



**FREEWAT**  
Free and Open Source Software Tools for Water Resource Management  
EU HORIZON 2020 Project



 **ict4water.eu**

# Open source and free software for water resource management: the H2020 FREEWAT platform

## UNESCO-SADC Regional Training on Groundwater Modelling

Johannesburg, South Africa

March 20<sup>th</sup> 2017

Rudy Rossetto - Scuola Superiore Sant'Anna (Italy)  
[r.rossetto@santannapisa.it](mailto:r.rossetto@santannapisa.it)



# WATER FOOD ENERGY NEXUS GROUP

@Institute of Life Sciences

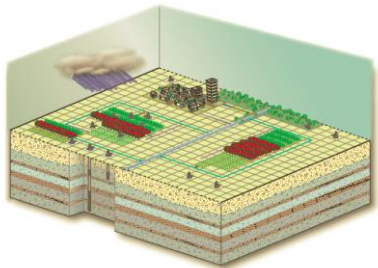
Devising innovative ways to sustainable water management developing theoretical and applied approaches and technology transfer.



- *The science and policy of agricultural water management at farm- and regional-level*



- *Exploring green/blue infrastructures for the provision of water related agro-ecosystem services*



- *Development and application of innovative ICT tools for water management and governance*

# THINK DIFFERENT  
Cross Fertilization Meeting @ The Institute of Life Sciences

INSTITUTE  
OF LIFE  
SCIENCES



Scuola Superiore  
Sant'Anna

# water resource management and planning

Although a lot of science is produced on water resource management (especially in the ICT sector)

WRM is still today poorly addressed via scientific means

## REASONS

underrated importance given at political and decision maker level

low-capacity of the research environment to transfer the results to the real world

missing capacity at agencies and governing authorities

# no water no party no water no party no water

## OUTCOMES

*Poorly addressed water management is largely performed*

*Hydrological systems at risk of crisis*

**Climate change is strongly exacerbating this baseline**

## BARRIERS

>>>> to **#SDG6**

>>>>to **#SDG8**



A whole economic sector & the possibility to create innovative jobs especially for young people is prevented from developing

# data water data water data water data water

Many countries are now producing water related data:

- in EU countries case:

>>>>> *Massive amount*

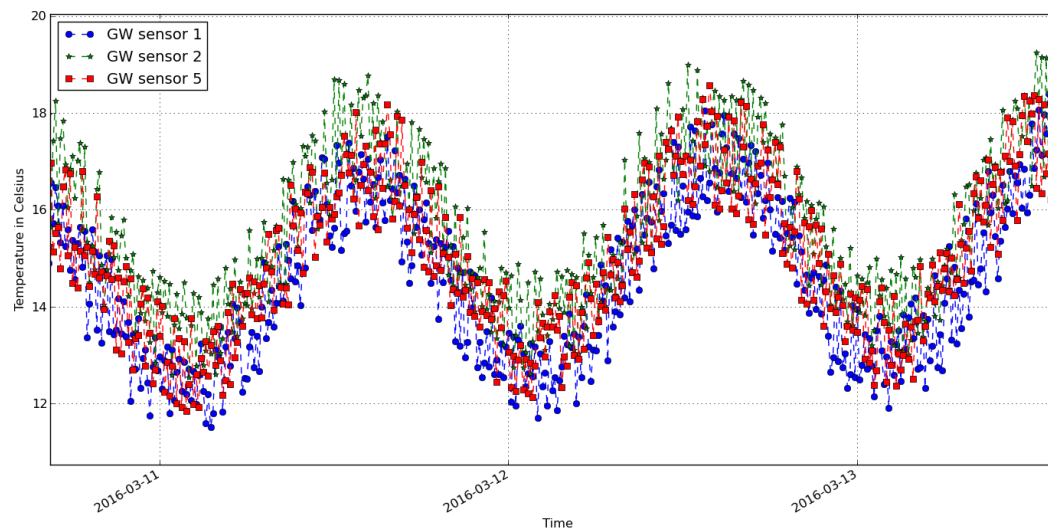
- in other countries

>>>>> *maybe less data are available*

Actions		idsgw_1	date	time	level	temperature	ph	ces
<a href="#">Edit</a>	<a href="#">Delete</a>	4968	2015-04-22	09:26:24	8.01714	9.68442	1	489.071
<a href="#">Edit</a>	<a href="#">Delete</a>	4969	2015-04-22	09:41:25	8.02453	9.74725	1	478.441
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<a href="#">Edit</a>	<a href="#">Delete</a>	4981	2015-04-22	12:41:33	7.99031	9.69059	1	483.874

Information CONTENT of this data not fully exploited as today

ICT tools would allow



FREEWAT is a EU H2020 ICT project for *improving* Water Resource Management by *simplifying* and *strengthening* the application of EU water related Directives and non-EU water related regulations

### *MAIN EXPECTED RESULT*

Open source and public domain GIS integrated modelling platform allowing data storage and analysis and simulation of several processes for WRM

### **FREEWAT expected main impact →**

*help producing scientifically and technically sounding decision and policy making based on:*

