



“Water footprint of Food for a Sustainable Agriculture *Concept and Technologies*”

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Welcome to the Department of Agricultural Sciences of the University of Naples “Federico II”

We are hosted in the prestigious Royal
Palace, built in 1742 by the King of
Naples Charles of Borbon

(later King Charles III of Spain)





UNIVERSITÀ DEGLI STUDI DI NAPOLI
FEDERICO II

DIPARTIMENTO DI
AGRARIA



With the unification of Italy on 1871, the Province Administration of Naples acquired the building and destined to the High School of Agriculture, the first one in Southern Italy, after Pisa and Milan (1870).

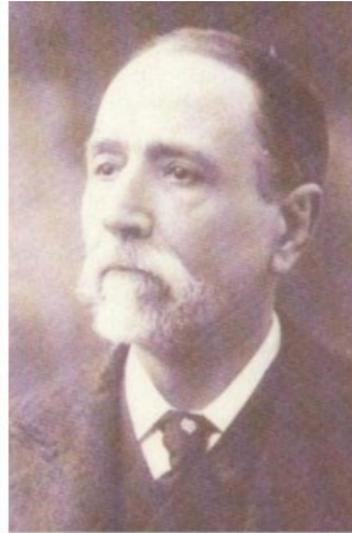
From the Academic Year 1935-1936 the school became Faculty of Agriculture of the University of Naples, today Department of Agricultural Sciences.





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AGRARIA



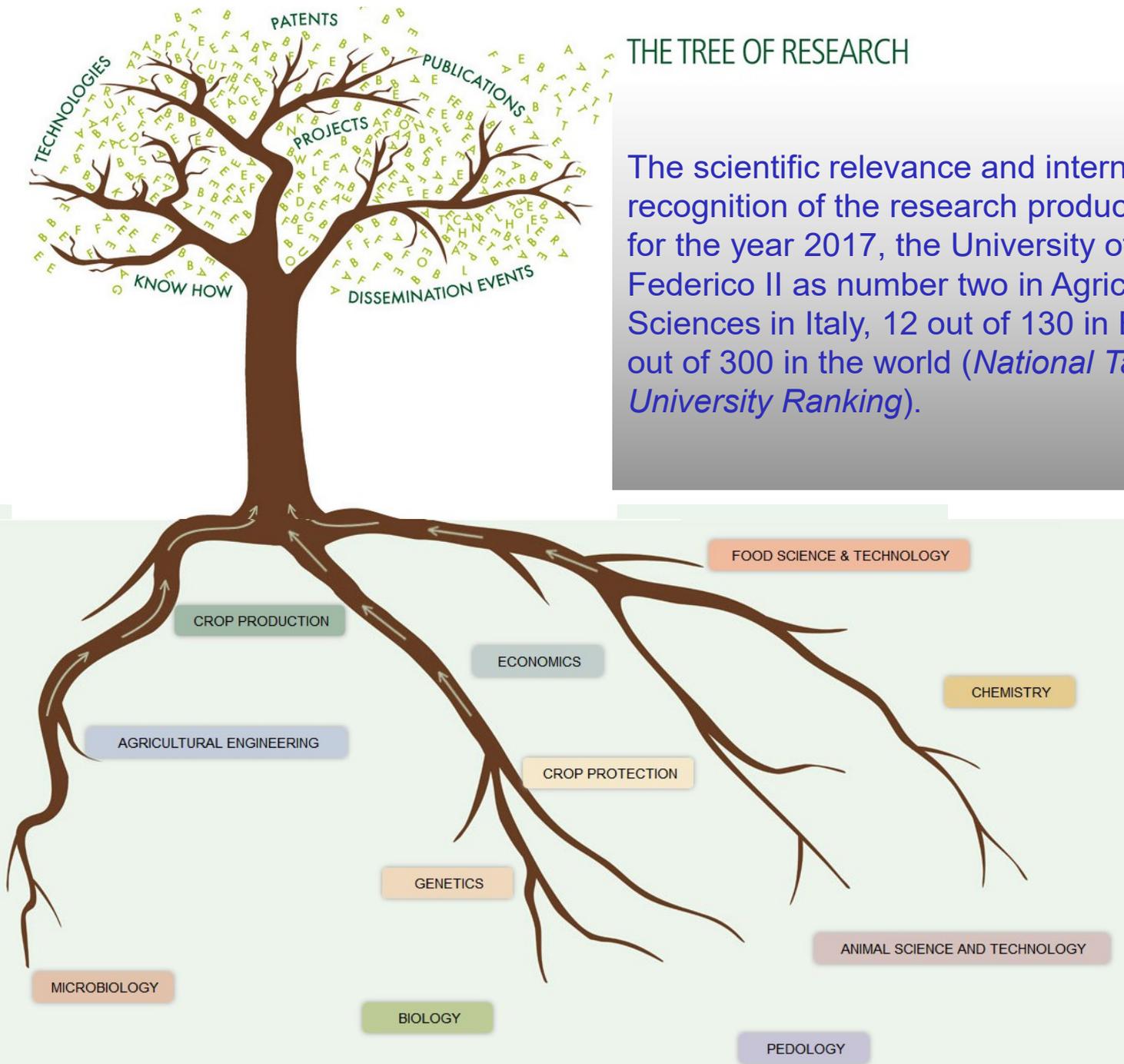
Professors of this Faculty have largely contributed to the development of rural areas in Southern Italy, especially after the II World War.

Building on this tradition, today we have in many areas of Southern Italy the most modern agricultural systems of the world



THE TREE OF RESEARCH

The scientific relevance and international recognition of the research products positioned, for the year 2017, the University of Naples Federico II as number two in Agricultural Sciences in Italy, 12 out of 130 in Europe, and 45 out of 300 in the world (*National Taiwan World University Ranking*).





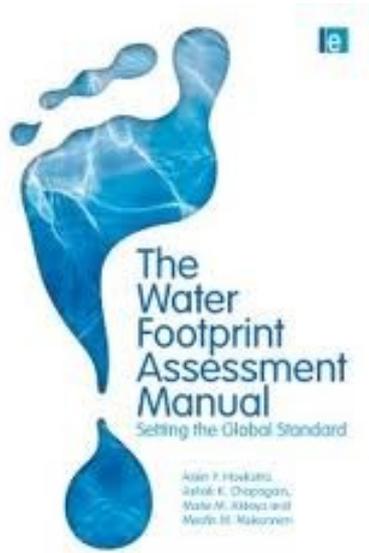
Water footprint of Food



300 g flour	→	288 Liters
100 g peeled tomatoes	→	38 l
125 g mozzarella	→	890 l

Total = 1216 Liters of water

Examples of food water footprint



900
l/kg



1850 l/kg

300 l/l



15400 l/kg



17500 l/kg



The water footprint of a product



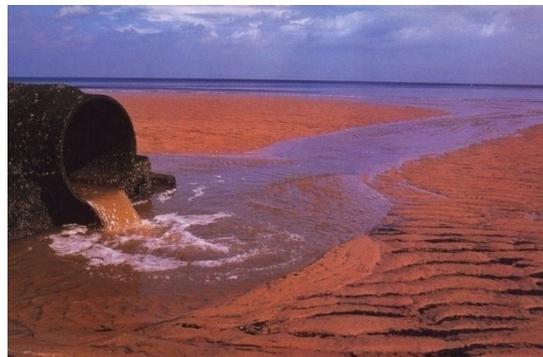
Green water footprint

volume of rainwater evaporated or incorporated into a product



Blue water footprint

volume of surface or groundwater evaporated or incorporated into a product



Grey water footprint

volume of polluted water



The total water footprint of the average consumer in the world

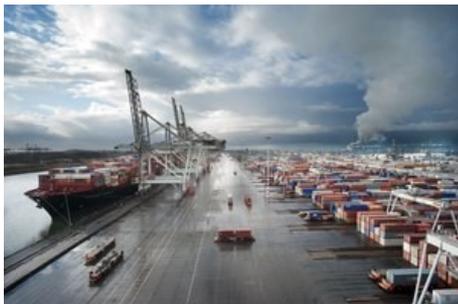


3.8% of the water footprint relates to home water use



96.2% of the water footprint is 'invisible',
related to the products bought on the market

