ViWA.geographie-muenchen.de/ViWA-marketplace

ViWA – Virtual Water Values

multiscale monitoring of global water resources and options for their efficient and sustainable use

ViWA Virtual Water Values

RESEARCH GOALS OF ViWA

ViWA aims at improving practical understanding of efficiency and sustainability in agricultural water use. On the global, regional and local scale!

Agriculture uses 92 % of all green and blue water (rainwater, irrigation). Wasteful, water-inefficient agriculture withholds water from natural ecosytems and human use without any gain for human food and water security. Monitoring and improving agricultural water use efficiency (AWUE) is therefore part of SDGs 2 and 6.

How can we monitor AWUE and incentive its improvement through its consideration in ecological and economic analyses of water use and food trade scenarios?

Goal 1

Develop an independent global monitoring system for AWUE and agricultural yields with high resolution (spatial/temporal) based on Copernicus Sentinel-2 satellite remote sensing data.

Goal 2

Use goal1 to assess and evaluate the economic consequences of increasing AWUE for current water use and scenarios of water use and water allocation, including trade in virtual water for agriculture, industry and water management.

Goal 3

Investigate ecological consequences of increasing AWUE e.f. through irrigation on the regional scale.

Goal 4

Assess the vulnerability of agriculture and ecosystems to climate variability with special emphasis on water availability.

Goal 5

Identify regional hot-spots of low AWUE and unsustainable water use to describe institutional obstacles for a sustainable and efficient water use.

Goal 6

Identify trade-offs between the commercial water use and protection of ecosystem services.

Goal 7

Develop solutions through analysis of trade-offs with scenarios.

WHO WE ARE AND WHAT WE DO:

Institute for the World Economy, Kiel

Dr. Ruth Delzeit

Prof. Dr Gernot Klepper

Development of the IfW's computable general equilibrium model to integrate water use and virtual water flows.

Identification and quantification of the competition for water and its impact on international virtual water trade.

Modeling of allocation of scarcs regional water resources.

Simulation of scenarios to improve sustainability of water use. Modeling of scarcity measures for regional water resources.

VISTA Geoscience Remote Sensing GmbH, Munich

Dr. Heike Bach

Processing of remote sensing data and derivation of agricultural and non-agricultural environmental parameters.

Assimilation of remote sensing data into PROMET with the aim of establishing a global monitoring system for water use efficiency.

Department of Geography, University of Munich

Prof. Dr. Wolfram Mauser (coordinator)

Project coordination and stakeholder interaction.

Development of a global monitoring system for water use efficiency.

Global and regional multiscale simulation of water consumption, water use efficiency and related yields in agriculture using PROMET land surface process modeling and parameters derived from EU Copernicus Sentinel remote sensing data.

Determination of water balances in globally distributed watersheds.

Development of scaling methods from regional to global scale.

A water research network to support the implementation of the UN Sustainable Development Goals

Leibniz Supercomputing Centre (LRZ) of the Bavarian Academy of Sciences and Humanities, Munich

Prof. Dr. Dieter Kranzlmüller

Dr. Anton Frank

Support for HPC-workflows and data management for global high-resolution land surface simulations using PROMET.

Helmholtz-Zentrum Geesthacht, Climate Service Center Germany

Prof. Dr. Daniela Jacob

Dr. Susanne Pfeifer

Provision of dynamically down-scaled meteorological reanalysis data as driver for the land surface processes model PROMET.

Analysis of natural climate variability

Institute for Environmental Planning, Leibniz University of Hannover

Prof. Dr. Christina von Haaren

Investigation of conflicts between ecosystem functions and agricultural production for various ecosystem types.

Identification of hot spots of unsustainable water use related to water use in agriculture.

Assessment of the vulnerability of ecosystems against changed water regimes caused by water extractions.

Development of a sustainability assessment of water use and distribution based on the ViWA monitoring system.

Detection of institutional obstacles.

Helmholtz Center for Environmental Research (UFZ), Leipzig

Prof. Dr. Sabine Attinger

Development of a coupled version of the finite differences groundwater model OpenGeoSys to connect to PROMET land surface simulations.

Large scale validation of simulated water fluxes using mHM.