- data and innovative data analysis tools
- participatory approach

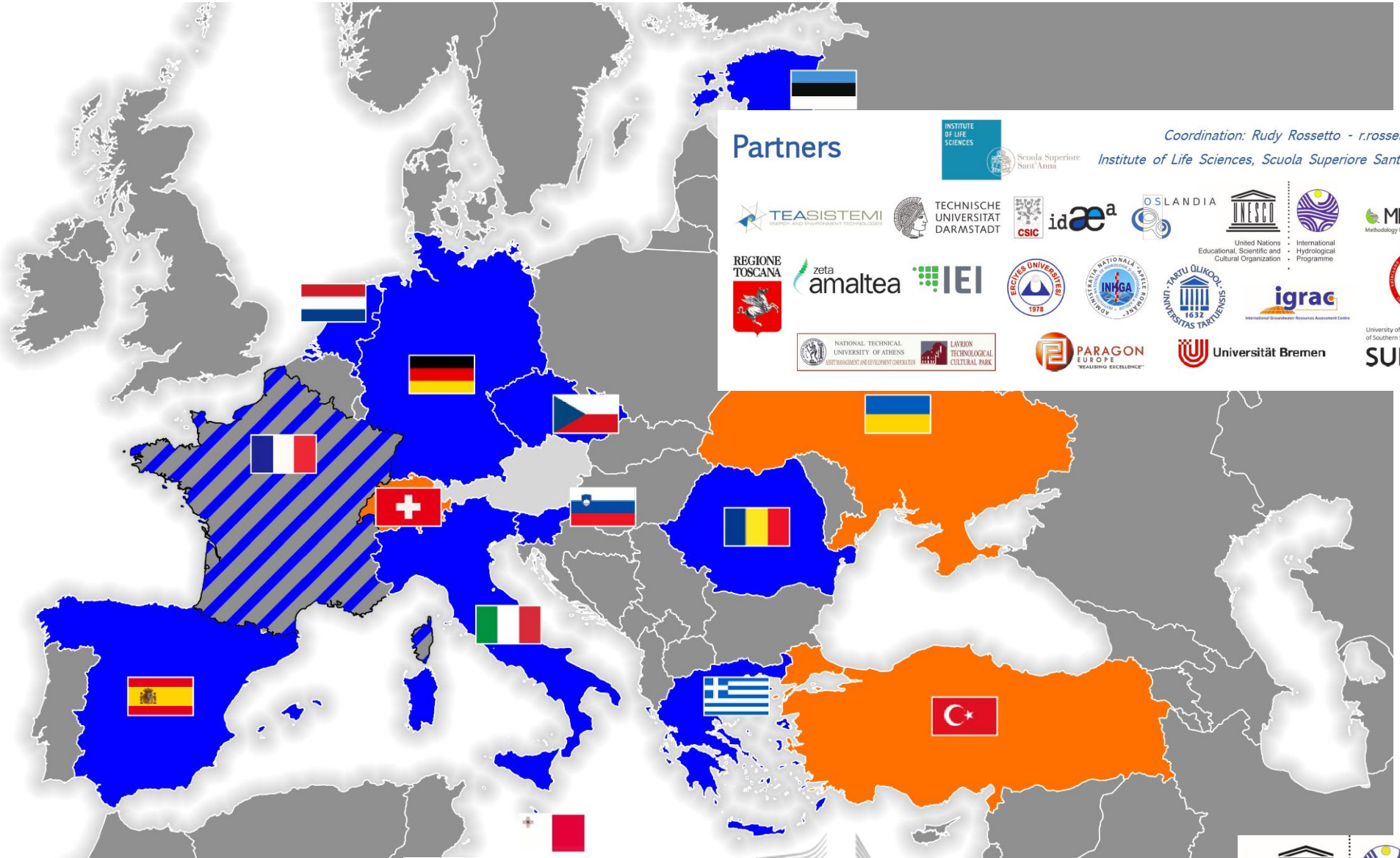
# MOTIVATIONS

1. free and open source tools, numerically based, GIS integrated to perform spatial and temporal analysis on water quantity and quality issues in order to simulate climate change effects on water resource and adaptation strategies reliability,
2. use effectively data provided by geospatial databases and by the extensive monitoring required by the WFD;
3. training technical staff at authorities and private companies on the use of state-of-the-art innovative software for water management (*digital breakthrough in wrm*)

Open source characteristics of the project →

initiative "*ad includendum*" - further research institutions, private developers etc. may contribute to the project development

# FREEWAT Consortium



## Partners

Coordination: Rudy Rossetto - [r.rossetto@sss.up.it](mailto:r.rossetto@sss.up.it)  
 Institute of Life Sciences, Scuola Superiore Sant'Anna (Italy)



## ***SOFTWARE DEVELOPMENT***

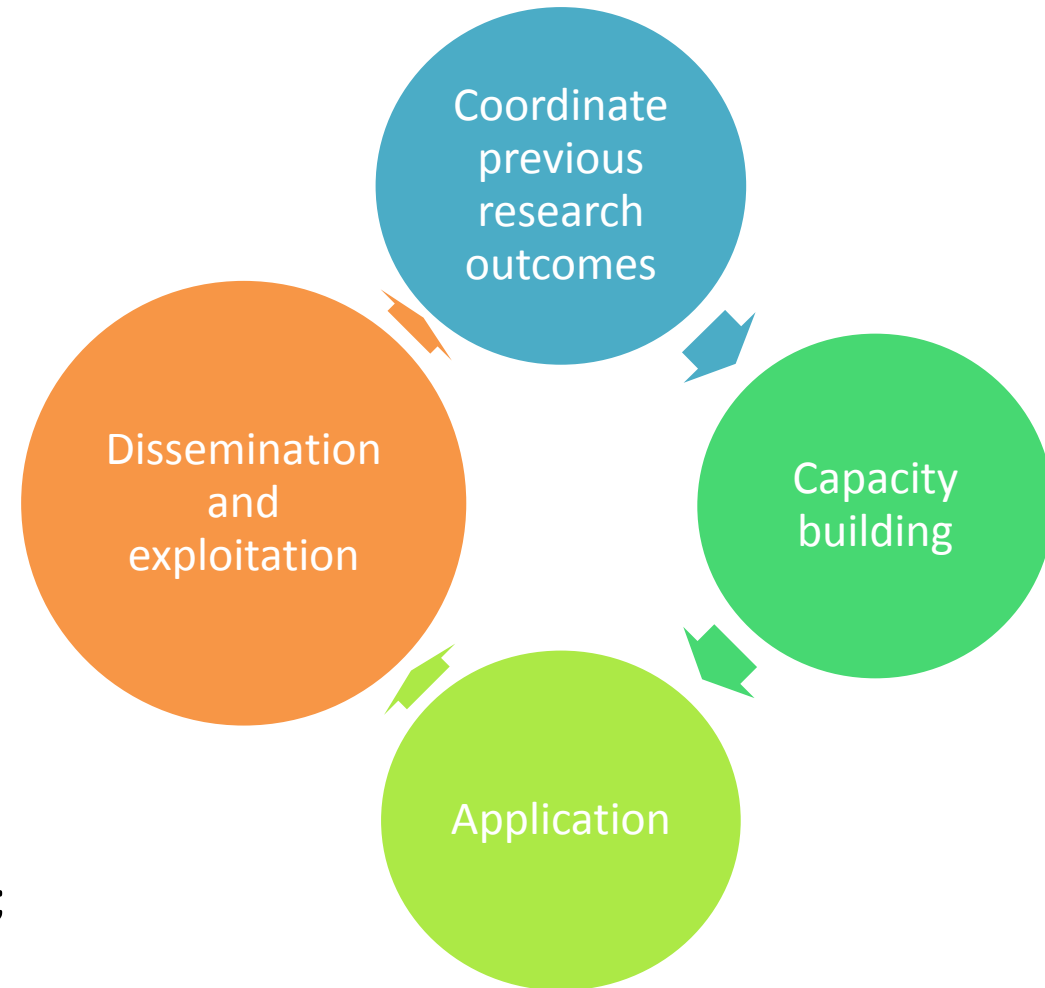
- Building the software platform (WP2)

## ***CAPACITY BUILDING***

- Intensive training (WP3)