91.5% agricultural products, 4.7% industrial products

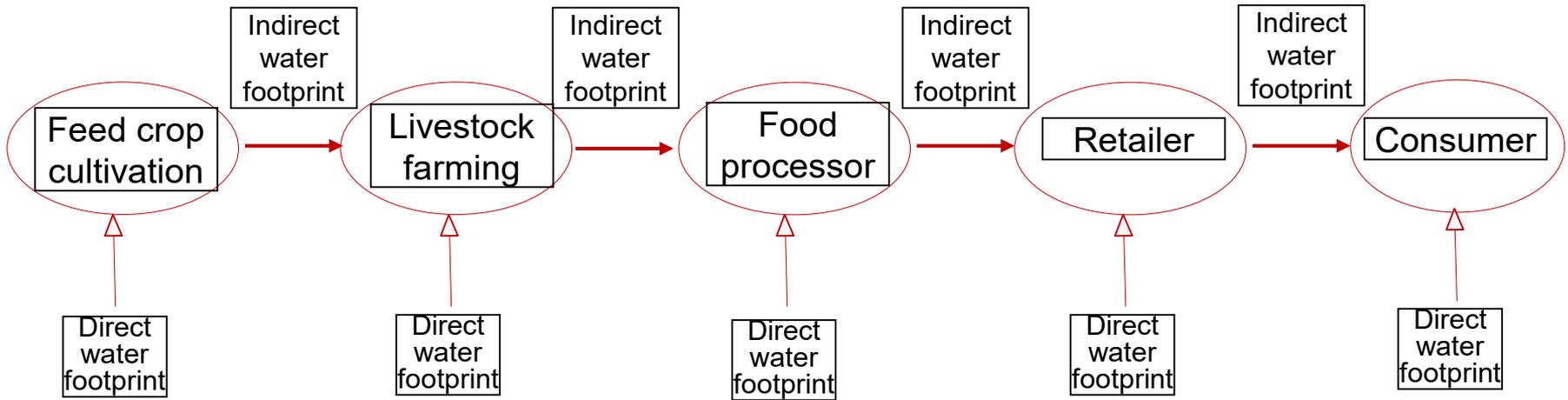


**22% of the water footprint does not lie within the country
of the consumer, but other parts of the world**

Water footprints along a supply chain

Example: MEAT

15400 l/kg



Virtual water flow through the supply chain

Brazil

Netherlands

Netherlands

UK

UK

Cotton from the Aral Sea Basin, Central Asia



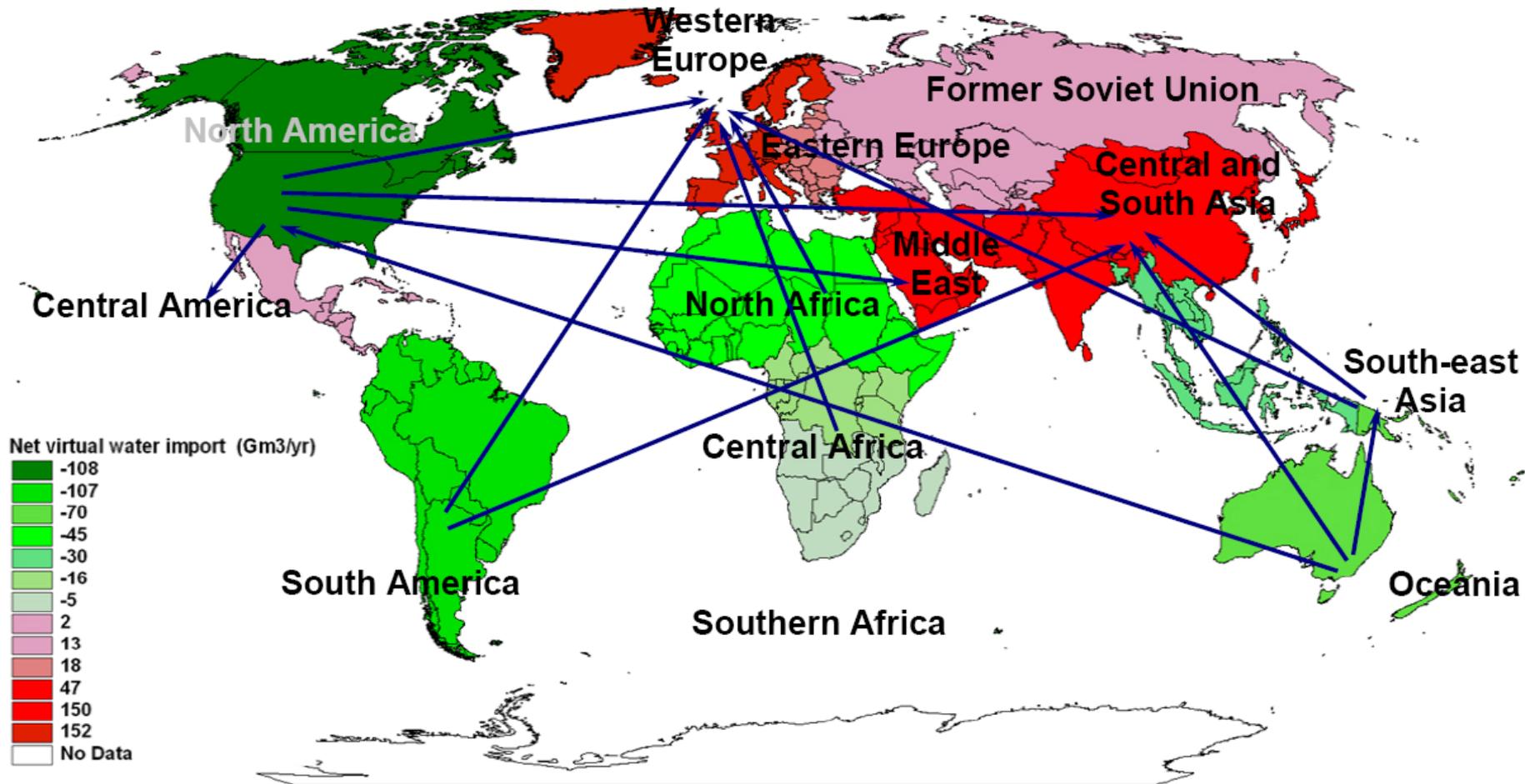
2008



Source: NASA

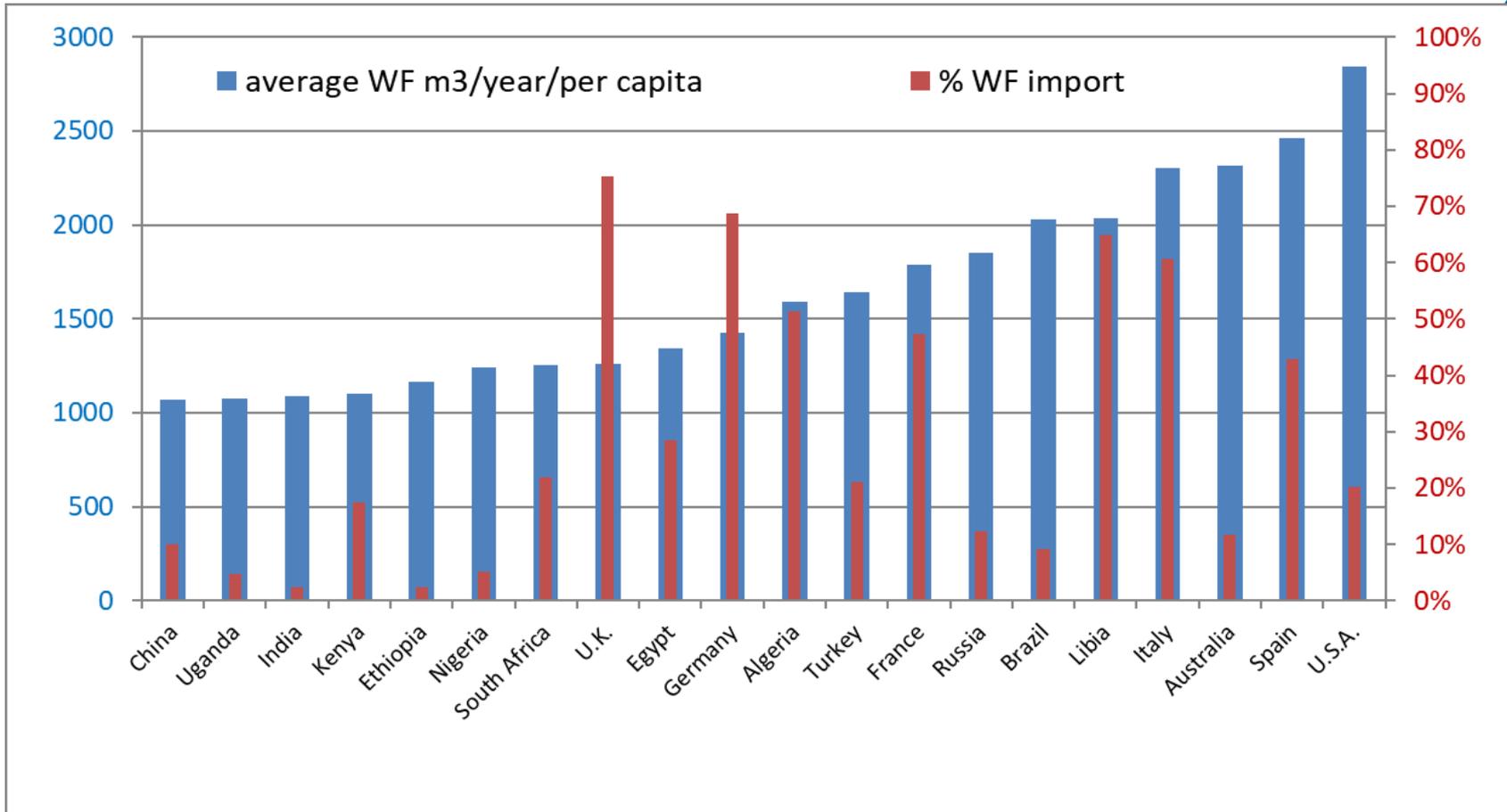


VIRTUAL WATERS

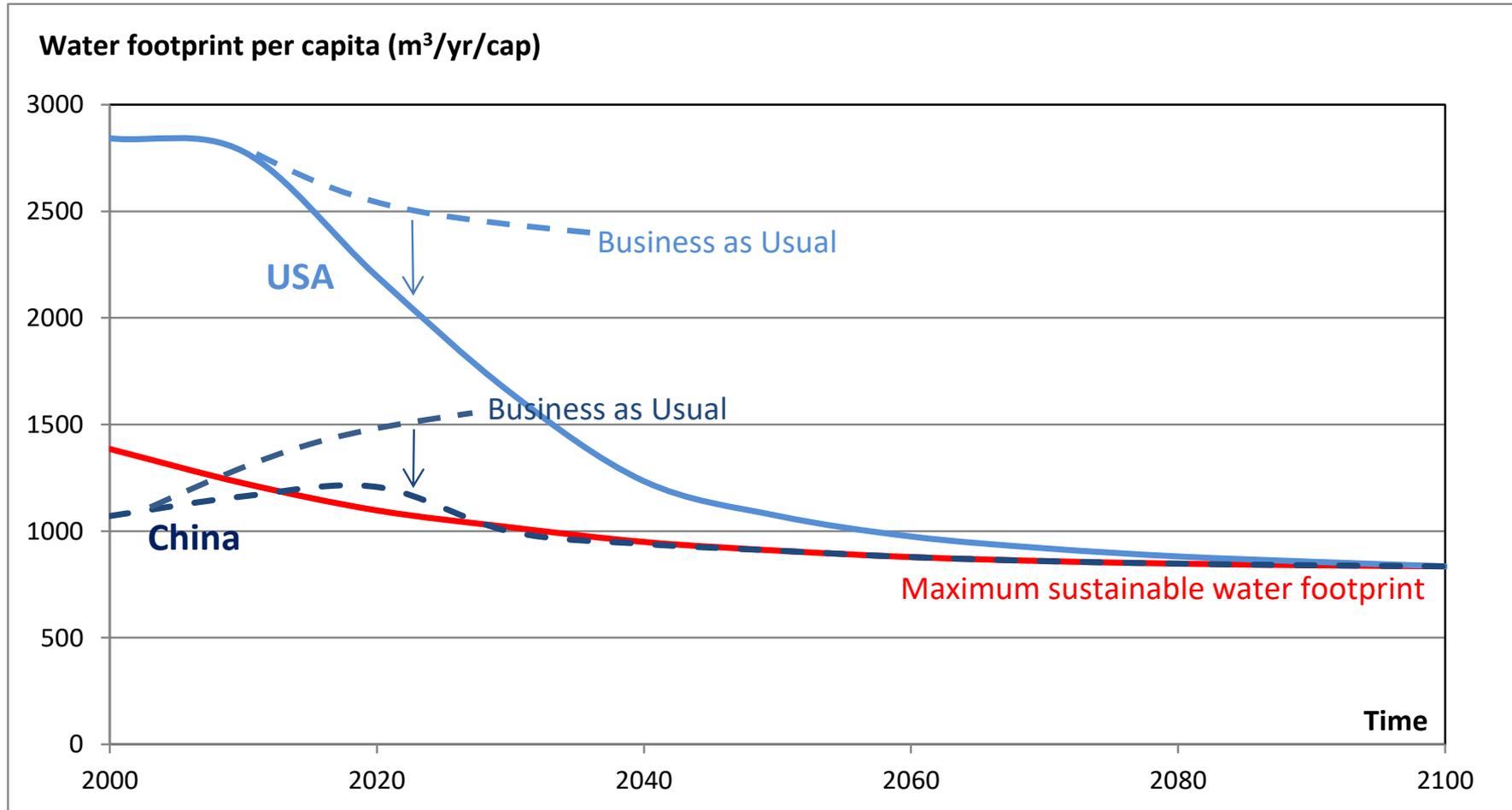




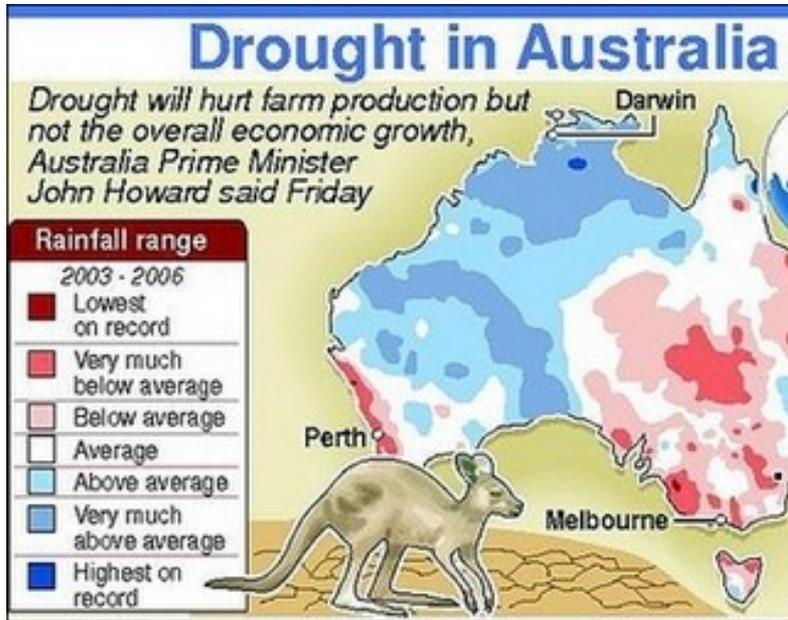
Water footprint : Country level



The need for contraction and convergence



Global warming and the Arab spring



Global Politics and Strategy
Volume 53, 2011 - [Issue 2](#)

CNN Money 

By Annalyn Censky, staff reporter January 28, 2011: 5:11 PM ET

Home | Business | Markets | Investing

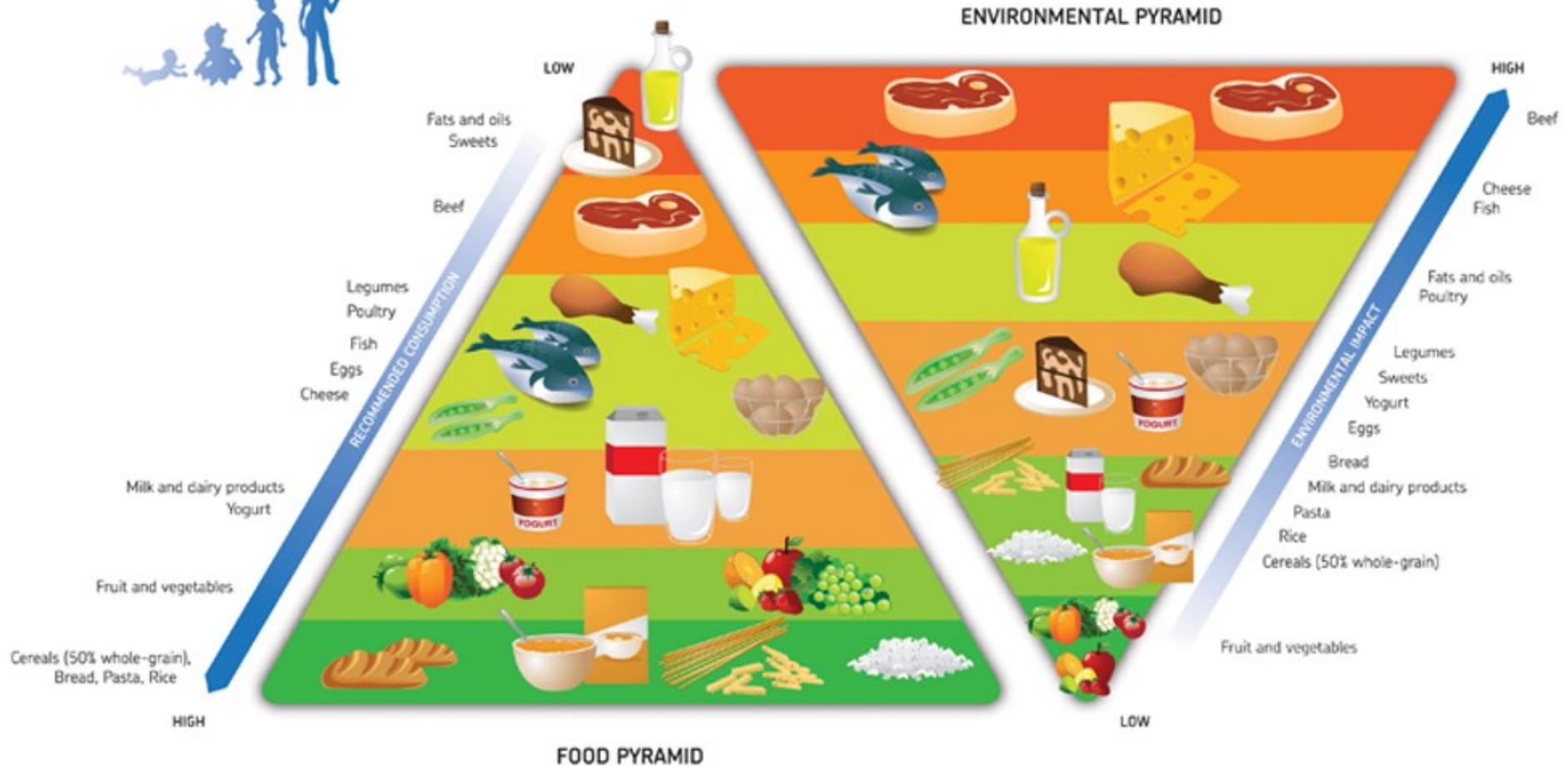
Tensions rise on surging food prices



PHOTO: MARTIN BUREAU/AFP/GETTY IMAGES

A Tunisian protester holds bread during a demonstration earlier this week.

