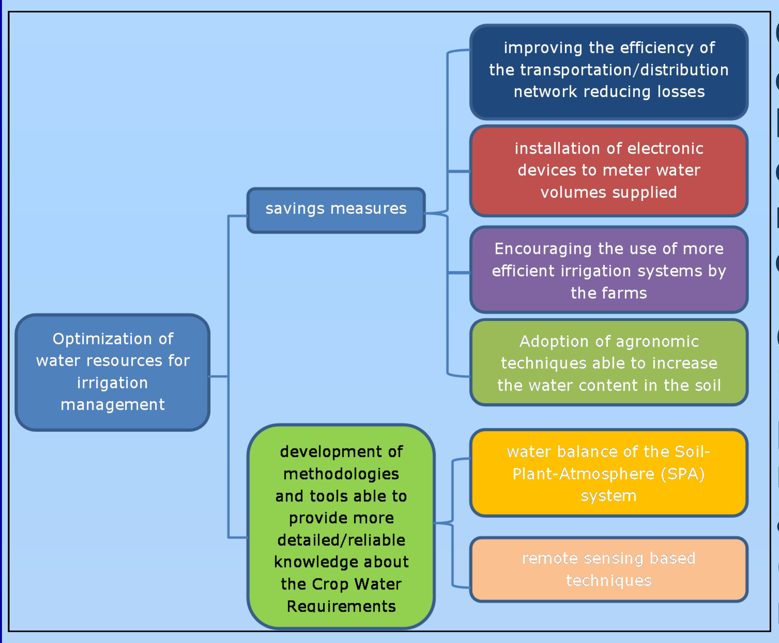
This poster presents the potential contribution of the optimization of WR management in agriculture to the CC mitigation goals, based on INEA recent activities, focused on the following topics:

Saving water: from the optimization of irrigation management, trough the development and dissemination of monitoring systems, particularly based on water balance modelling and satellite observations, to obtain an accurate assessment of the volume of water used in agriculture.
Plural uses: renewable energy production plays a key role to strengthen the EU 2020 and 2030 energy targets. Some appearance on the contribution of water resources in agriculture concerns the potential in the field of micro and mini hydropower systems linked to existing channels in irrigated areas of irrigation Consortia, where hydraulic storage, derivation and adduction schemes, can contribute to a better use of renewable energy sources, in a perspective of plural use of water resources.

Goals and Tools

What? To identify potential solutions focused on WR management for mitigation of Climate Change
Why? To enhance the positive role played by agriculture in the framework of international policies aimed at optimize water use and reduce GHG emissions
How? Trough innovative approaches based on optimization of WR management in irrigation (saving water and plural uses) both at farm and public level: Crop Water Requirements estimation (CWR) and Mini e Micro Hydropower Potential (MMHP)

Saving water from irrigation management



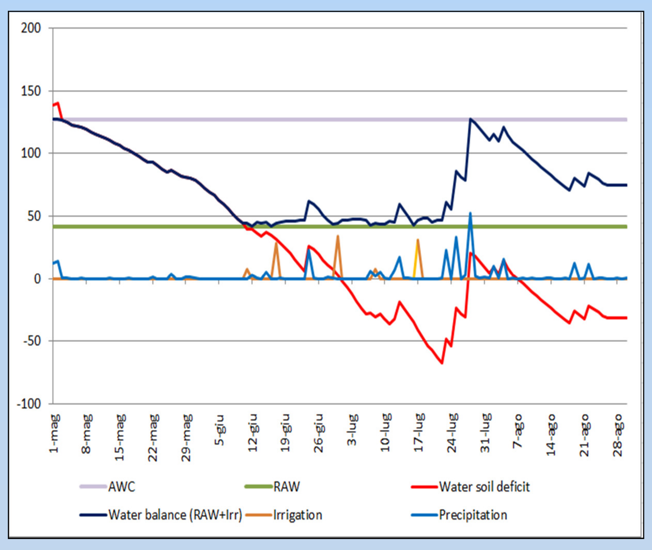
Crop Water Requirement (CWR) calculated through the water balance represent the actual evapotranspiration, (value resulting from the actual conditions of water availability)

CWR (or Etc) calculated through Remote sensing represent the potential evapotranspiration, namely the maximum value for a crop under standard condition (excellent agronomic and water management conditions).

Water balance of the Soil Plant Atmosphere (SPA) system

Water Balance

- Interactive relationship between energy and moisture;
- Based on water deficit in the soil: modeling moisture demand (potential evapotranspiration - *Etc* and supply - precipitation and soil moisture storage).