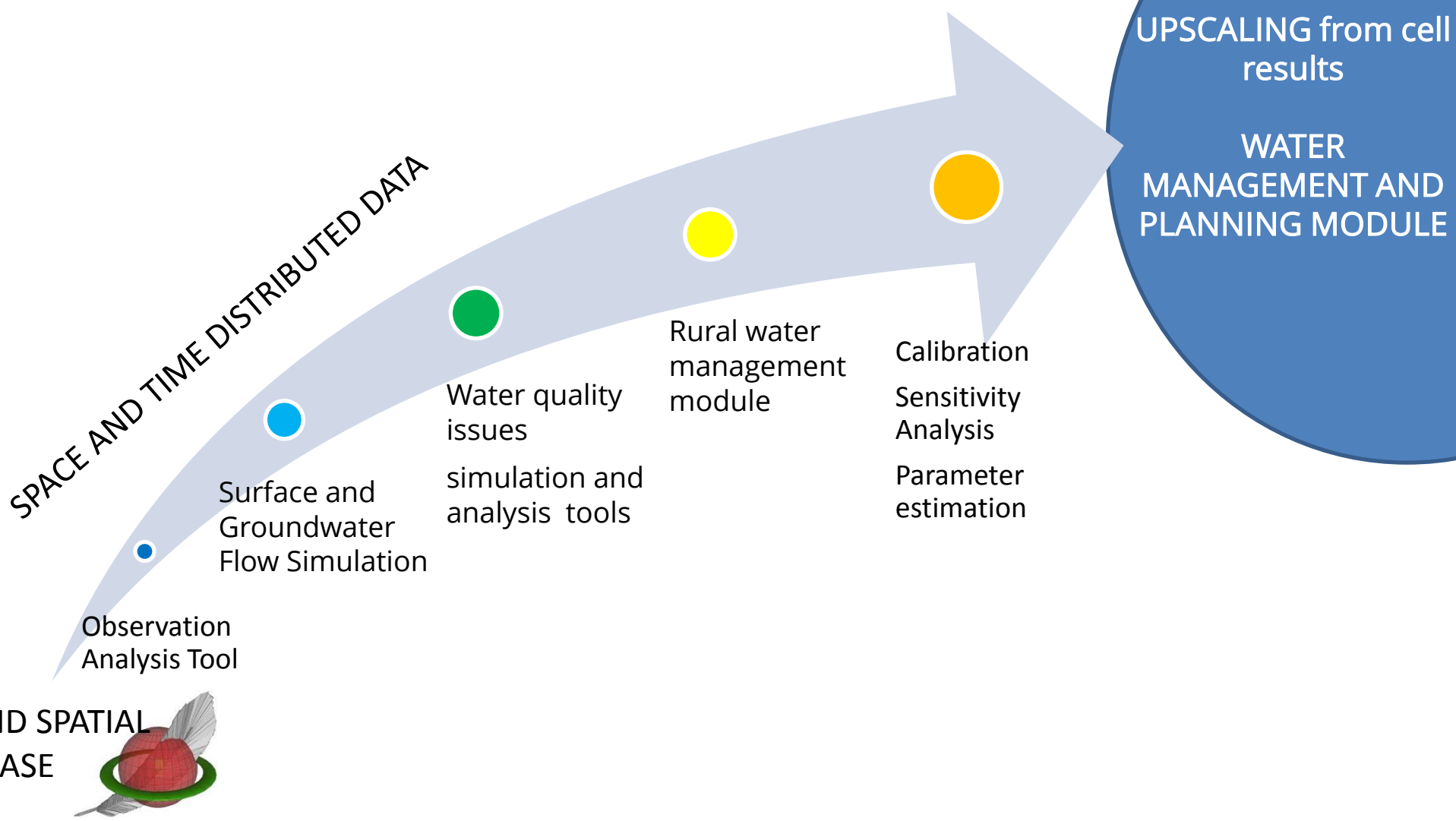
## ***APPLY THE FREEWAT PLATFORM***

- **Postulate your WRM goal;**
- Involve the stakeholders during FREEWAT application;
- Apply FREEWAT for solving your problem;
- Produce tailored policies!

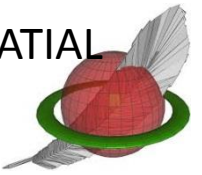




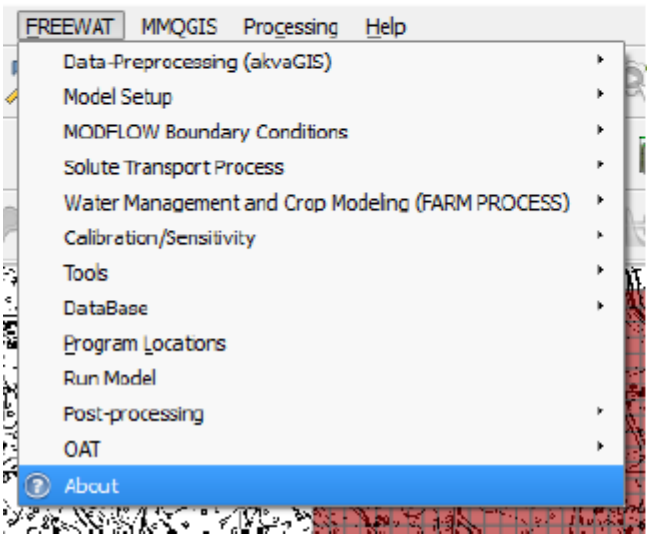
# FREEWAT architecture



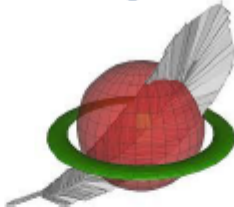
GIS AND SPATIAL DATABASE



## FREEWAT Pillars



GIS-layers & Tables



akvaGIS

OAT



MODFLOW and Related Programs (MT3DMS, SEWAT, UCODE, etc.)



## A QGIS integrated modelling environment in its v0.3 age along with 6 User Manuals

**FREEWAT Processing Help**

- Data-Preprocessing (akvaGIS)
- Model Setup**
- MODFLOW Boundary Conditions
- Solute Transport Process
- Water Management and Crop Modeling (FARM PROCESS)
- Calibration/Sensitivity
- Tools
- DataBase
- Program Locations
- Run Model
- Post-processing
- About

**Create Transport Model**

Flow Model Name: ex\_mt3d  
 Set a name for Transport Model: mymodel  
 Mass Unit: KG

Insert information on chemical species:

species_name	mobile
s1	yes

If you have more than 5 species, load CSV file:  **Browse**

```

#original data
CUC2.plot(quality=True)

#lowpass filter
CUC4.process(
  method.DigitalFilter(
    1, 0.01, orders=6, btypes='lowpass')
).plot(quality=True)

#Hydrograph separation
#with two parameter digital filter
CUCd = CUC2.process(
  method.Resample(freq='1D', how='mean',
    fill='ffill', how_quality='sum'))
base, runoff = CUCd.process(method.Hysep(mode='TPDF'))

CUCd.plot()
base.plot()
runoff.plot()

Calculate exceedance time
In [25]: #Exceedance values from exceedanc
A = CUC2.process(method.Exceedance(perc=[10, 50, 95]))
print "-----"
print "Percentage: %s%%" % A[0][0]
print "Value\t\t: %s\tm3/s" % A[0][1]
print "-----"
print A
-----
Percentage      : 5.0 %
Value           : 1.967 m3/s
[[ [ 5., 1.967]
   [ 50., 2.761]
   [ 95., 4.968]]
  
```



# FREEWAT CAPACITY BUILDING

Large stakeholders involvement (>>>220 stakes involved )

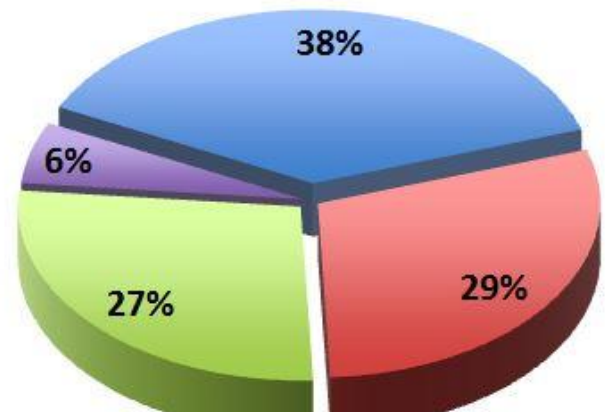
Web social and professional networks

(linkedin group >500 followers – twitter: >500 followers @h2020freewat)

More than 7000 unique visits per year at the web site

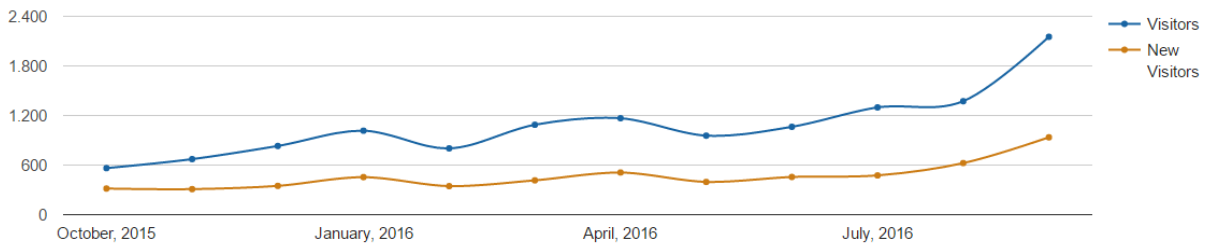
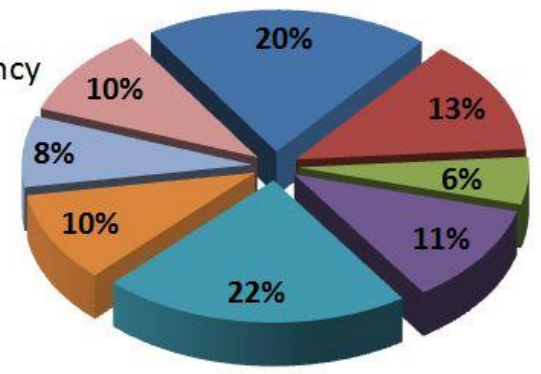
Area of interest