The impact of people diet on the water footprint



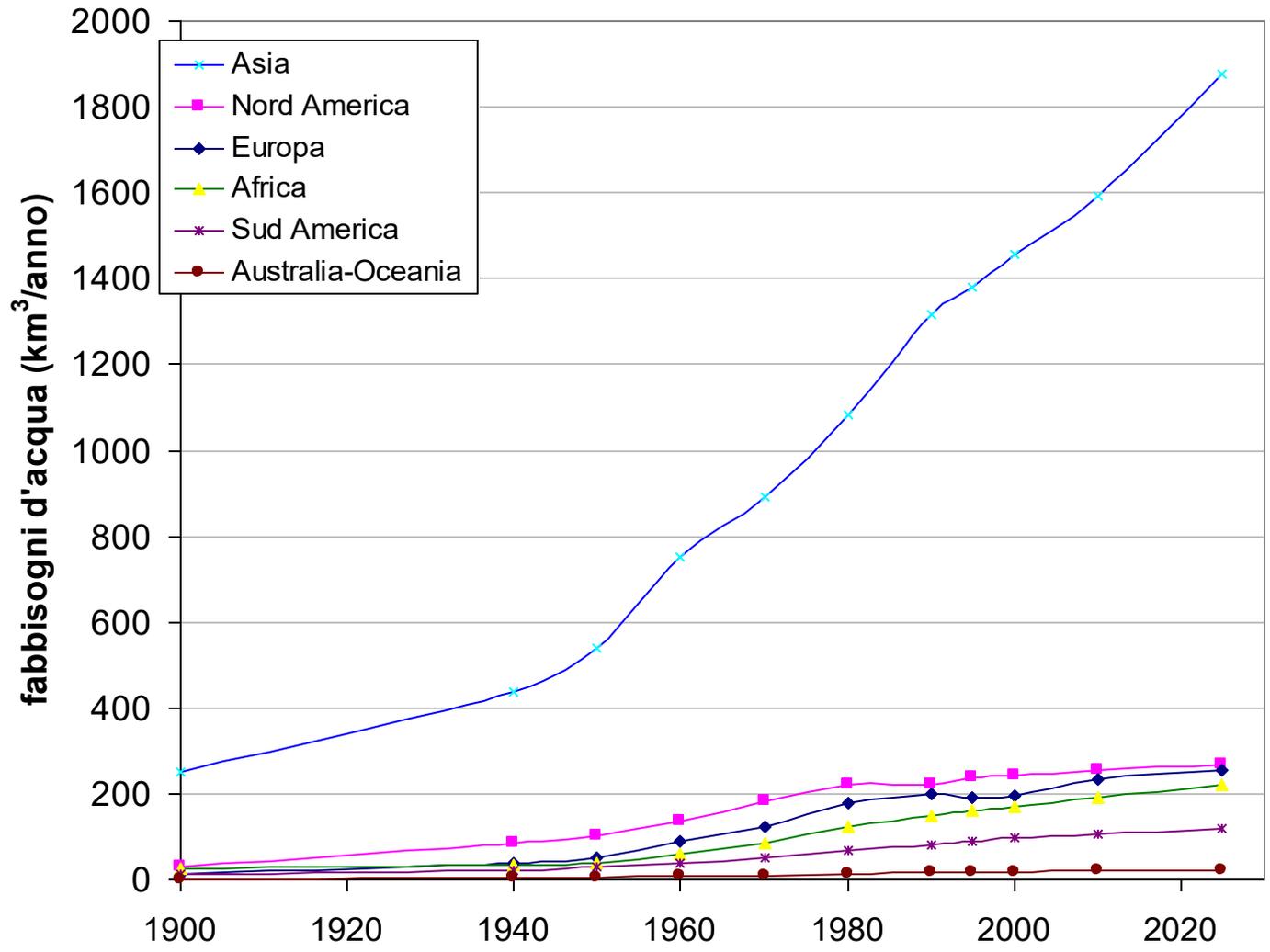


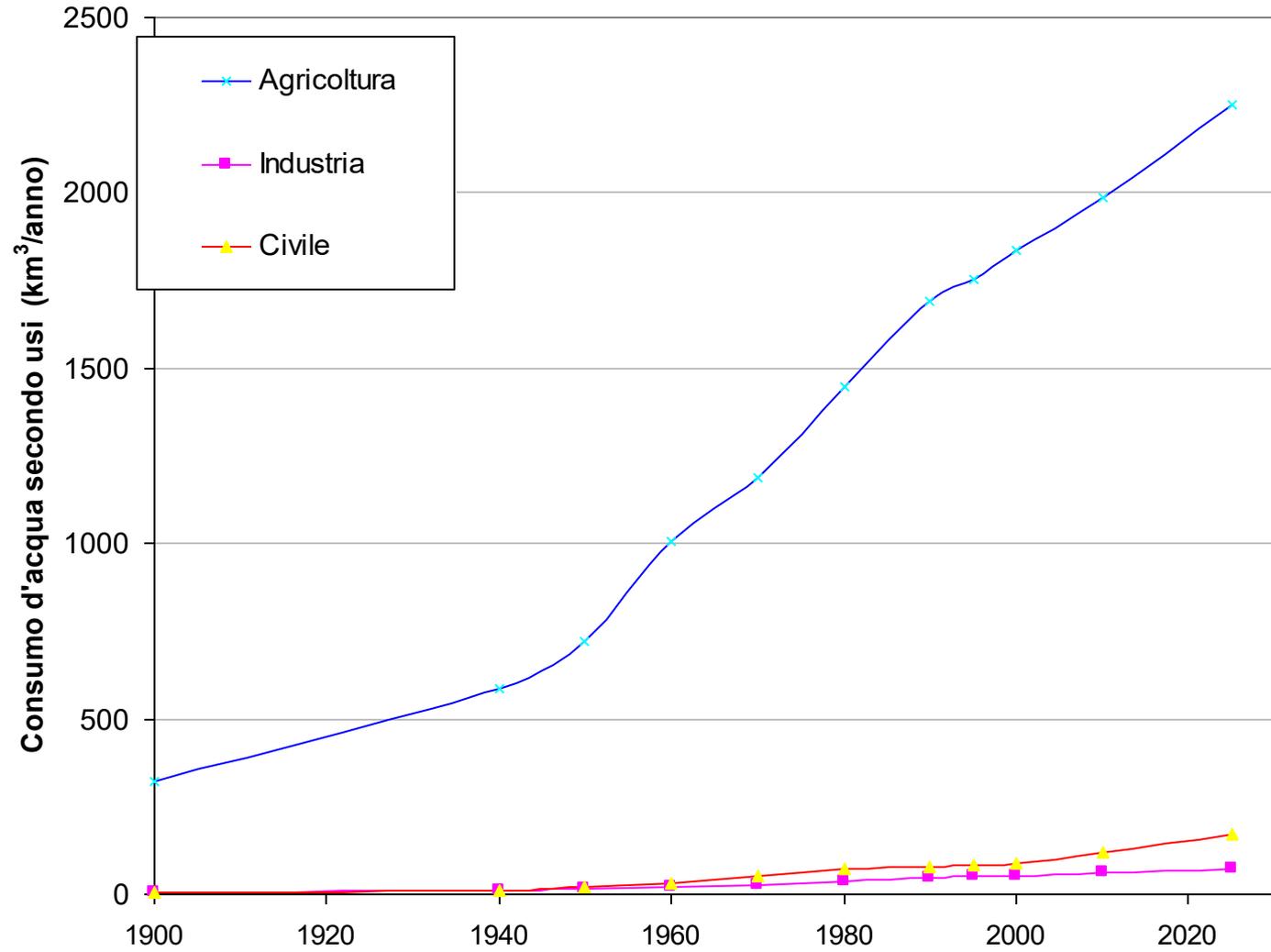
- **2000 m³/(year per capita): amount of water to guarantee an optimal food production**
- **ITALY = 2325 m³/(year per capita)**

52 Countries (2 billions of people) have less than 2000 m³/(year per capita)

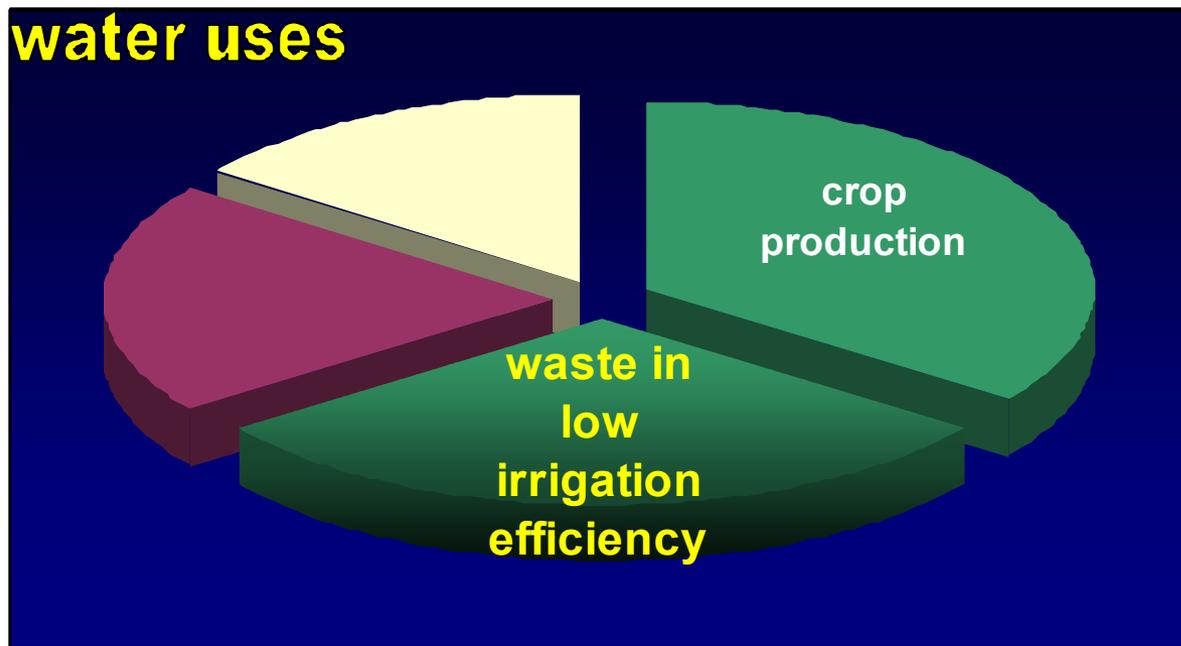
30 Countries (mostly located in Africa) have an availability less than 1000 m³/year per capita

40% of food is produced by irrigated agriculture (F.A.O.)





World-wide 70% of water resources depletion is due to agricultural water use.



Increasing the **efficiency of irrigation** is one of the most important challenges to address water scarcity in agriculture



An aerial photograph of a vast, dense tropical rainforest. The forest is a rich, vibrant green, with numerous tall trees and a thick canopy. In the upper portion of the image, a dark, overcast sky is pierced by a double rainbow. The primary rainbow is bright and clear, while a secondary, fainter rainbow is visible just above it. The text "What can we do?" is centered in the upper half of the image, overlaid on the sky and the top of the forest.

What can we do?

Reducing humanity's water footprint – Consumers

Reduction of the direct water footprint:

- water saving toilet, shower-head, etc.

Reduction of the indirect water footprint:

- change consumption pattern
- choose the sustainable version of products

Asking product transparency

from businesses and regulation from governments

“Save water in the supermarket”

theguardian

News | Sport | Comment | Culture | Business | Money | Life & style

Professional | Guardian Sustainable Business | Hubs | Events | A

Water hub

From Guardian Sustainable Business

Will we ever see water footprint labels on consumer products?

Displaying water inputs on consumer items is an idea floated frequently, but is it any closer to becoming reality?



Will Henley

Guardian Professional, Friday 23 August 2013 16.11 BST

Jump to comments (5)



On average it takes 15,400 litres of water to make 1kg of beef. Photograph: Bon Appetit/Alamy

Reducing humanity's water footprint – **Government**

Embed water footprint assessment in **national water policy making**

Promote **coherence** between water and other governmental policies: environmental, agricultural, energy, trade, foreign policy.

Reduce the own **organizational water footprint**

- reduce the water footprint of public services.