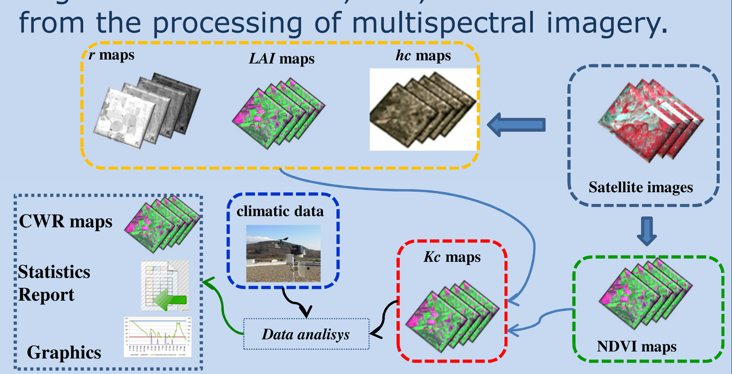


Soil water content
•Between AWC and RAW*: Soil wet-crop good conditions
•Below RAW: crop stress → **IRRIGATION**

*AWC: Available Water Capacity; RAW: Readily Available Water

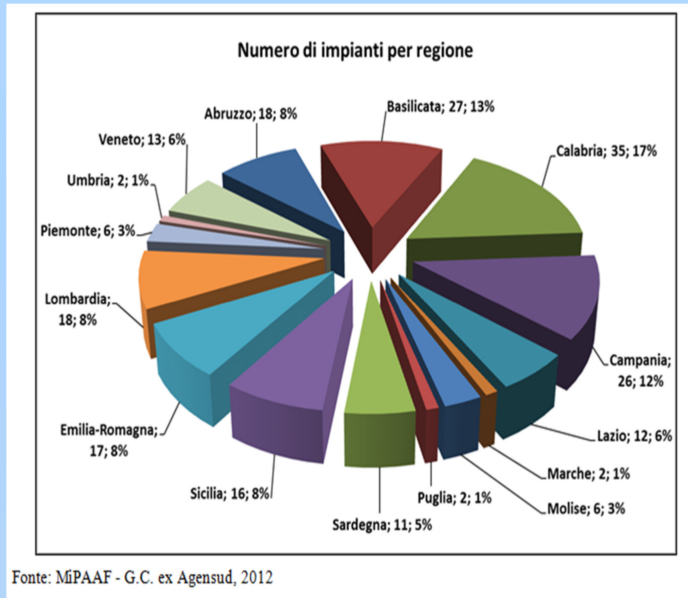
Remote sensing based techniques

The basic methodology for estimating CWR was codified by FAO in the publication "*Crop evapotranspiration - Guidelines for computing crop water requirements - Irrigation and drainage Paper 56*" edited by Allen et al. (1998), based on two different approaches.

FAO Methodology	Remote sensing approach
• Crop coefficient approach $ETc = Kc * Eto$ Where: *Kc* is the crop coefficient, which is specific for each crop and their grown status *ETo* is the reference crop evapotranspiration • Direct ETc calculation $Kc = \frac{ET_P}{Eto} = f(S, T_a, RH, U; r, LAI, hc)$ Where *Ta* is air temperature, *RH* relative humidity, *U* wind speed and *S* incoming short wave radiation, are climatic data. Surface albedo *r*, leaf area index *LAI*, crop height *hc* are vegetation variables	• Kc - NDVI Requires the definition of a linear relationship between NDVI (Normalised Differences Vegetation Index, derived from the processing of multispectral imagery) and Kc. $K_c = aNDVI + b$ • Analytical approach Vegetation variables *r, LAI, hc* are estimated from the processing of multispectral imagery. 

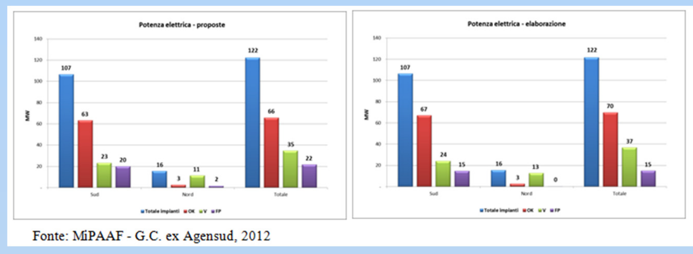
Plural uses - MMHP survey results

September 2012
Survey on the potential of the national irrigation Consortia concerning hydroelectric power plants connected to the irrigation systems **(211 plants)**