- Water quality
- Water policies
- Contaminated site remediation
- Other

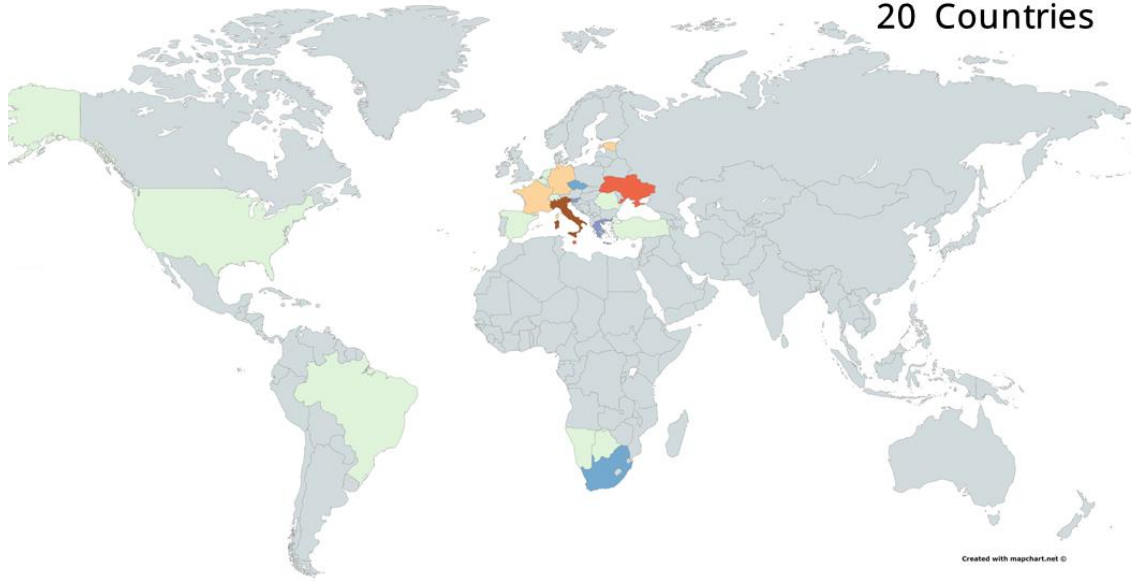


- Research
- River basin authority
- Environmental protection agency
- Water utility
- National authorities
- Local authorities
- Geoenvironmental company

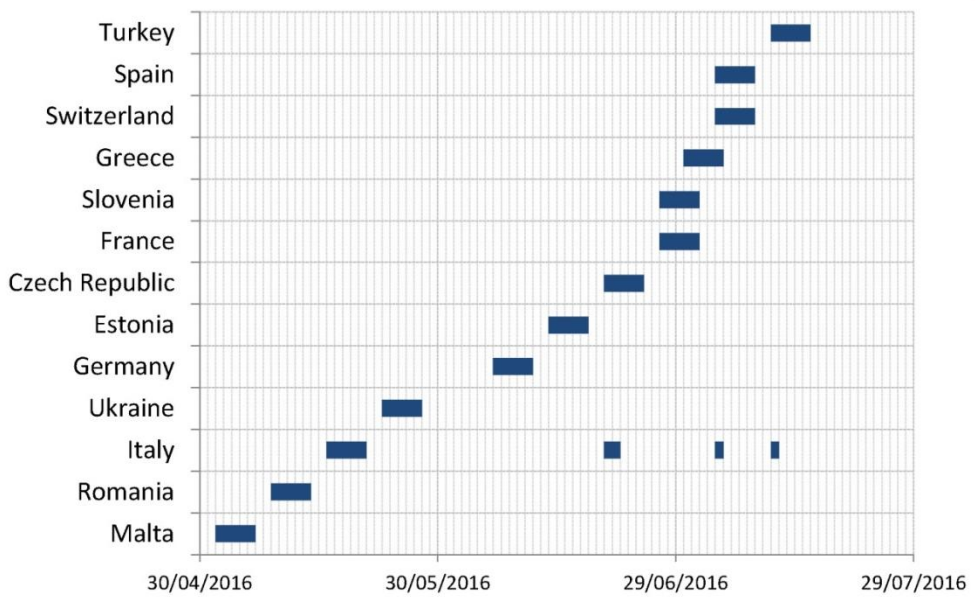
Type of Institution



# CAPACITY BUILDING



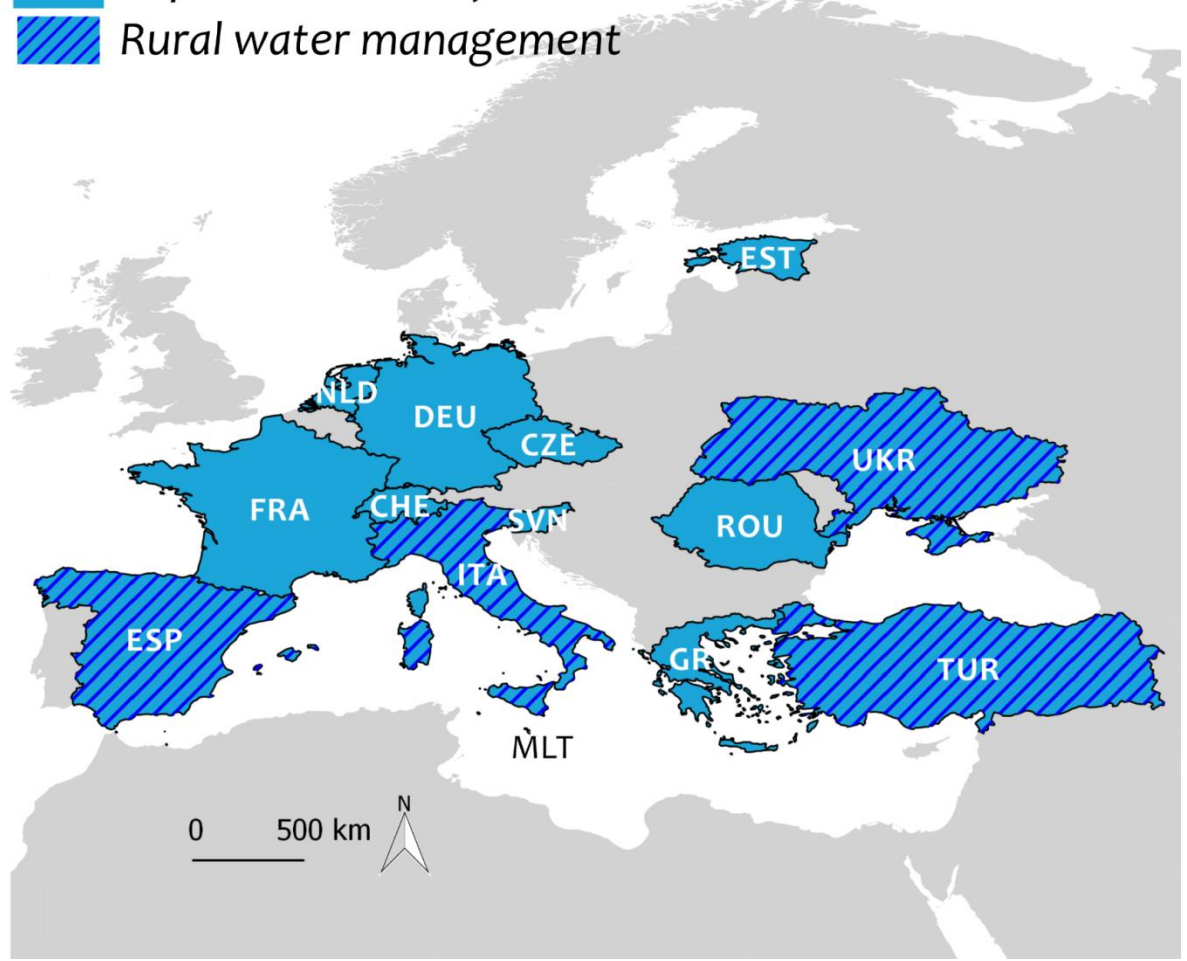
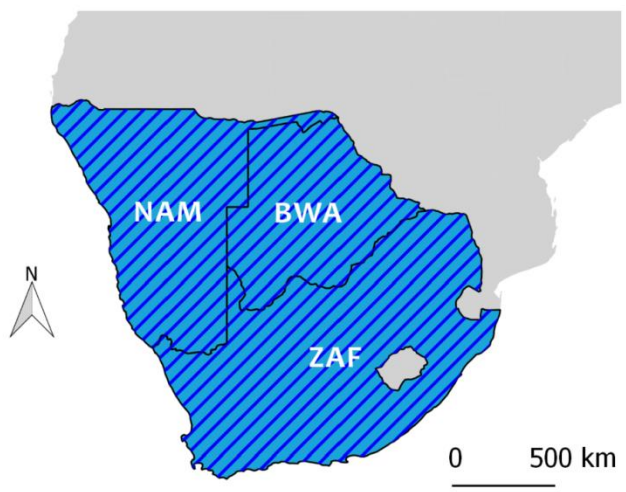
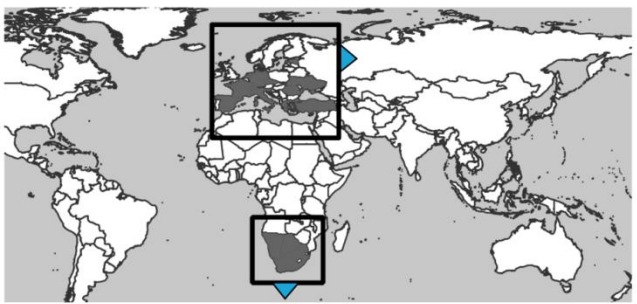
ERU (Kayseri, Turkey)