Promote **product transparency**



Water footprint reduction: Producers & Companies

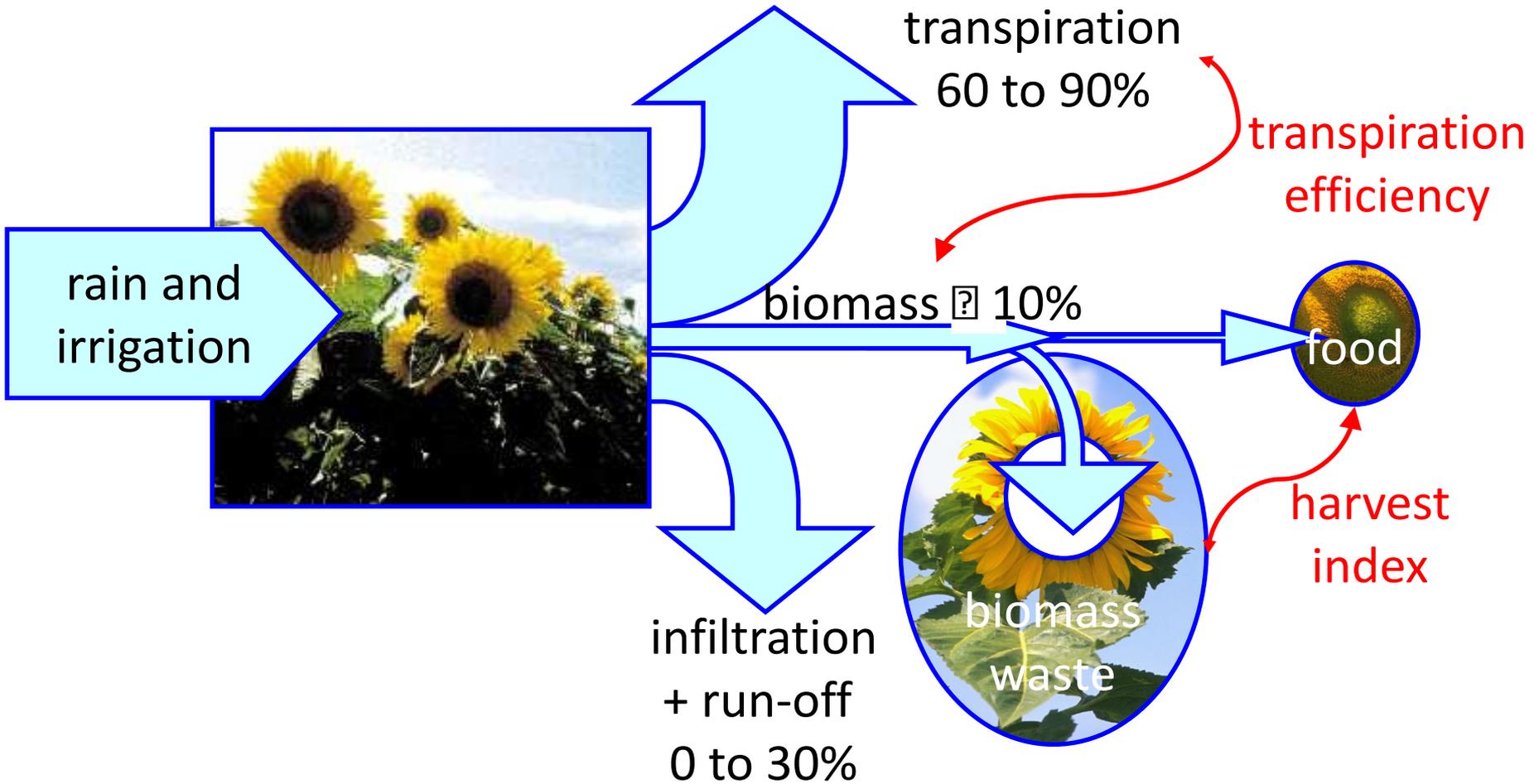


- ▶ Towards full water recycling in industries **zero blue water footprint**
- ▶ Towards full recycling of materials and heat **zero grey water footprint**



- ▶ Make rainwater more productive: **lower green water footprint**
- ▶ Towards supplementary or deficit irrigation & application of **precision irrigation** techniques: **lower blue water footprint**
- ▶ Towards organic or precision farming: **zero grey water footprint**

Water Use Efficiency (WUE)



Water Use Efficiency of crops (WUE)...

WUE = transpiration efficiency × harvest index

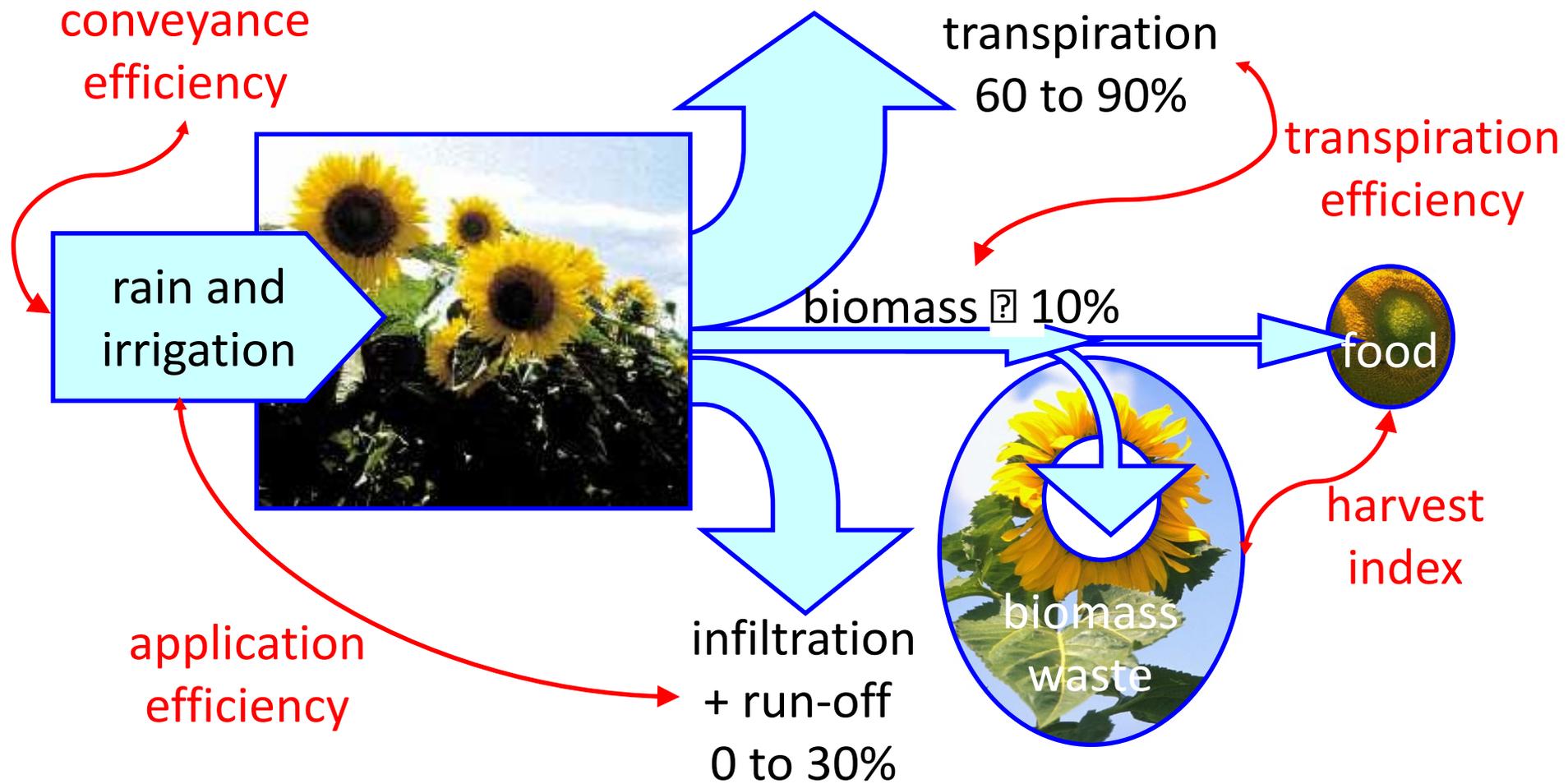
Litres of water per dry kg of...	
Potatoes	500
Wheat	900
Tomato	1000
Maize	1400
Rice	2000
Chicken	3500
Beef	>20000

... is affected by genotype

With 5% dry matter this is about 50 litres per kg tomato

(OECD, 1999; Stanhill, 1980)

Efficiency of Water Use (EWU)



Efficiency of Water Use (EWU) is affected by genotype, **environment** ...

Litres of water per kg of fresh tomatoes in...	
Israel (field)	60
Spain (unheated plastic house)	40
Israel (unheated glasshouse)	30
Holland (climate-controlled glasshouse)	22



(Stanhill, 1980; Castilla and Fereres, 1990; Stanghellini, 1994)

Techniques for water application

SURFACE IRRIGATION

- Basin irrigation
- Border irrigation
- Furrow irrigation



Techniques for water application

TRICKLE IRRIGATION



On-farm technology

Pressurised water distribution

- On-demand schedule - Flexibility
- Sprinkler and drip irrigation areas have increased, and higher value crops and new crop rotations have been introduced (hence demanding more water...)



Techniques for water application

OVERALL EFFICIENCY OF DIFFERENT IRRIGATION METHODS

IRRIGATION METHOD

OVERALL EFFICIENCY (%)

BASIN	20-40
FURROW	40-60
SPRINKLER	70-80
DRIP	80-90

Night irrigation improves production (already traditionally used in TK)

The screenshot shows the 'Unbottled our Blog' section of the Coca-Cola website. The main article title is 'COCA-COLA HELPS FARMERS IN TURKEY ADOPT EFFICIENT WATER IRRIGATION TECHNIQUES' by Erhan Akça, dated Sep 11, 2015. The article features a large image of a man in a white shirt standing in a field of green plants. Below the main image is a 'RELATED POSTS' section with a red header and a thumbnail image of a group of people in a field. The page also includes a search bar, navigation tabs for 'FRONT PAGE', 'BRANDS', 'VIDEOS', 'SUSTAINABILITY', 'INNOVATION', 'HISTORY', 'MUSIC', and 'UNBOTTLED', and a list of tags such as '#cokestyle', 'Water Replenishment', and 'EKOCENTER'.

<http://www.coca-colacompany.com/coca-cola-unbottled/coca-cola-helps-farmers-in-turkey-adopt-efficient-water-irrigation-techniques/>



European Agricultural Fund for Rural Development (EAFRD) supports investments in irrigation for the period 2014-2020.

If improvements to existing facilities will be supported, the conditions of EU Reg. must be set out. Among these:

One or more minimum potential water saving levels (expressed as a %) must be chosen. The minima chosen ought to reflect what can reasonably be expected in terms of efficiency gains. This is why Art. 46 specifies a minimum of "between 5 % and 25 % according to the technical parameters of the existing installation or infrastructure".

"Potential water savings" and "effective reductions in water use"

Techniques for water supply and distribution

SURFACE WATER RESOURCES



Techniques for water supply and distribution

WATER HARVESTING

usually practised in areas of low rainfall (100 to 200mm/y)



- Micro catchments - small catchments surrounding a tree or a small plot.
- External catchments - larger catchments 30 to 300m long used to channel water into a smaller cropped area.

Techniques for water supply and distribution

GROUND WATER

- Shallow groundwater
- Deep Groundwater



An in-field hand dug well in northeast Ghana, used with rope-and-bucket abstraction.

Techniques for water supply and distribution

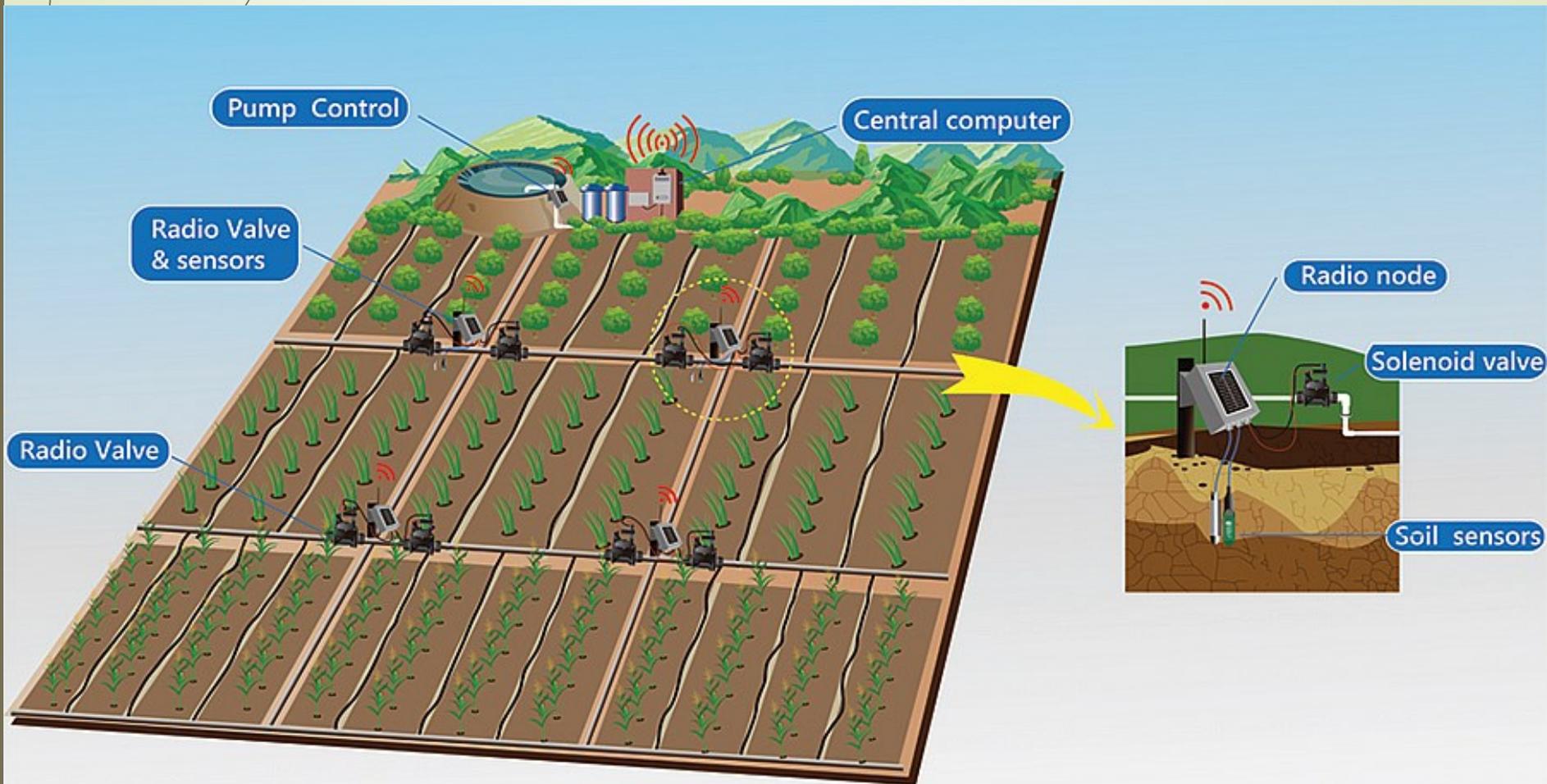
- re-engineering a deficient infrastructure to return it to the original design
- usually applies to the physical infrastructure