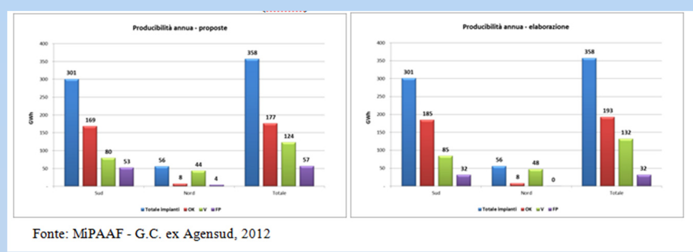


Fonte: MiPAAF - G.C. ex Agensud, 2012

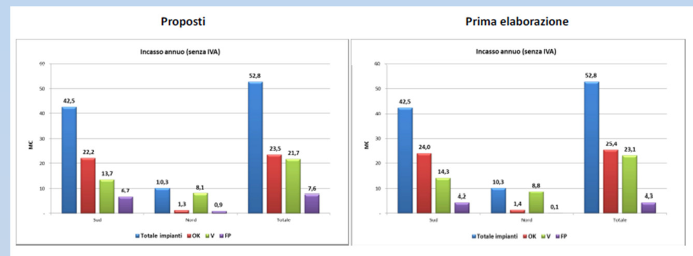
Total power
122 MW, of which 106 MW respectively (South Central) and 16 MW (North Central).


Fonte: MiPAAF - G.C. ex Agensud, 2012

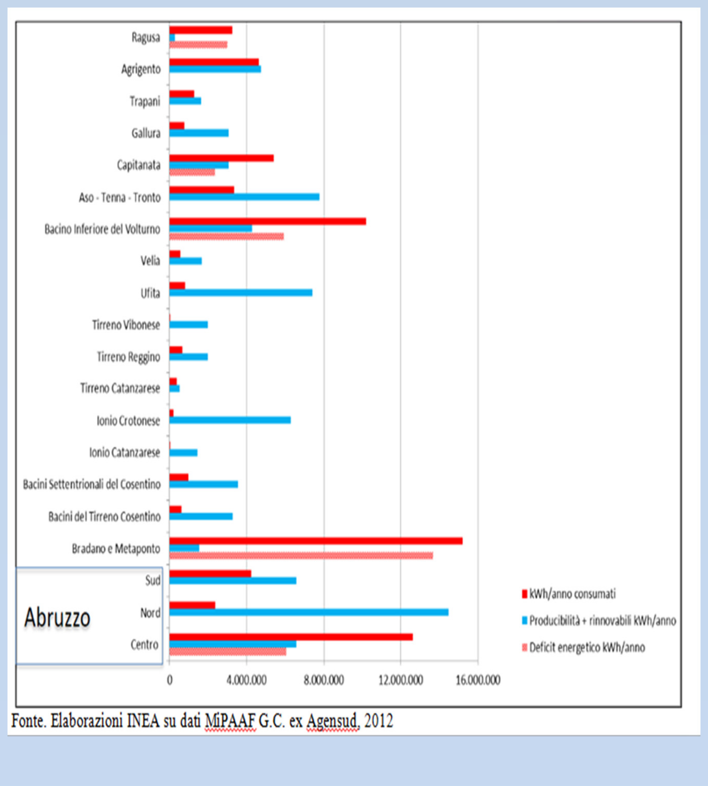
Annual potential capacity
258 GWh with plant average of 1.9 for the Center South and 1.0 GWh Centre North


Fonte: MiPAAF - G.C. ex Agensud, 2012

Annual revenues
52,4 M€, with plant average of 0,3 M€ for the Center South and 0,2 M€ for Centre North.



Perspectives
•Reduced energy consumption
•Covering of the entire energy needs
•Additional revenues.



Fonte: Elaborazioni INEA su dati MiPAAF G.C. ex Agensud, 2012

National potential
•Hydropower production in Italy:45.000 GWh/year
•Irrigation Consortia MMHP: 680 GWh/year (1,5%)
•Environmental end economic positive impacts.

Results and discussion

Saving water
Case study in Sannio Alifano irrigation Consortia (EU FP7 Sirius project): adopting described approach an average saving of 20% of water resource consumed in corn crops has been achieved in 6 pilot farms (near 63.800 m^3) thus lower costs for irrigation. Considering an estimated energy needs of 0,04 kWh/m^3 of water delivered, water saving obtained reflects in reduced energy consumption of 2.552 kWh/year for corn crops in pilot farms (thus lower energy costs). It can be translated, adopting national emission coefficient for thermoelectric energy production (510 gCO_2/kWh, ISPRA, 2009), in 1,3 tCO_2 avoided.
Main constraints: High efficiency of irrigation systems – Consumption based irrigation rates – farmers availability in adopting innovative approaches

Plural uses
Environmental and economic benefits. Hydropower is the source that provides the best environmental performance in terms of the relationship between energy expenditure for the construction of facilities and energy returned during operation (EROEI Index).
The full exploitation of its potential in irrigation Consortia, provides an increasing of environmental and economic performances from the reduction of energy expenses for irrigation delivery, which reflects in lower rates paid by farmers and CO_2 avoided as consequence of increasing of national renewable energy production (approximately 360.000 tCO_2).
Still needed. Clarification of authorization processes (subjection to the VIA – Environmental Impact Evaluation) and classification of plants (basin/tank or flowing/water supply systems, not subject to registration).

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