UNESCO and IGRAC (Paris, France)

# FREEWAT CASE STUDIES

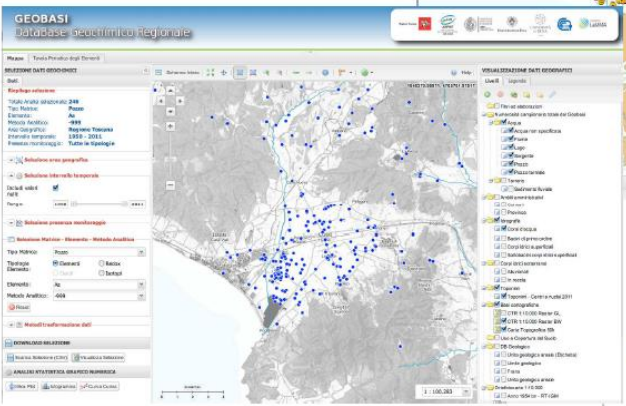
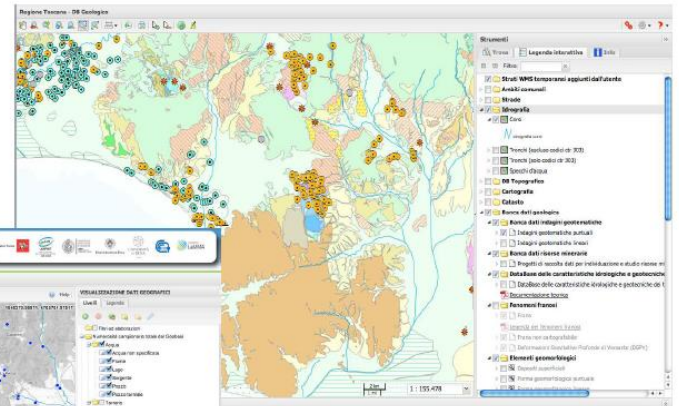
Implementation of the Water Framework Directive  
 Rural water management



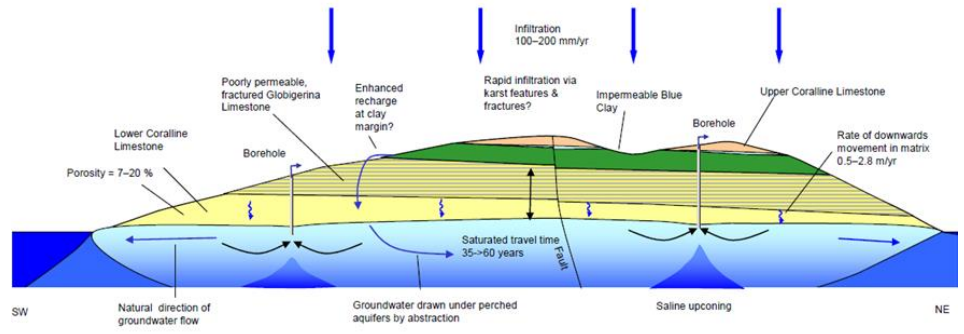
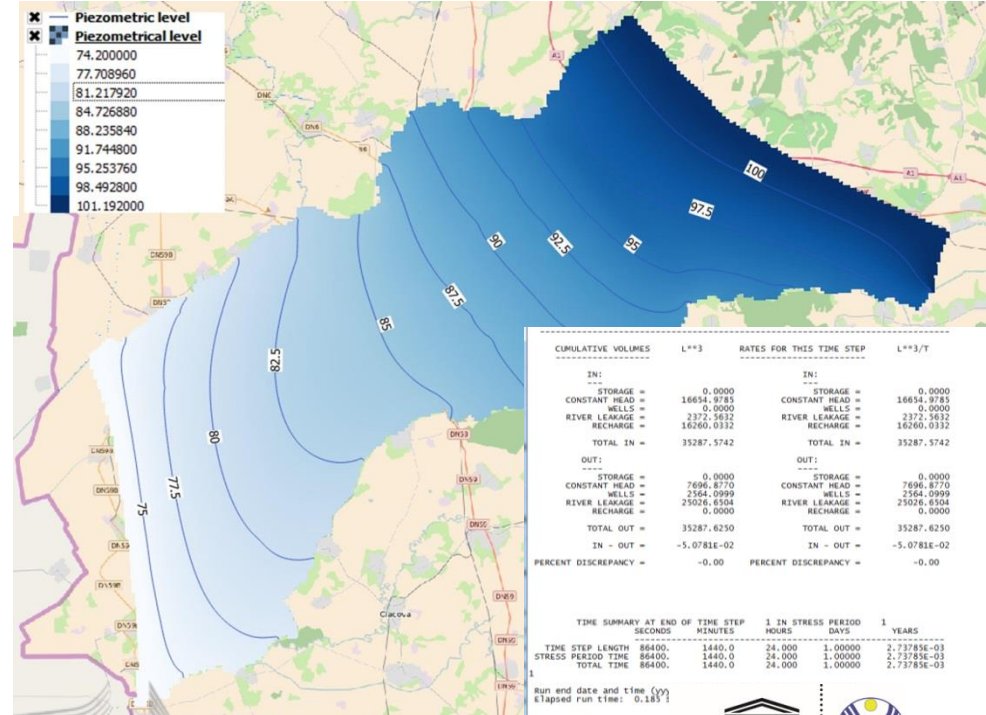
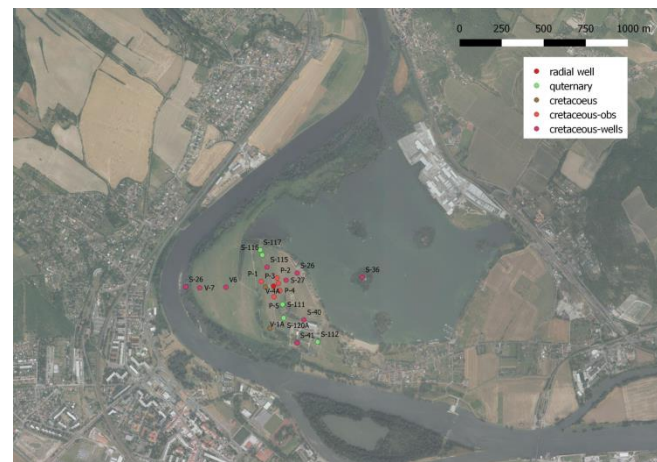
# Addressing WFD and GWD issues