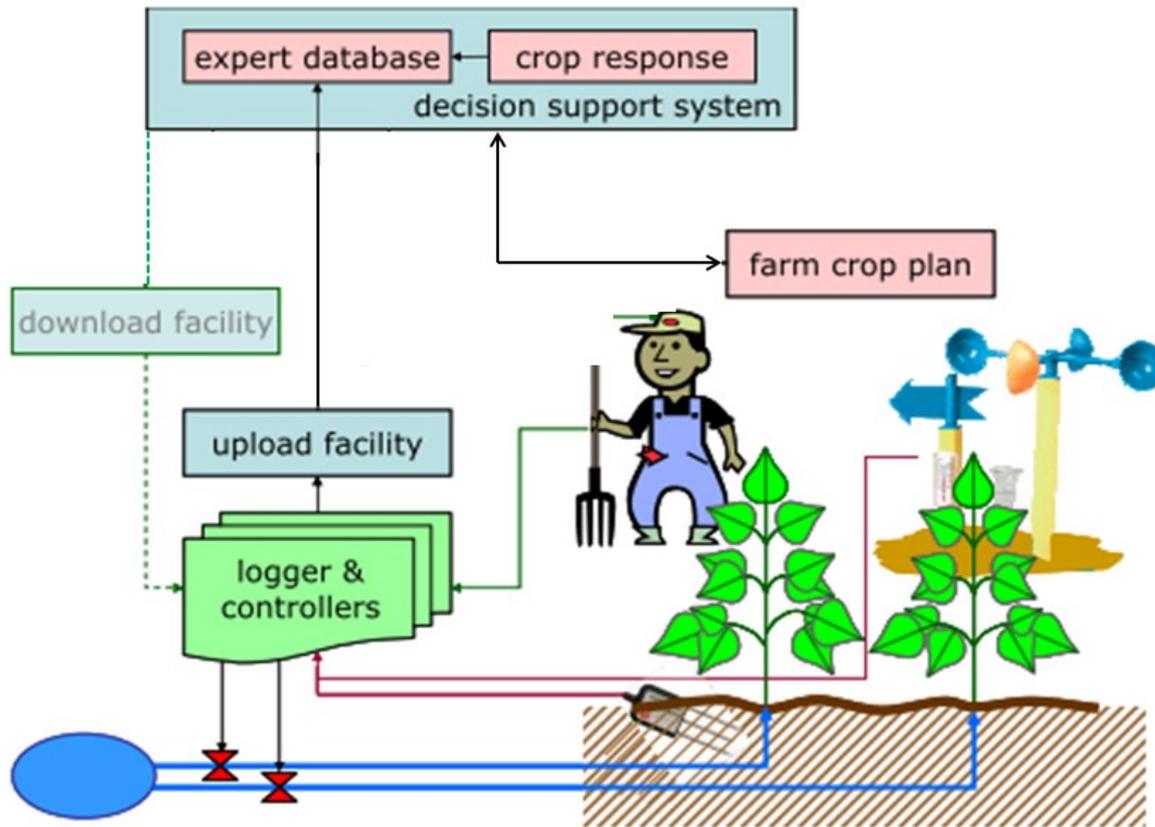


The research and the development of knowledge in the Universities can support the sustainable use of water resources



Field sensors for irrigation guidance and control





1. Installation of the sensors



FDR- Decagon 10 HS

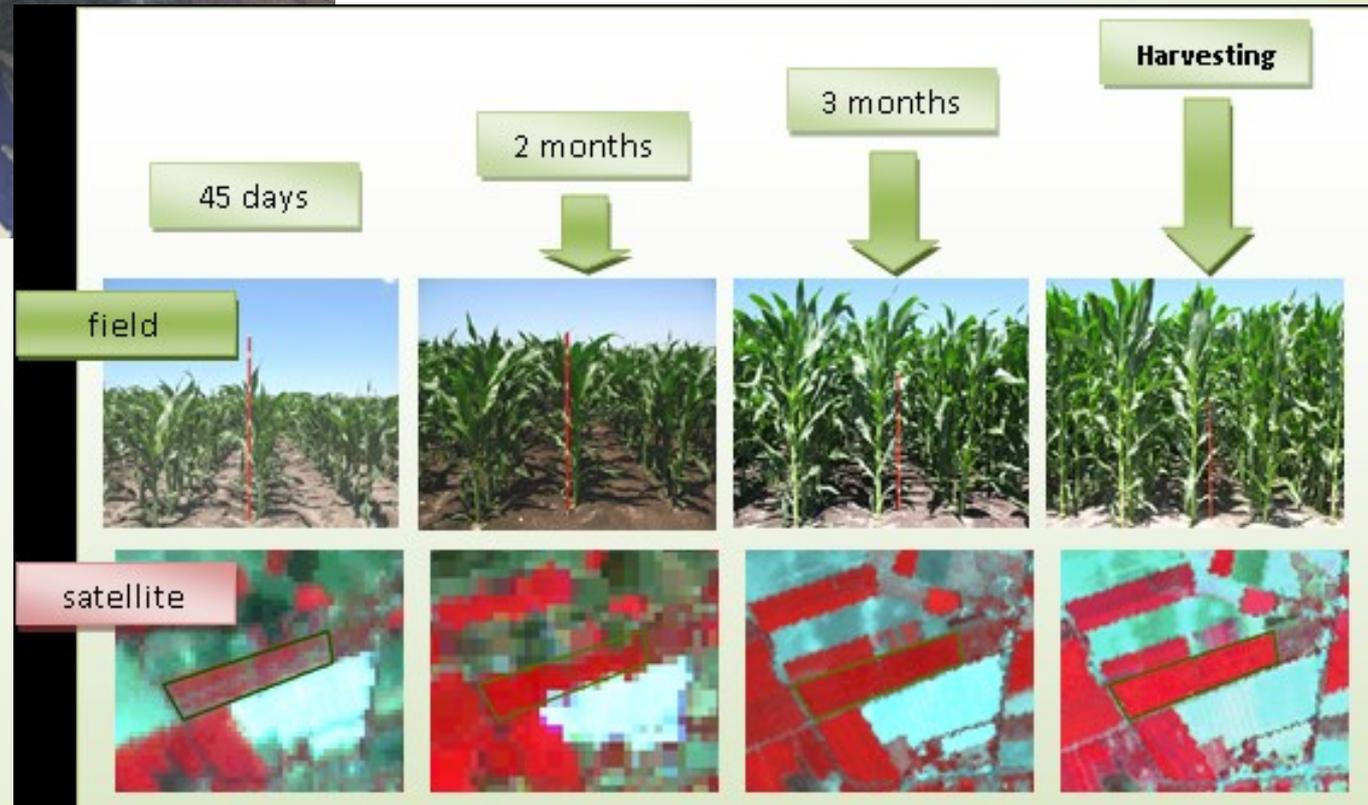
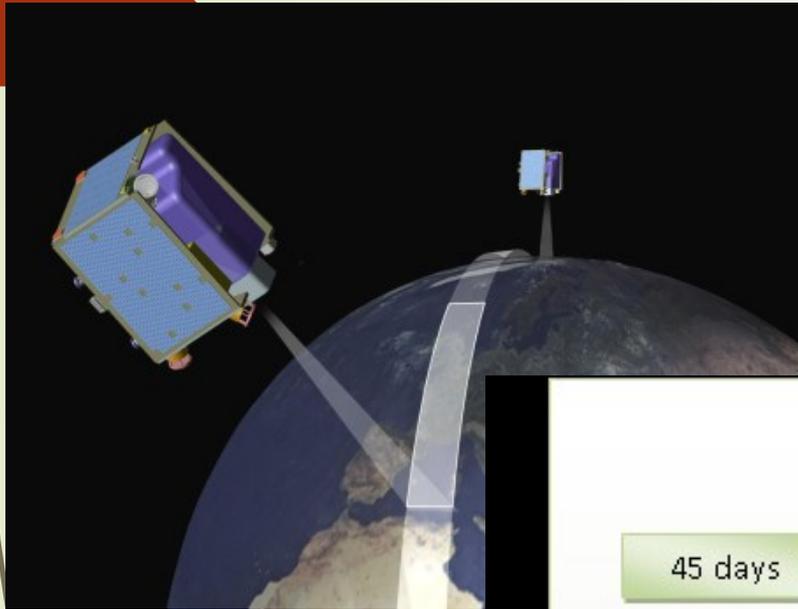


FDR- Decagon 5 TE



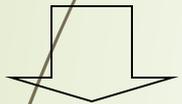
Crop images by remote sensing

Maps of canopy development (LAI, albedo and soil cover) are derived from VIS-NIR high-resolution multispectral satellite images.



Satellite sensors

Landsat 7 ETM+ => 30 m



SPOT5 => 10 m



Quick Bird => 2,8 m



Landsat 8 image availability from Apr. to Oct. 2015

South. ADANA : **12**

<http://earthexplorer.usgs.gov/>

Path 175 Row 34

Search Criteria Data Sets Additional Criteria **Results**

4. Search Results

If you selected more than one data set to search, use the dropdown to see the search results for each specific data set.

Show Result Controls

Data Set [Click here to export your results »](#)

L8 OLI/TIRS

« First < Previous 1 Next > Last »

Displaying 1 - 12 of 12

1	 <p>Entity ID:LC81750342015278LGN00 Coordinates:37.47444,35.49353 Acquisition Date:05-OCT-15 Path:175 Row:34</p> 
2	 <p>Entity ID:LC81750342015262LGN01 Coordinates:37.47474,35.49235 Acquisition Date:19-SEP-15 Path:175 Row:34</p> 
3	 <p>Entity ID:LC81750342015246LGN00 Coordinates:37.47431,35.50949 Acquisition Date:03-SEP-15 Path:175 Row:34</p> 

Search Criteria Summary (Show) Clear Criteria

Map Satellite (38° 22' 51" N, 037° 21' 12" E) Options Over



Major recent breakthroughs in satellite Earth Observation:



WorldView-2 (2009):

- Constellation of 5 satellites
- **Daily** coverage for any location
- **0.5 m** spatial resolution
- First sensor with 8 bands from visible to near infrared



Sentinel-2

Launch:

Sentinel-2A in 11 June 2015

Sentinel-2B in 7 March 2017

13 spectral bands

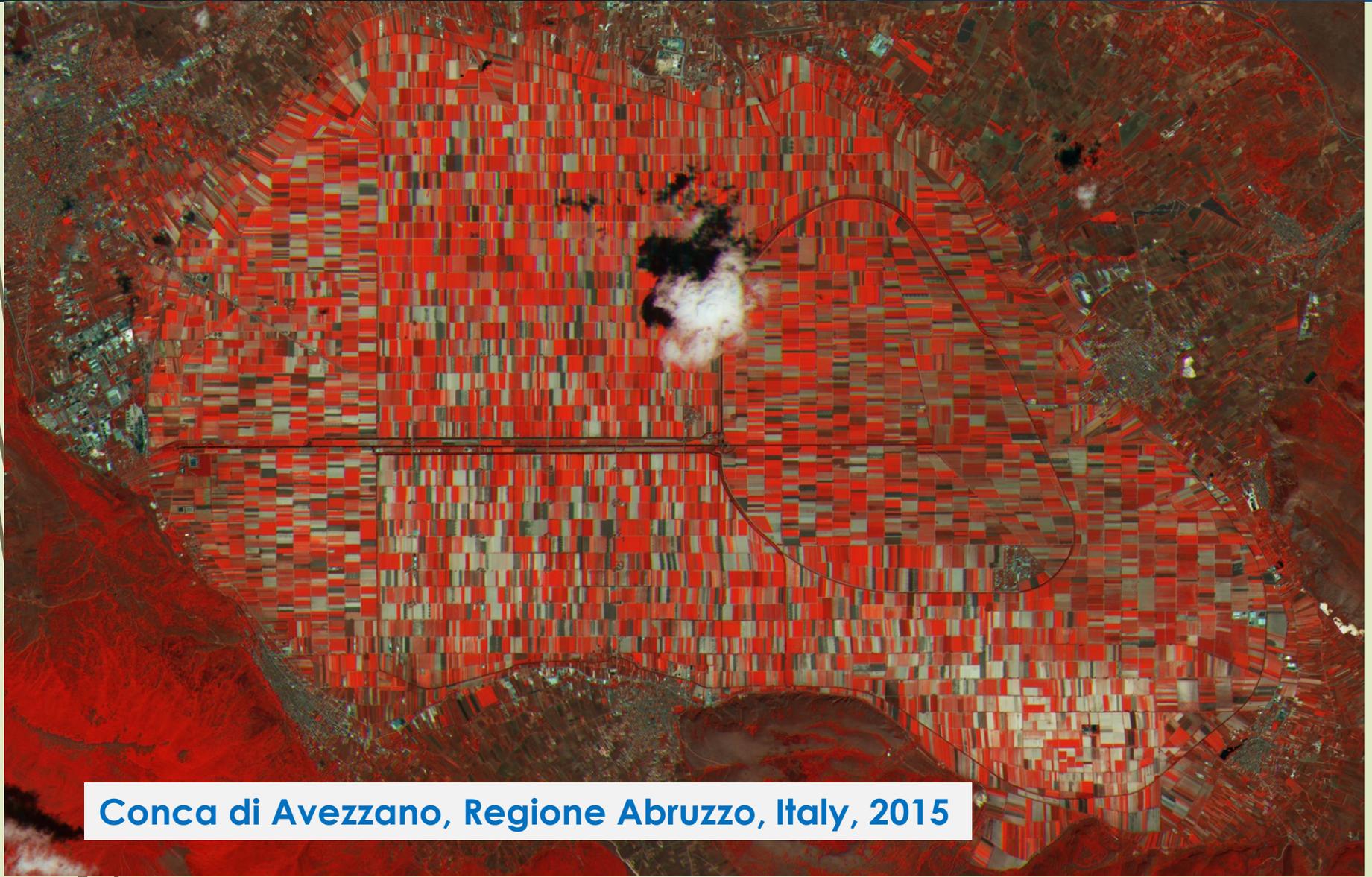
spatial resolutions of 10 – 20 m
5-7 days revisit time