Prediction of the global near-surface groundwater, base flows and storages under dynamic water management scenarios.

Federal Ministry of Education and Research

FONA Forschung für nachhaltige Entwicklungen BMBF

GRoW GLOBALE RESSOURCE WASSER

ViWA.geographie-muenchen.de\ViWA-marketplace

poster design: LMU Munich

ViWA.geographie-muenchen.de/ViWA-marketplace

ViWA - Project Highlight

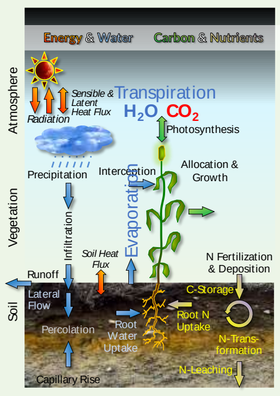
multiscale monitoring of global water resources and options for their efficient and sustainable use

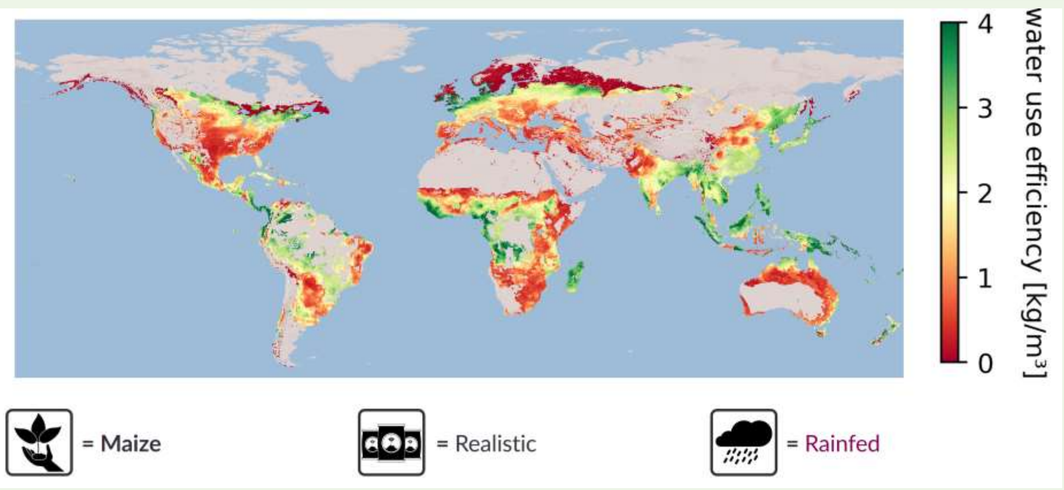
ViWA
Virtual Water Values

Global AWUE Simulations

ViWA uses the land surface processes model PROMET, informed by Sentinel-2 measurements, to simulate globally the actual growth, water-use, yield and AWUE of 18 major crops (resolution 1 km,1h). Up to 250 management scenarios (fertilization, irrigation, etc.) are considered and simulated.

The High Performance Computeing (HPC) System SuperMUC-NG is used to compute the simulations for the global AWUE monitoring system.





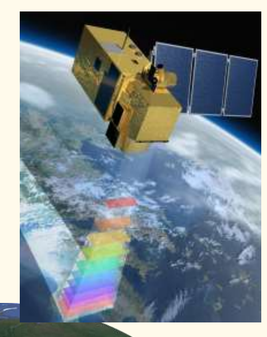
Visit:
ViWA.geographie-muenchen.de/ViWA-marketplace

THE RESEACH GOALS

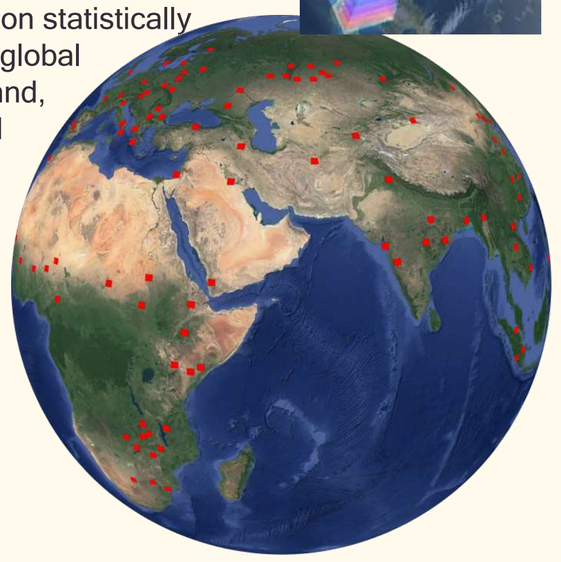
ViWA aims at monitoring agricultural water use efficiency (AWUE) and explores ways for its improvement through its consideration in ecological and economic analyses of water use and food trade scenarios.