## Regione Toscana web services

**Geoscopio**  
<http://www.502.regione.toscana.it/geoscopio/geologia.html>

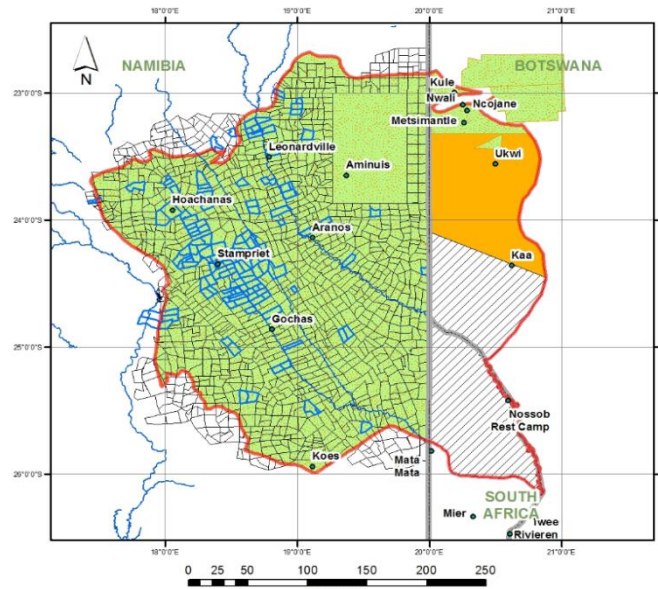
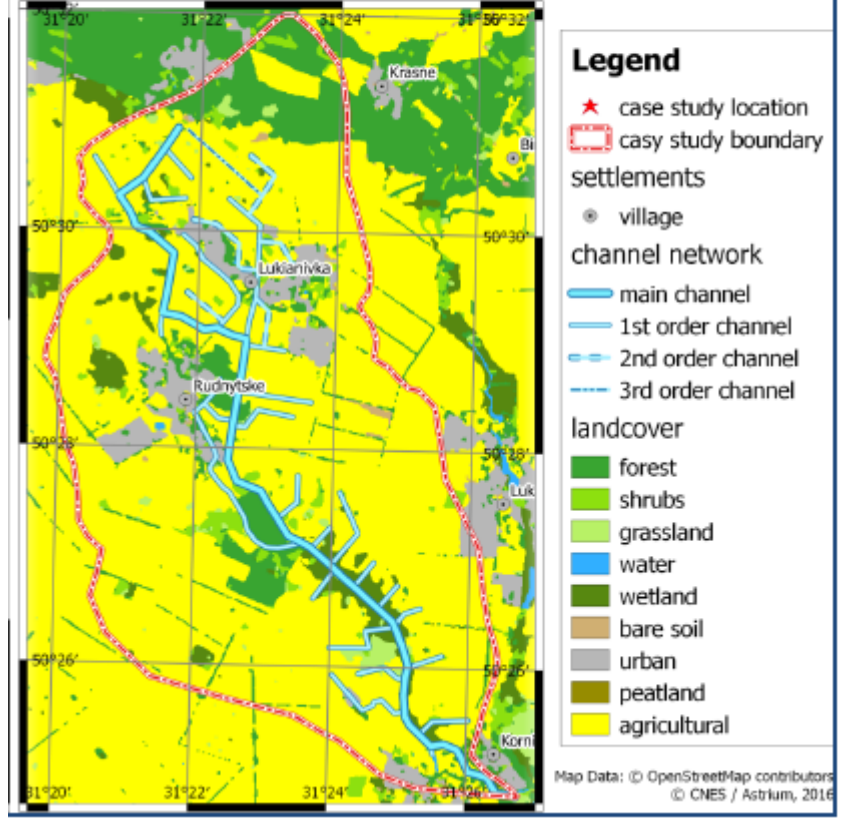
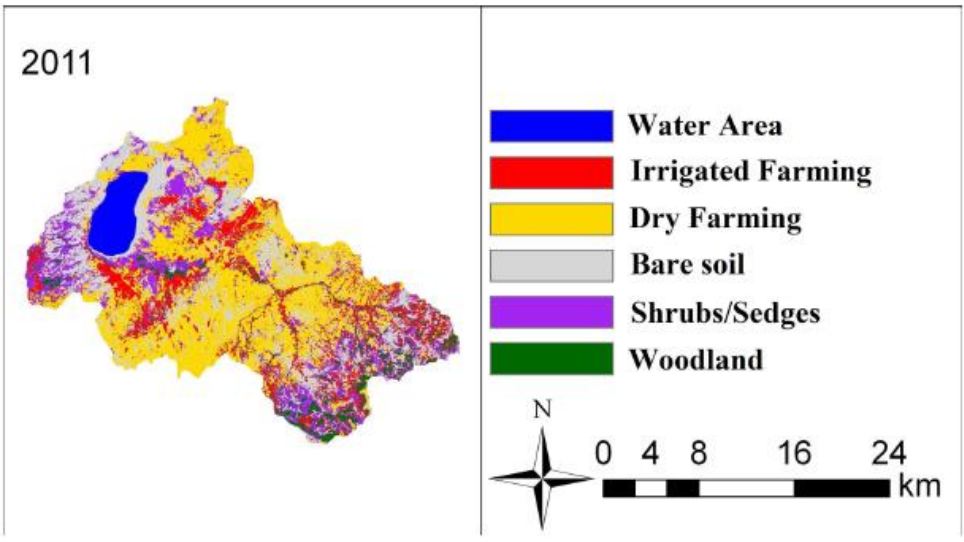