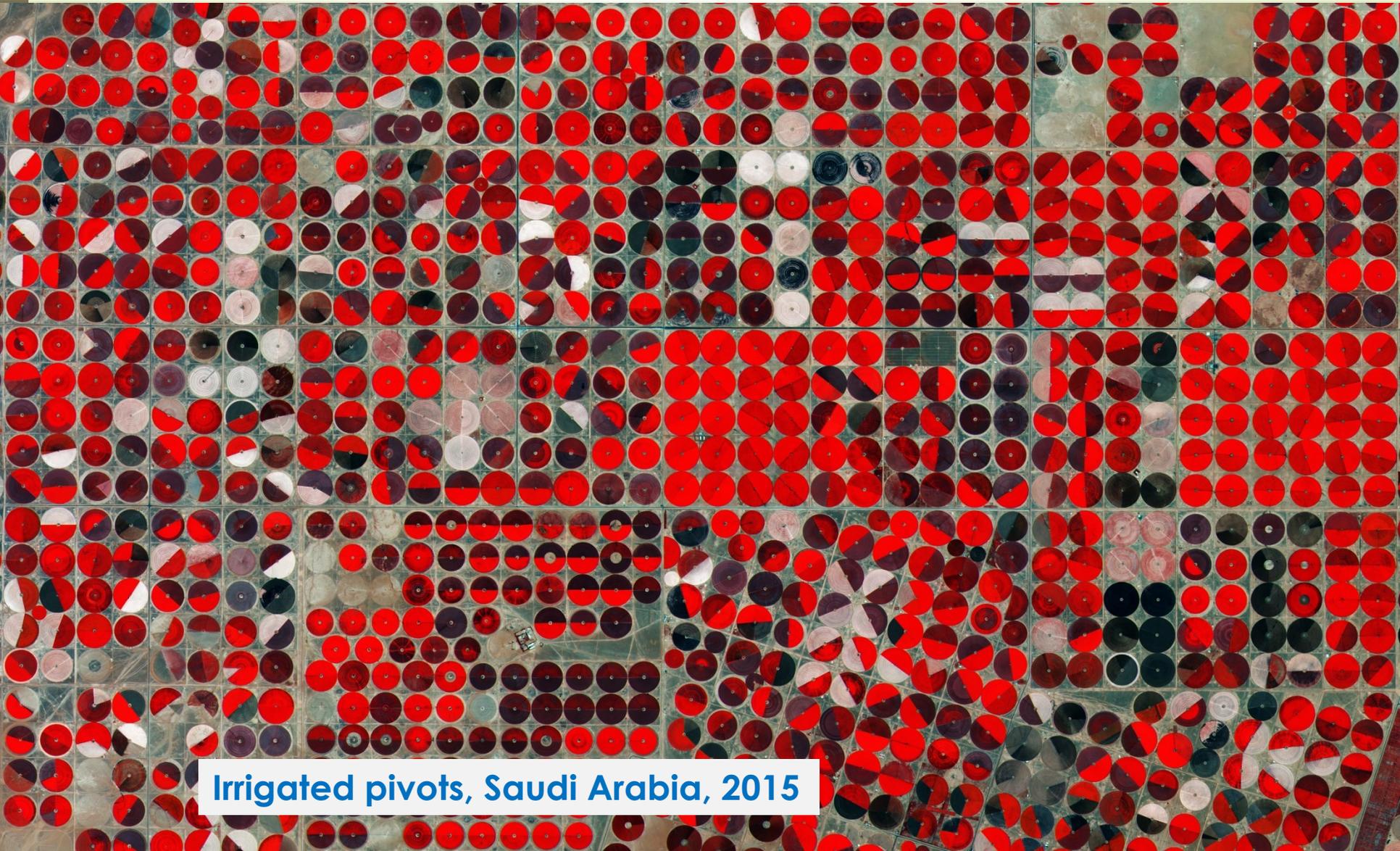
Potential applications in precision agriculture:

- *Crop stress detection*
- *Chlorophyll content*
- *Weed mapping*
- *Pest & disease mapping*

ked_tight



Conca di Avezzano, Regione Abruzzo, Italy, 2015

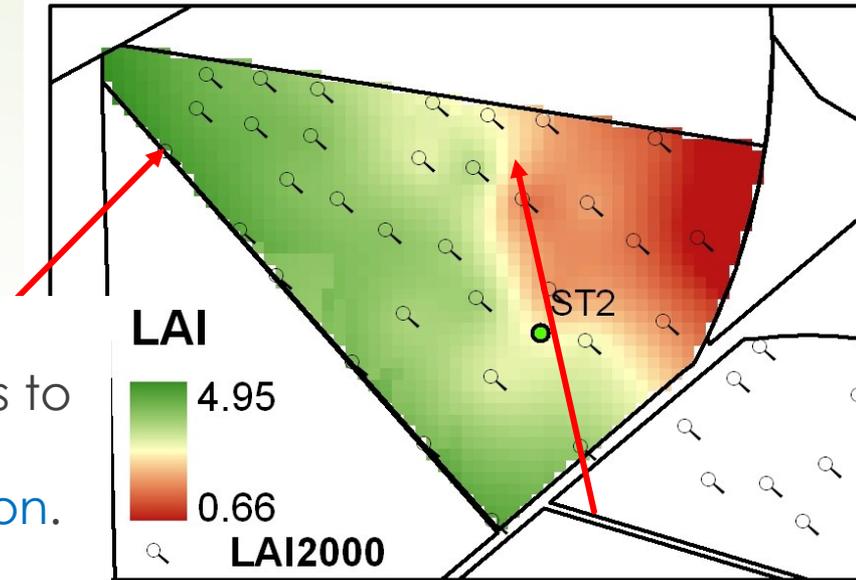


Irrigated pivots, Saudi Arabia, 2015

Research development

Huge knowledge (more than 30 years) on applications of optical remote sensing for crop conditions assessment

Multispectral reflectance and temperature of crop canopies relates to two basic physiological processes: **photosynthesis** and **evapotranspiration**.

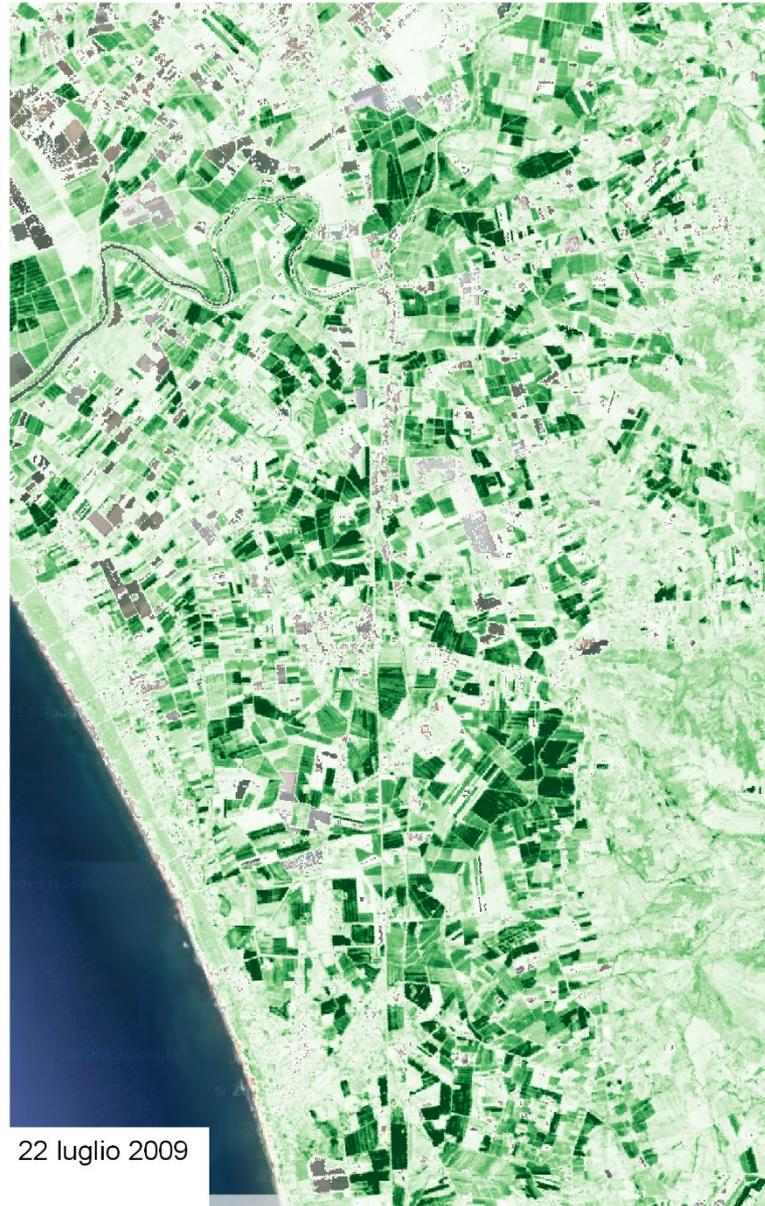


In both processes **Leaf Area Index (LAI)** is the fundamental canopy parameter.

Mitra, et al. Remote Sensing Environ., 1997)

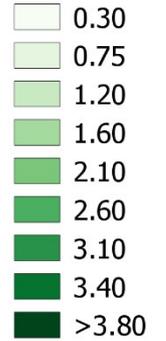


Piana del Sele: Mappa del LAI derivata da immagini SPOT4 (risoluzione 20 m)



Legenda

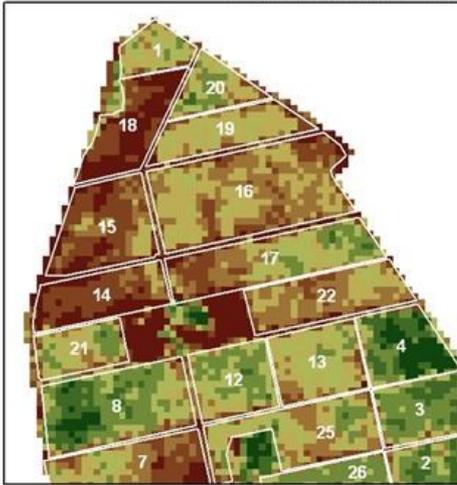
Piana del Sele



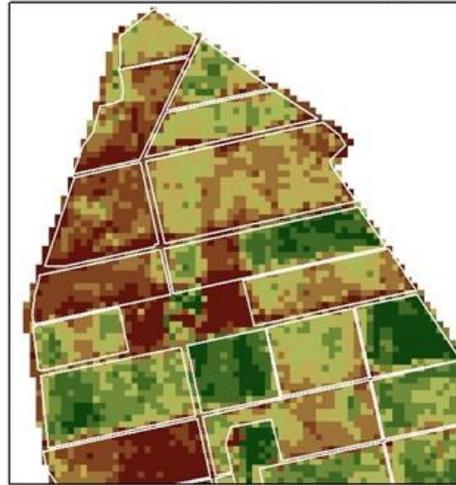
LAI maps for canopy and yield management

Irrigated vineyards, Sella e Mosca, Sardinia

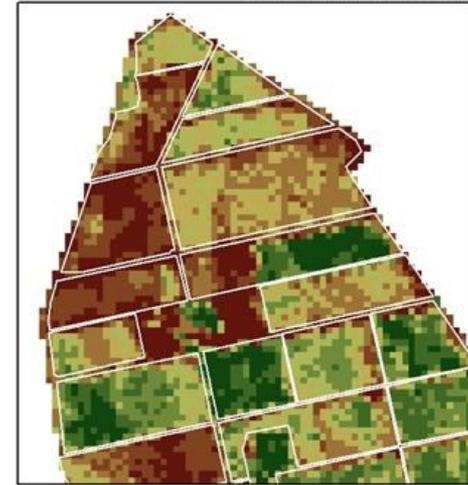
Landsat TM5 23/06/2007



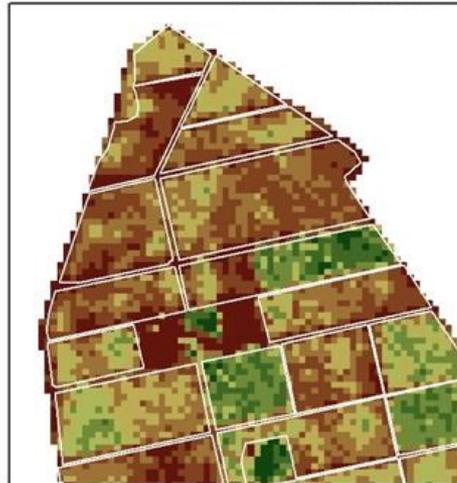
Landsat TM5 09/07/2007



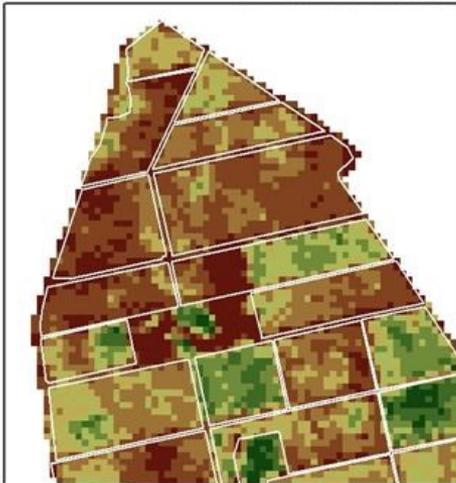
Landsat TM5 25/07/2007



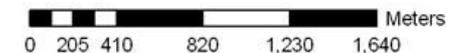
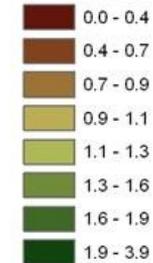
Landsat TM5 26/08/2007