Sentinel-2 Observations

Sentinel-2 images are used to derive important land surface parameters like leaf area index and phenology:



15000 100x100 km images at a resolution of 10 m were processed at 120 agricultural sample location statistically representing global agricultural land, practices and Systems.

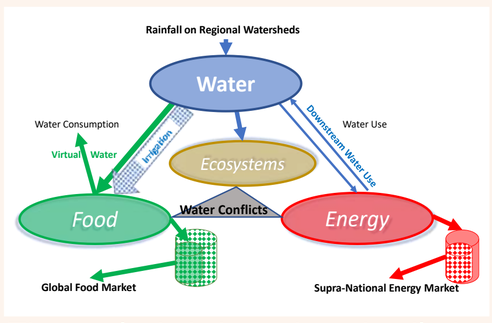


The data is used for global monitoring of yields and AWUE.

Visit:
vista-geo-service.de/ViWA_Testsites/
foodsecurity-tep.net/
ViWA.geographie-muenchen.de/ViWA-marketplace

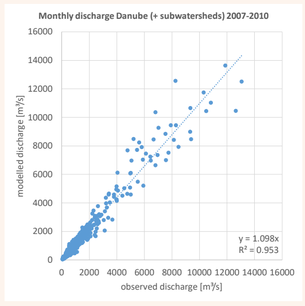
Regional Water-Food-Energy-Ecosystem Assessment

ViWA analyses in large transnational basins, like the Danube and the Zambesi water-food-energy conflicts and their ecological consequences.

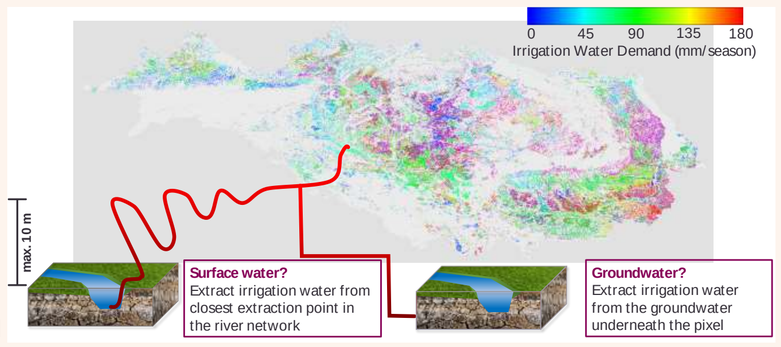


The analysis is based on detailed water-balance simulations (1-5 km/1h-1month) using the land-surface models PROMET and mHM and the groundwater model OpenGeoSys.