**Geobasi**  
<http://www.506.regione.toscana.it/geobasi/index.html>





# Addressing rural water management




Stampriet Transboundary Aquifer System Land Use



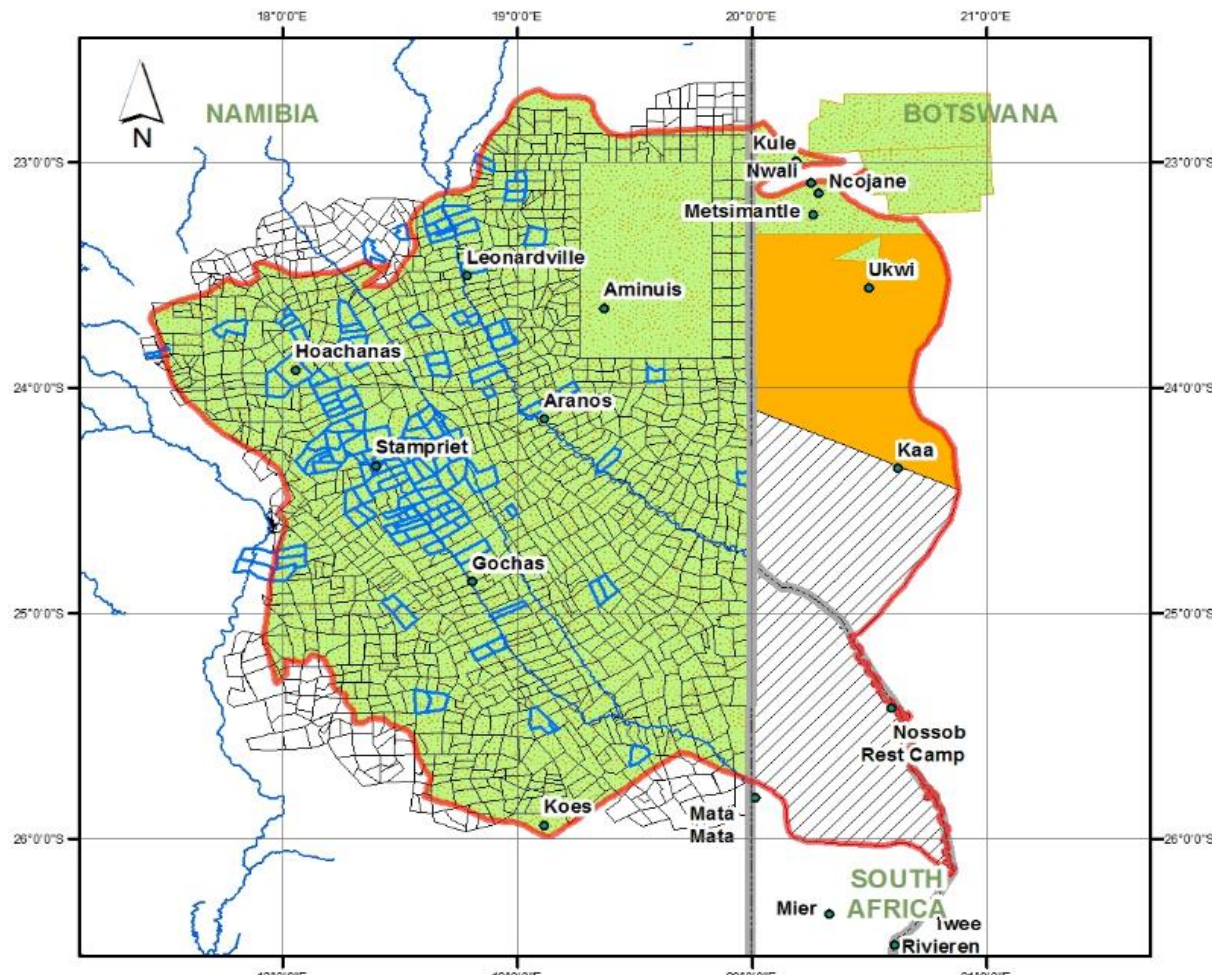
# Land use in the STAS

The STAS is a large farming area with approximately 1200 farms (mostly in Namibia), out of which 80 are irrigation farms

Groundwater use: 52% irrigation, 32% stock watering, 16% domestic use

No mining and industrial activities

Area lightly populated (approximately 50 000 inhabitants)



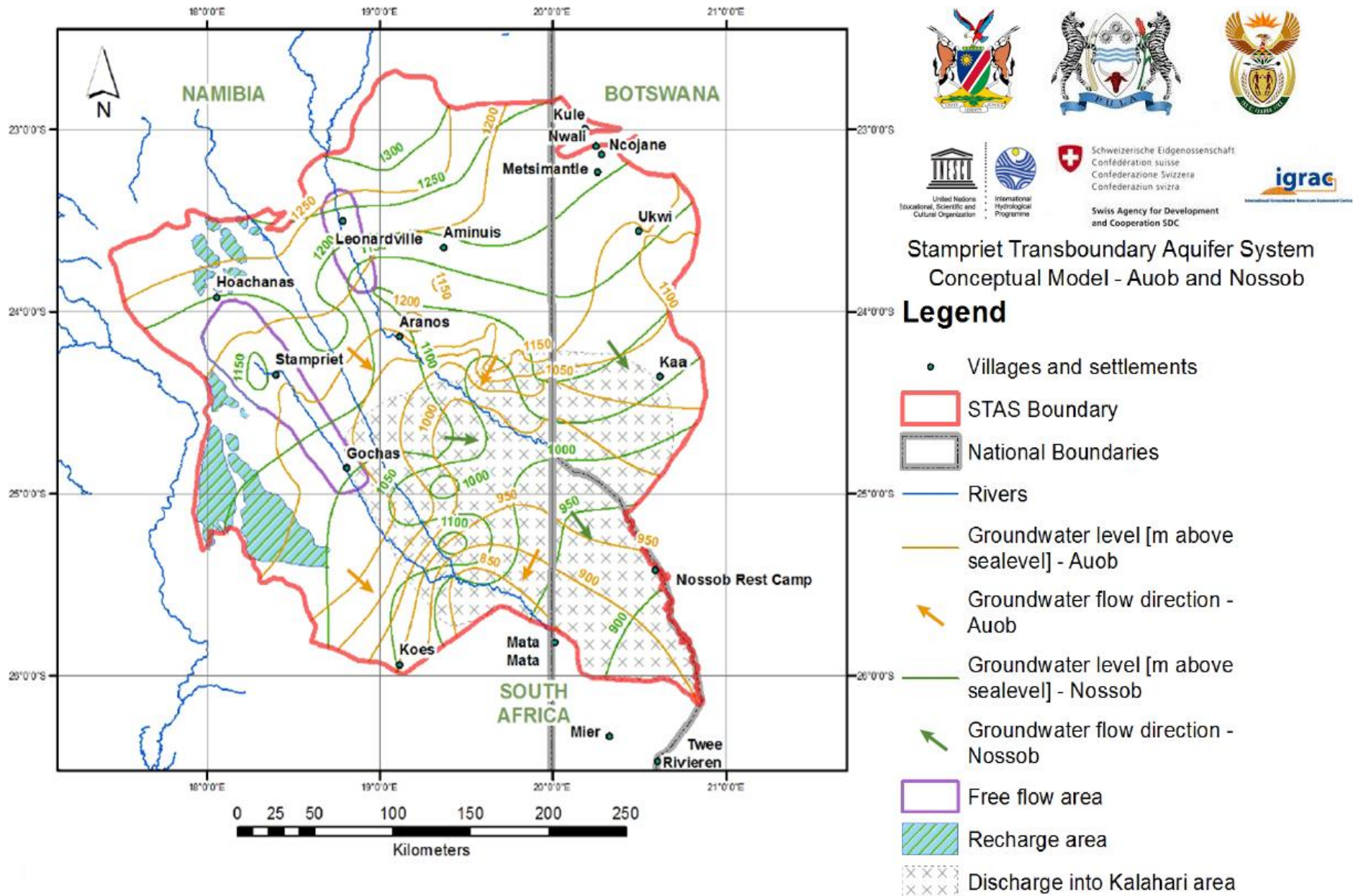
Stampriet Transboundary Aquifer System  
Land Use

## Legend

- Villages and settlements
- STAS Boundary
- National Boundaries
- Rivers
- Farms with irrigation areas
- Farms delineation
- Land use**
  - Agricultural Land
  - National Park
  - Wildlife Management Area

# STAMPRIET AQUIFER SYSTEM

## Auob and Nossob aquifers (confined):



Schweizerische Eidgenossenschaft  
Confédération suisse  
Confederazione Svizzera  
Confederaziun svizra



# Landscapes

The STAS is characterized by various landscapes, including sand dunes in Namibia and South Africa, calcrete/sandy surface area with shrubs and in some cases thick bushes. Seasonal pans are also important features found across the STAS.



*Common landscapes in the STAS: dune area stretching from the Auob to the Nossob*

*River (top left), calcrete/sandy surface where pans are quite common (top right), deep cut in the Auob and Nossob Rivers (bottom center) (Source: J. Kirchner)*



# FREEWAT and Nitrates Directive



The EU Nitrates Directive aims to prevent nitrates from agricultural sources polluting ground and surface waters.



The directive forces member states to develop action programs and to declare “Nitrates Vulnerable Zones” (NVZs); there prevention measures are compulsory to farmers, as part of CAP cross-compliance.

Although it is very difficult to estimate the actual nitrate leaching due to a specific fertilizer and irrigation management, FREEWAT brings an opportunity to simulate such leaching from each farm.