Landsat TM5 11/09/2007



Indice di Area Fogliare



EO data provider

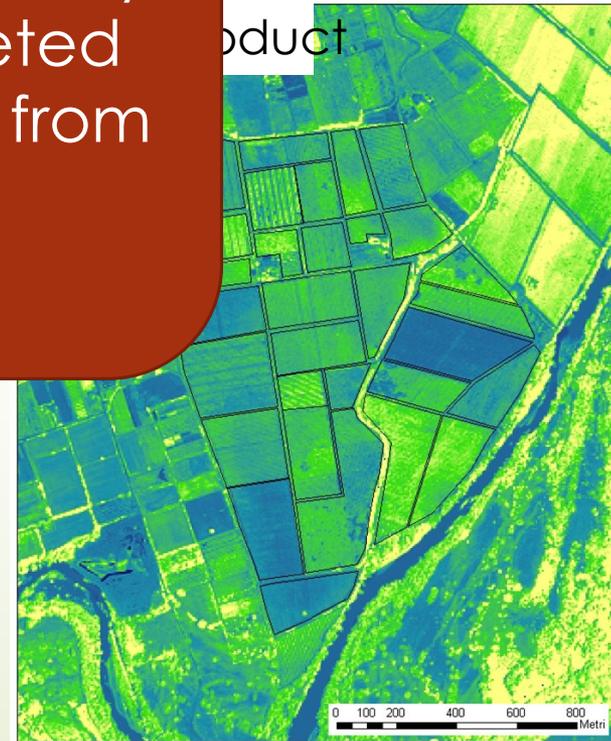


EO image processing center



The entire processing chain (including delivery to final user) can be completed within **few hours** from the satellite acquisition

Delivery to final user

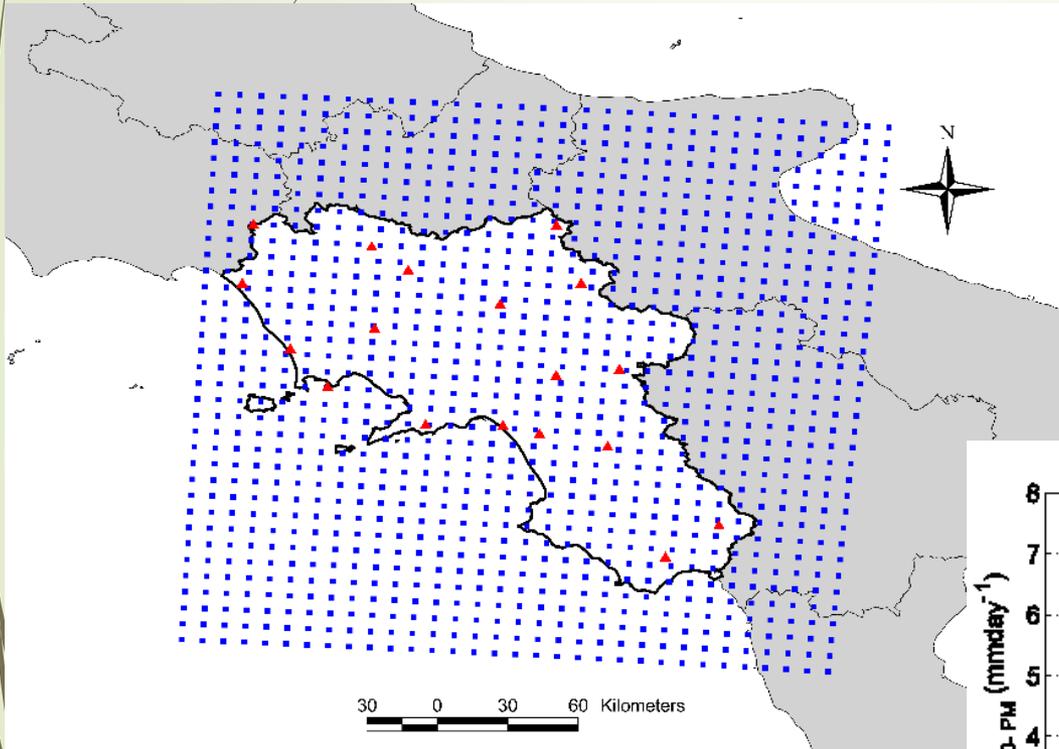


Web2.0 service for delivering the irrigation advice



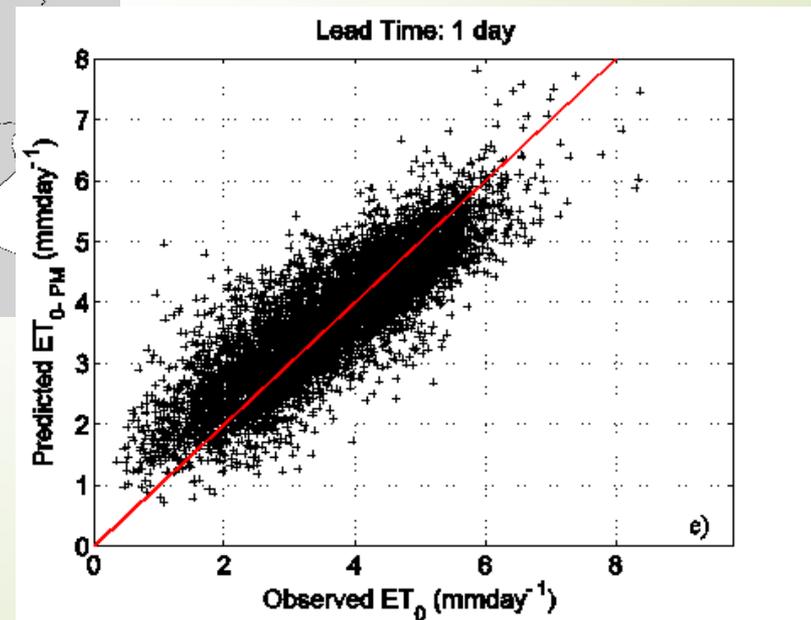
Meteo data forecast & re-analysis

European COnsortium for Small-scale Modelling (COSMO)



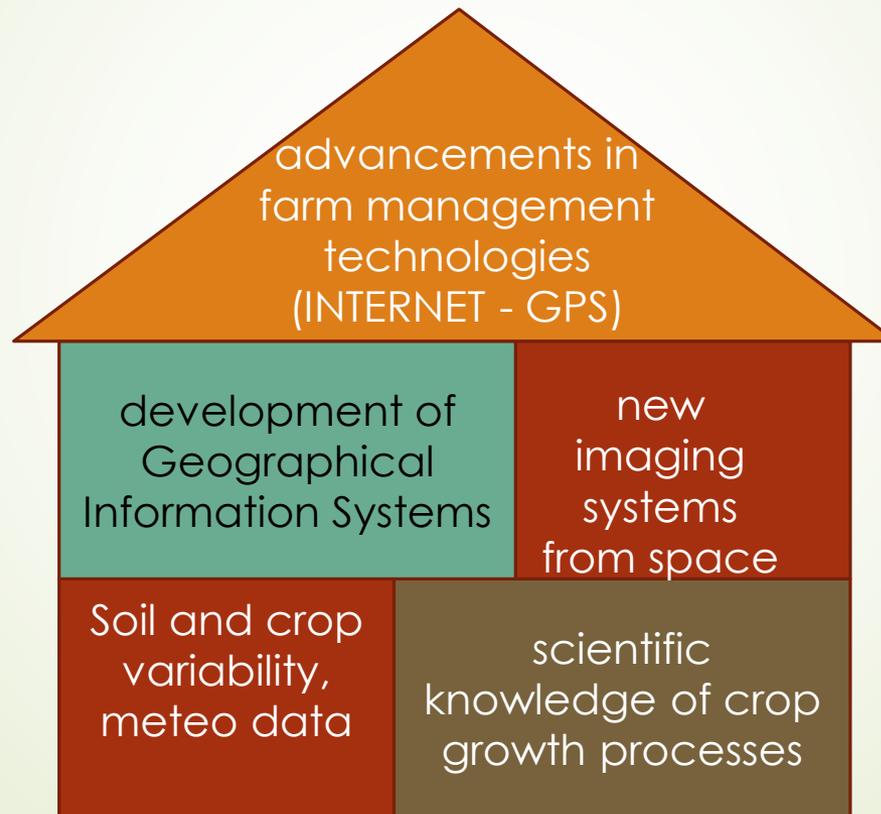
Maps of relevant meteo variables to calculate ET (instead of ground station data) at 7 km resolution

Comparison of ET_0 with reference WMO standard stations

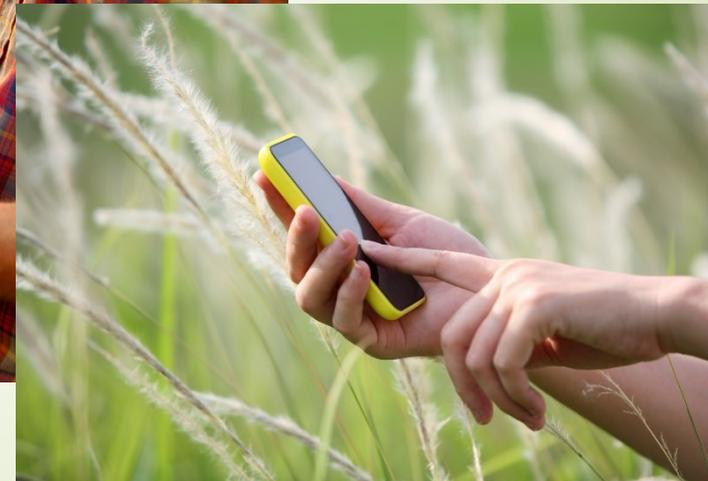
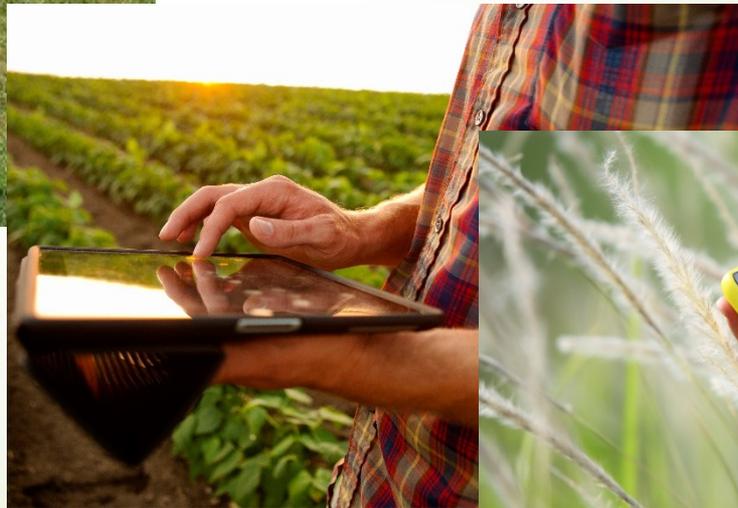




the NEW FARMER' HOUSE: tools for enhancing the traditional background experience with scientific knowledge and new technologies



An example of....



How users access the data ?

www.irrieye.com

A screenshot of the 'Login' form on the website. It features a title bar with a lock icon and the word 'Login'. Below the title bar, there are two input fields: 'Utente:' and 'Password:'. A 'Login' button is located at the bottom right of the form.

1. Farmer access

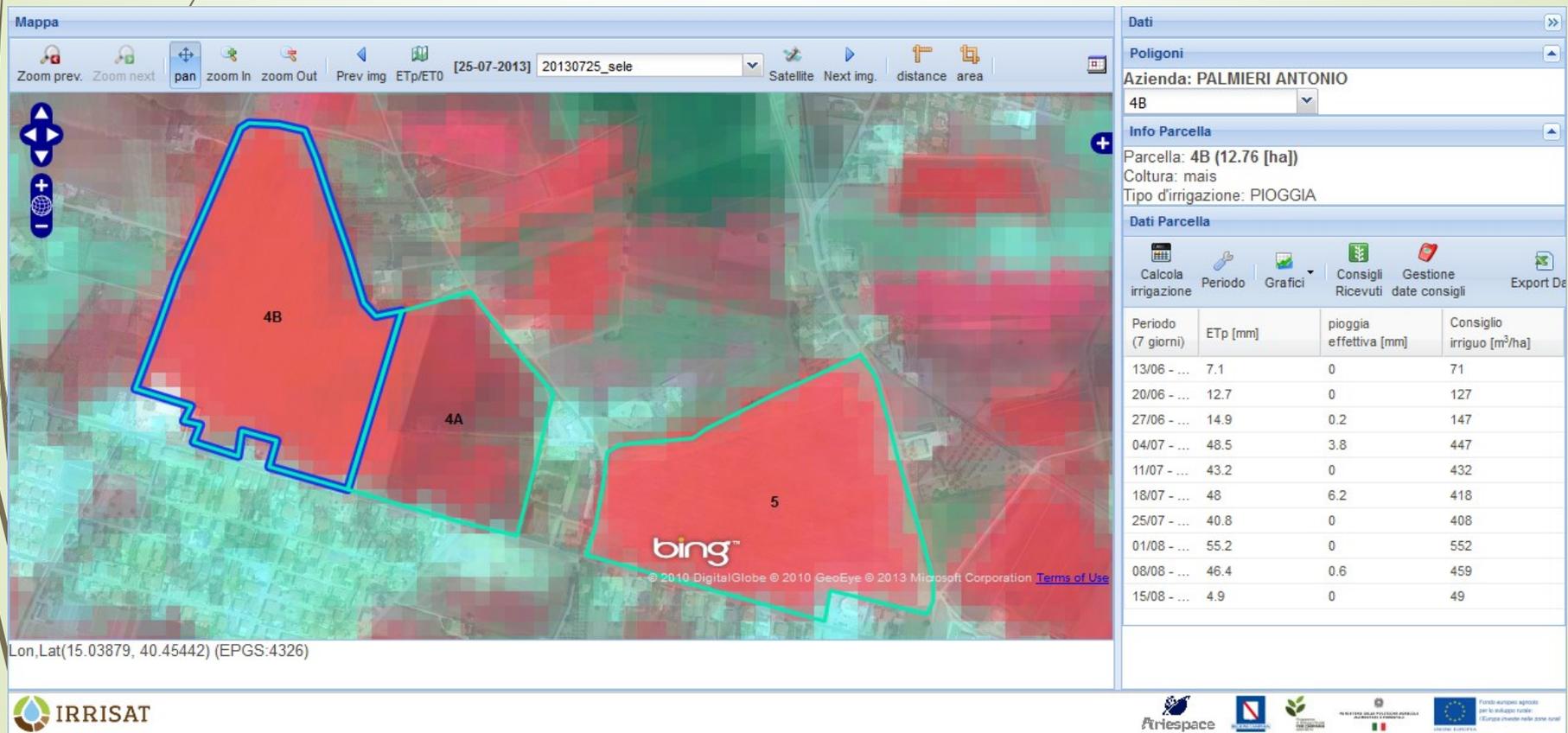
A screenshot of the 'Login Area Riservata' form on the website. It features a title bar with a lock icon and the text 'Login Area Riservata'. Below the title bar, there are two input fields: 'Utente:' and 'Password:'. A 'Login' button is located at the bottom right of the form.