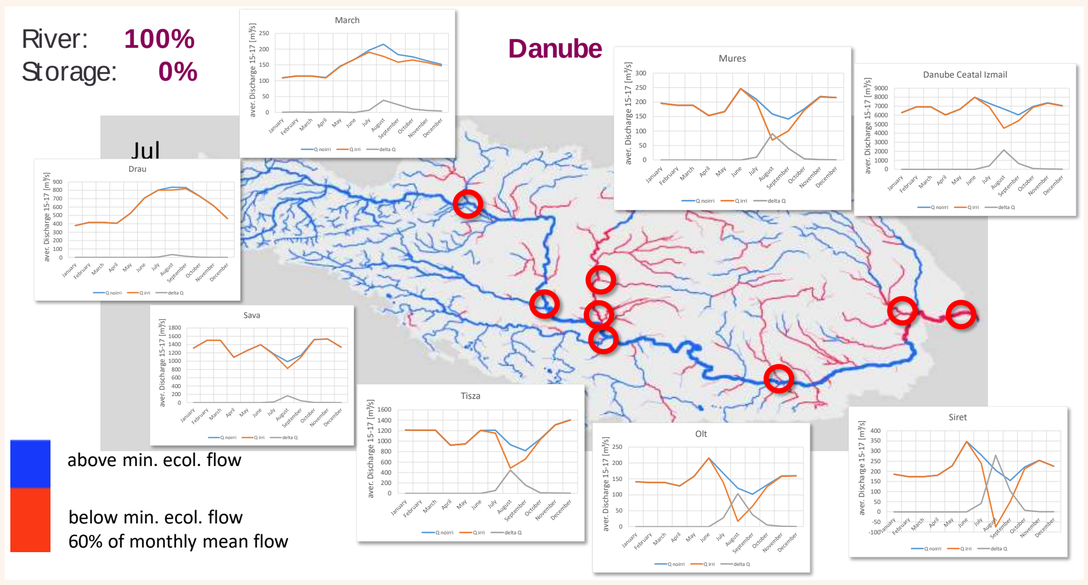
The case of expanding irrigation in the Danube basin was exemplary studied. Impacts of irrigation on Maize yield was simulated. The required irrigation water was extracted from surface and groundwater. The consequences for hydropower production and monthly ecological flows was determined.



Water balance Danube and tributaries (sim vs. obs.)



Danube Agriculture Irrigation Water Requirements (mm per season 2017)



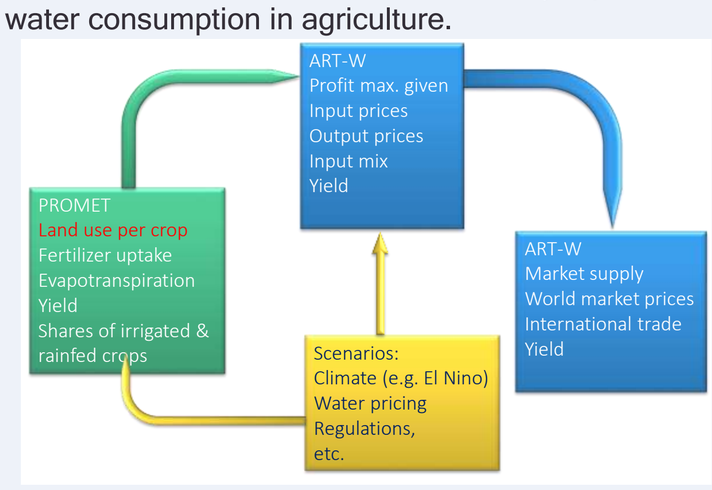
Exemplary scenario result: Change in July and monthly (charts) mean flows in the Danube due to expansion of irrigantion (extraction 100% surface water) and ecological flow considerations

Integrated Assessment:
Water: ~ 5 billion m³ extracted per year mostly Hungary and Romanian affected
Food: maize production increased from 37.7 to 66.5 mio t (roughly doubled), increase in volume of sales by app. 4.6 billion € (@ 160 €/t maize)
Energy: reduction of hydropower production from 37.5 to 36.7 PWh/a decrease in volume of sales by app. 30 mio. € (@ 0.04 €/kWh)
Ecosystems: in July >50% of all tributaries in Hungary and Romania including lower Danube experience average monthly flow below 60% of normal -> severe ecological consequences!

Visit:
ViWA.geographie-muenchen.de/ViWA-marketplace

Economic Analysis of Water in Global Agricultural Trade

The computable general equilibrium model Applied Regional Trade - Water (ART-W) was developed to investigate the role of irrigation water in scenarios of global agricultural trade. ART-W uses detailed information from PROMET to realistically represent water consumption in agriculture.



Coupling Scheme of ART-W and PROMET

The impact of different water use scenarios such as regulatory options (e.g. water pricing), improved technologies (irrigation) or external risks (climate variability) can be analyzed with respect to water scarcity and virtual water trade.

Visit:
ViWA.geographie-muenchen.de/ViWA-marketplace

Federal Ministry of Education and Research
FONA Forschung für nachhaltige Entwicklungen BMBF
GRoW GLOBALE RESSOURCE WASSER

ViWA.geographie-muenchen.de\ViWA-marketplace
poster design: LMU Munich