Zeta Amaltea has a similar previous experience in a LIFE project



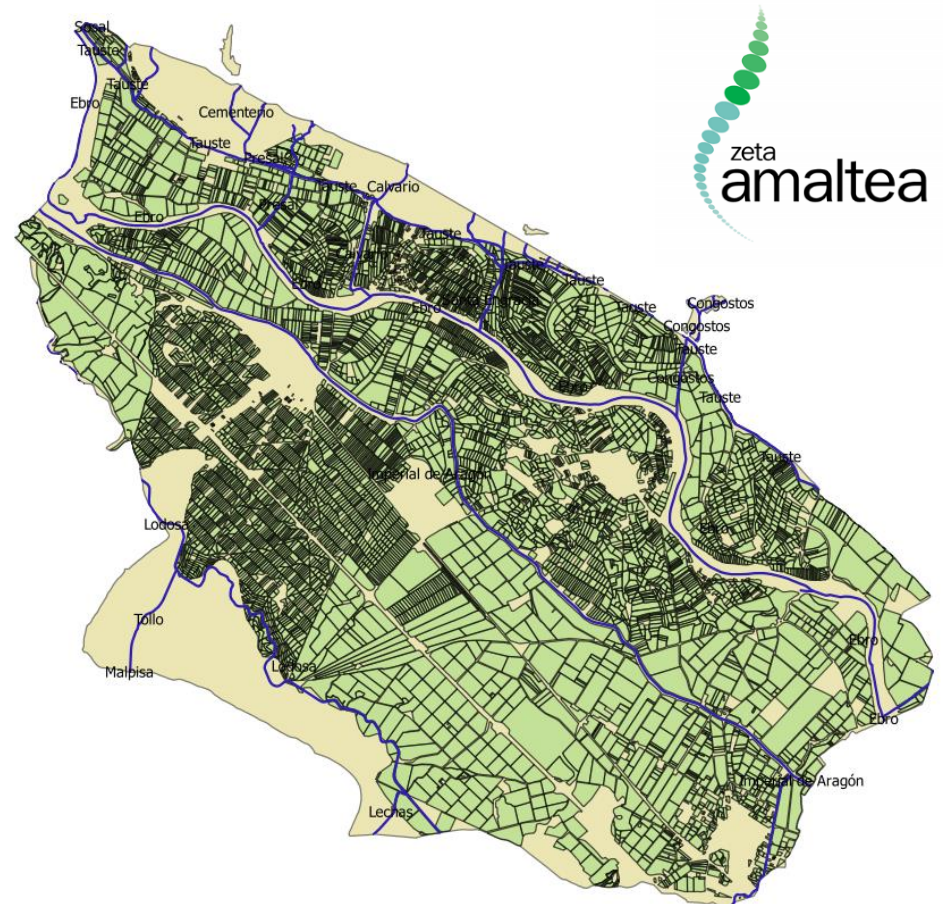
# Case study: Nitrates Directive

FREEWAT as a tool to evaluate reliability of action programs

Zeta Amaltea will use CAP data, soil maps and local irrigation and fertilizer managements to simulate nitrate pollution of groundwater.

The EU member states have to review NVZ designation and the effectiveness of their action programs every 4 years. FREEWAT could be the right tool to conduct such evaluations.

Zeta Amaltea seeks for FREEWAT future developments, as a business opportunity!



# PARTICIPATORY APPROACH

## Relevant part of the FREEWAT approach

At each case study a FOCUS GROUP is set

It includes all relevant stakeholders dealing with water and not only.

<i>Type of stakeholder</i>	<i>Name of stakeholder</i>
Local /governemnt	Regione Toscana
River Basin authority	Autorità di Bacino del Fiume Serchio
River Basin authority	Autorità di Bacino del Fiume Arno
Environmental Protection Agency	Agenzia Regionale di Protezione Ambientale Toscana
Land managers	Consorzio di Bonifica Toscana Nord
Municipality	Comune di Vecchiano
Water utility	ASA spa
Water utility	GAIA spa
	Ingegnerie Toscane
	Servizio idrologico Regionale
Natural area/protected area	Parco Naturale Regionale Migliarino San Rossore Massaciuccoli
Farmer association	Confagricoltura
Farmer association	CIA
Farmer association	Coldiretti
Industrial association/Commerce Chamber	Camera di Commercio di Pisa, Camera di Commercio di Lucca
Environmental protection association	WWF
Environmental protection association	LIPU
Environmental protection association	Legambiente
Research	University of Pisa

# PARTICIPATORY APPROACH

## Relevant part of the FREEWAT approach

At each case study a FOCUS GROUP is set

These will meet at least 7 times and aim at include the society in the technical part of the game.

Aim also at demonstrating at the general level that water resource management and planning may be performed with open source and public domain sw

This is a common space for the participants to bring their experience and values in order to generate at case studies scale a shared knowledge on the value of water.







# Guidance on model-supported application

To promote a consistent and sound approach to the development of ICT-based application of EU water related Directives with a special focus on water quantity and quality issues.

To collect and publish the outcomes of the test sites analysis in a report named "Guidance on model-supported application of EU water related Directives for water quantity and quality".

This report will be a proposal for a reference document at the European level to be used as support for decision makers dealing with Water Resources Management (WRM).

The Guidance will define "best practices" for using GIS-based numerical modelling tools as fundamental instrument for preparing water management plans.





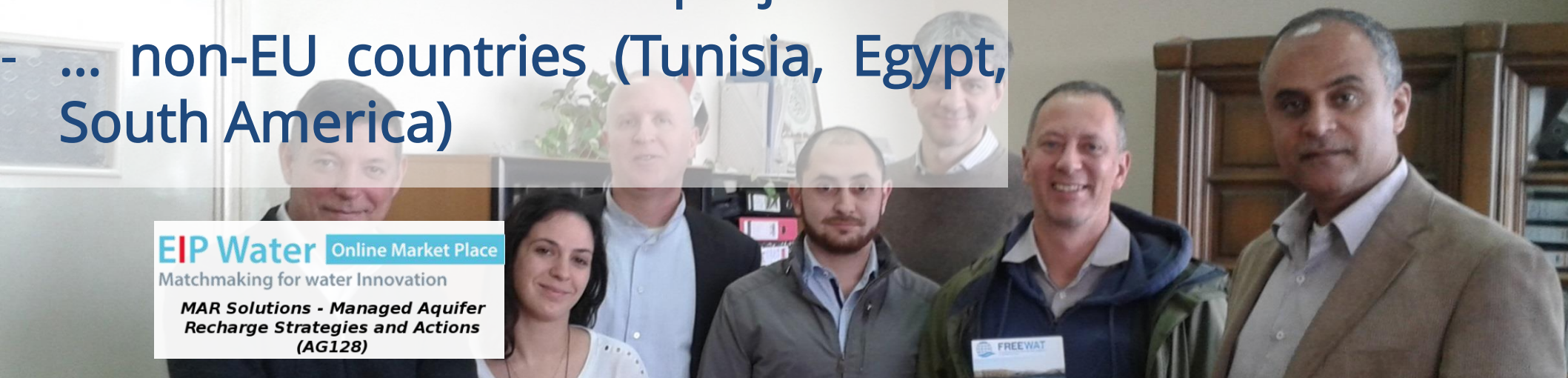
# FREEWAT Synergies



- H2020 sister projects
- FP7 MARSOL
- LIFE REWAT - other LIFE projects
- ... non-EU countries (Tunisia, Egypt, South America)



**EIP Water** Online Market Place  
 Matchmaking for water Innovation  
**MAR Solutions - Managed Aquifer Recharge Strategies and Actions (AG128)**



**UNESCO's Hydro free and/or Open-source software Platform of Experts (HOPE)**



**Barely every week new interest and request for cooperation**



# FREEWAT CONCLUSIONS FREEWAT

- Unite the power of GIS geo-processing and post-processing tools in spatial data analysis to that of simulation software
- Public authorities have the chance to build a high informative and dynamically growing representation of a hydrologic system where performing planning analysis
- WRM modules for decision-making and policy applications
- No cost for licences (money can be moved to development of client tailored applications>>>> *new companies and jobs*>>>SDG8)





# FREEWAT

Free and Open Source Software Tools for Water Resource Management  
EU HORIZON 2020 Project



# ict4water.eu



## SUSTAINABLE DEVELOPMENT GOALS

17 GOALS TO TRANSFORM OUR WORLD

# Thank you!



### GROUNDWATER MANAGEMENT INSTITUTE

**EIP Water** Online Market Place  
Matchmaking for water Innovation  
*MAR Solutions - Managed Aquifer Recharge Strategies and Actions (AG128)*

## FREEWAT - Free and Open Source Software Tools for Water Resource Management

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