2. Admin access

Which data are given to the farmers ?

1

Mapping of the effective crop vigour

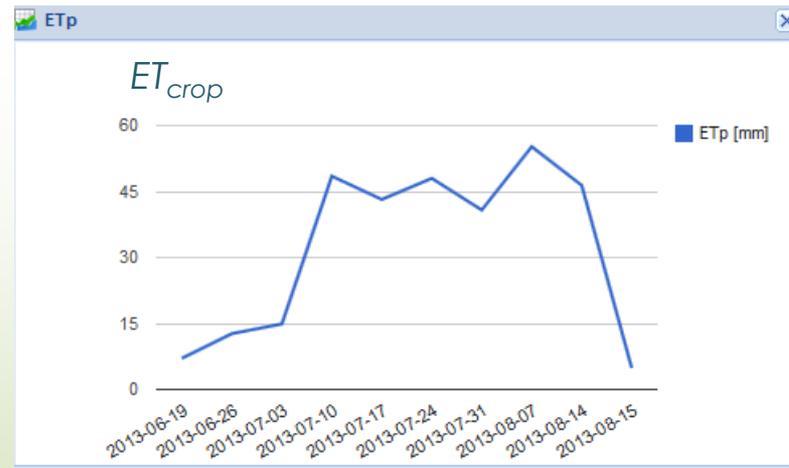


Which data are given to the farmers ?

2

Acquiring local meteorological data

... and now also **weather forecast**



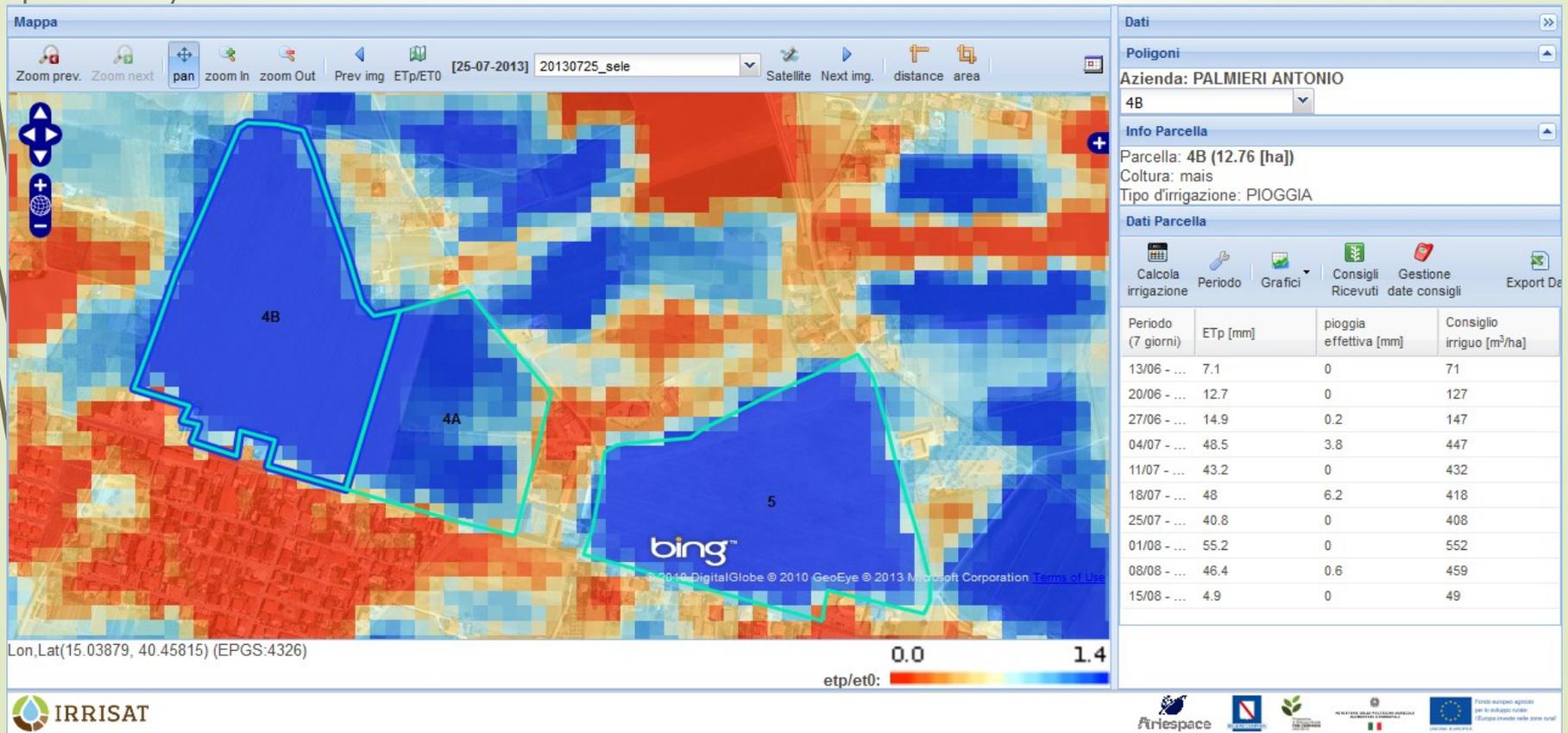
Easy integration with other data at farm-level (i.e. from soil moisture sensors)

Which data are given to the farmers ?

3

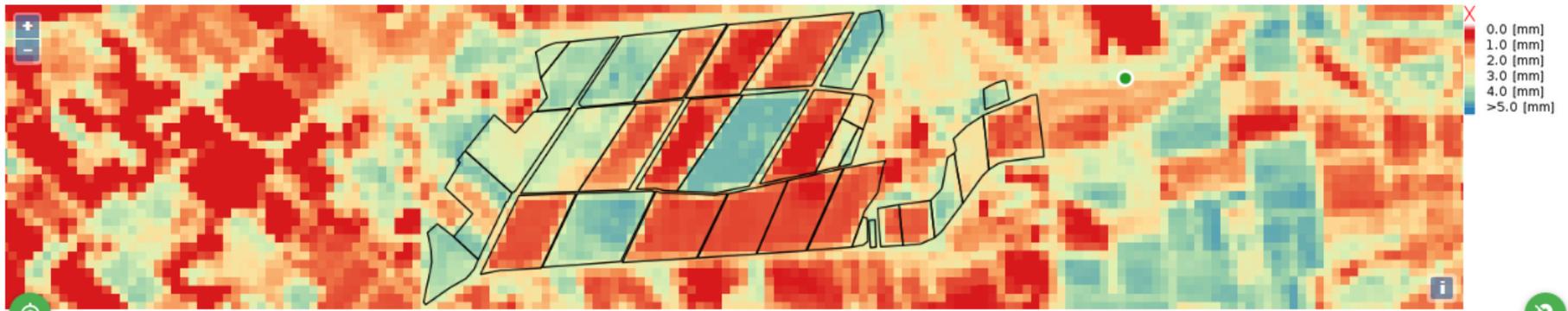
Irrigation advices:

maximum irrigation amount calculated by considering the **ACTUAL CROP DEVELOPMENT**



EXAMPLE OF SATELLITE-BASED IRRIGATION ADVISORY SERVICE IN ITALY

www.app.irrimet.eu



EVAPOTRASPIRAZIONE (ETP)

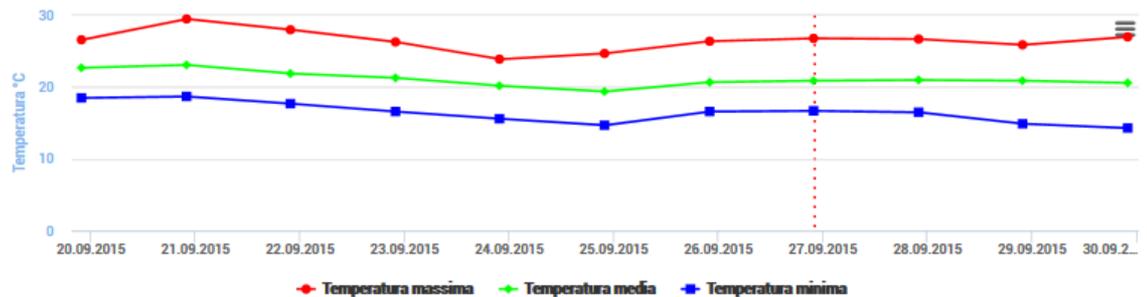
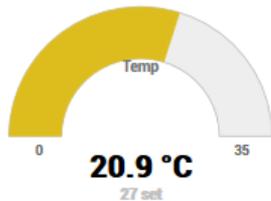
IRRIGAZIONE (WR)

TEMPERATURA (TEMP)

PIOGGIA (RAIN)

INDICE DI VEGETAZIONE (LAI)

RIEPILOGO



► The "irrisat" farmer...



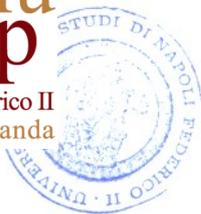


Università di Napoli Federico II
Gulu University of Uganda



UNIVERSITÀ
DEGLI STUDI
DI NAPOLI
FEDERICO II





MEMORANDUM OF AGREEMENT BETWEEN THE UNIVERSITY OF NAPLES FEDERICO II IN ITALY AND GULU UNIVERSITY IN GULU UGANDA

The University of Naples Federico II, in ITALY, represented by its pro-tempore the Rector, and the University of Gulu, in UGANDA, represented by its vice-Chancellor, wishing to establish cooperative relations between the two universities, especially in the areas of education and research, agree as follows:

ARTICLE I

SCOPE OF THE COOPERATION

The areas of cooperation include, subject to mutual consent, any program offered at either university as felt of interest or feasible on either side or that both sides deem will contribute to the fostering and development of the cooperative relationships between the two universities.

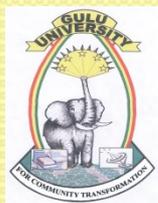
The obligations assumed by each of the contracting parties will consist in teaching, research, exchange of faculty staff, students, education, and all the activities deemed beneficial by the two institutions to achieve the goals of the present agreement.

ARTICLE II

GENERAL AREAS OF COOPERATION

Cooperation will translate in the activation of the following activities or programs, subject to availability of funds and the approval of the Board of the University of NAPLES and of the University of GULU:

1. Joint educational, cultural, and research activities:



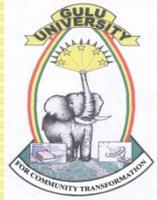


Our professors teach in Gulu

Bach. Agriculture

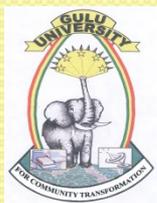
Bach. Biosystems Engineering

Courses: Maths, Biochem.,Agronomy, Plant Pathology, Food Processing, Economy



Pilot projects development

- Portable grain dryer
- Food microbiology
- Mechanisation and Post harvest losses





Martine NYEKO, XXIII PhD Cycle
Final exam - January 2011

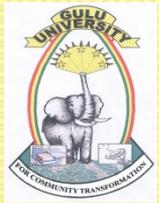
- Management of water resources in the Aswa River Basin, Northern Uganda

Collins OKELLO, XXVI PhD Cycle
Final exam - May 2014

Sustainable production of energy from biomass in Uganda

Geoffrey Openy, XXIX PhD Cycle
Final exam - May 2014

Technical and economical suitability of micro-irrigation techniques in Northern Uganda



Collaborative research



Journal of Agricultural Engineering 2012; volume XLIII:e24

Adaptive simulation of the impact of changes in land use on water resources in the lower Aswa basin

Martine Nyeko,¹ Guido D'Urso,² Walter W. Immerzeel³

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Bioenergy potential of agricultural and forest residues in Uganda



Collins Okello^{a,b}, Stefania Pindozi^b, Salvatore Faugno^b, Lorenzo Boccia^{b,*}

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Bacteriophage P22 to challenge *Salmonella* in foods



Paola Zinno^{a,b}, Chiara Devirgiliis^b, Danilo Ercolini^a, Duncan Ongeng^c, Gianluigi Mauriello^{a,*}

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Thoughts and conclusions ...

Everybody can do something for a better utilisation of water resources.

From the behaviour of individuals and an increased awareness it is possible to induce actions at higher levels

The technology is able to support us in a very effective way

The research advancements are opening new perspectives for a sustainable agriculture with a growing demand for food

We need to support developing Countries to assure our and their own future

The University is the place to form technicians and scientists to face the challenges of new agricultural systems



Thank you for the attention

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