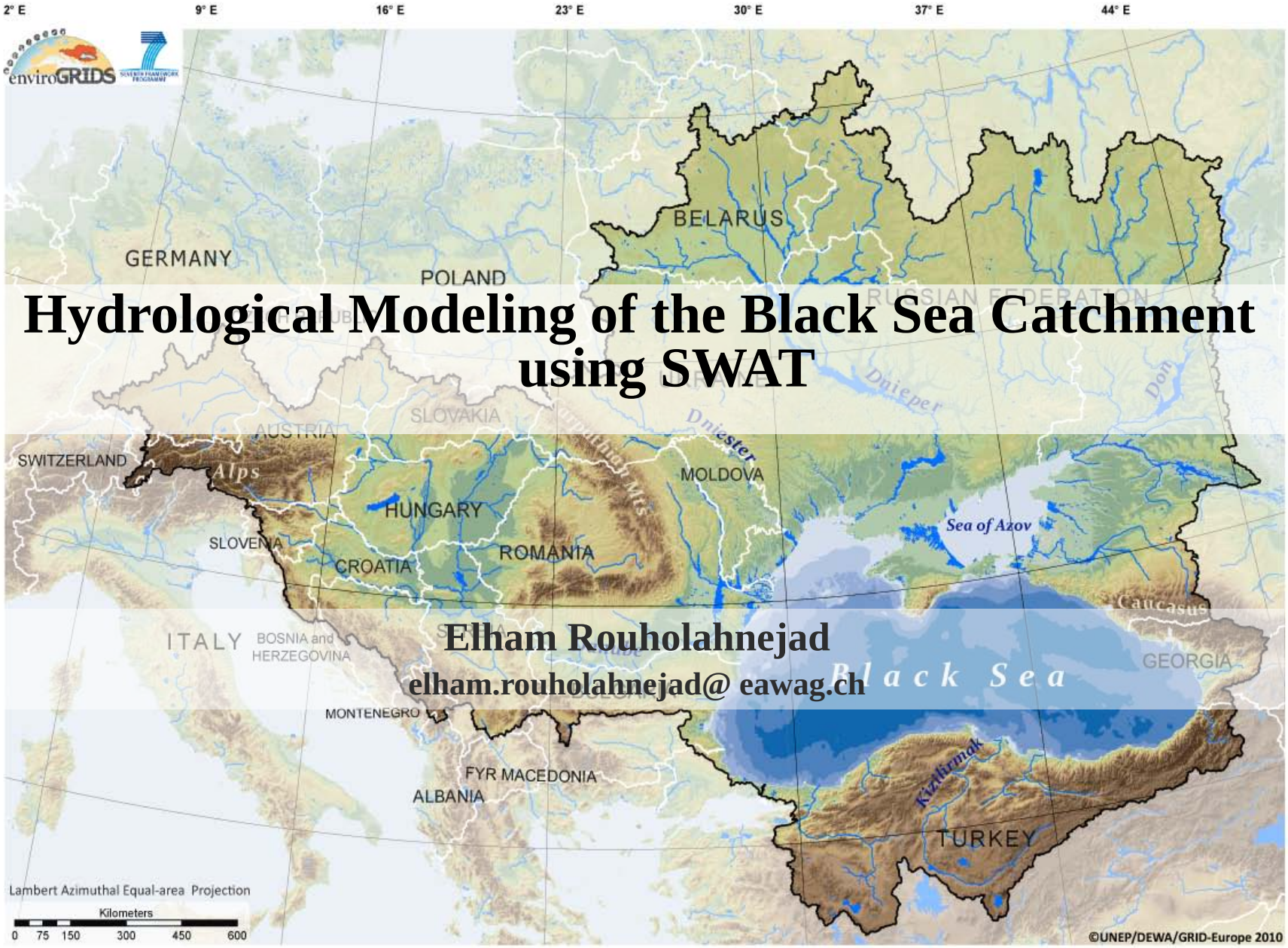


# Hydrological Modeling of the Black Sea Catchment using SWAT

**Elham Rouholahnejad**

**elham.rouholahnejad@ eawag.ch**

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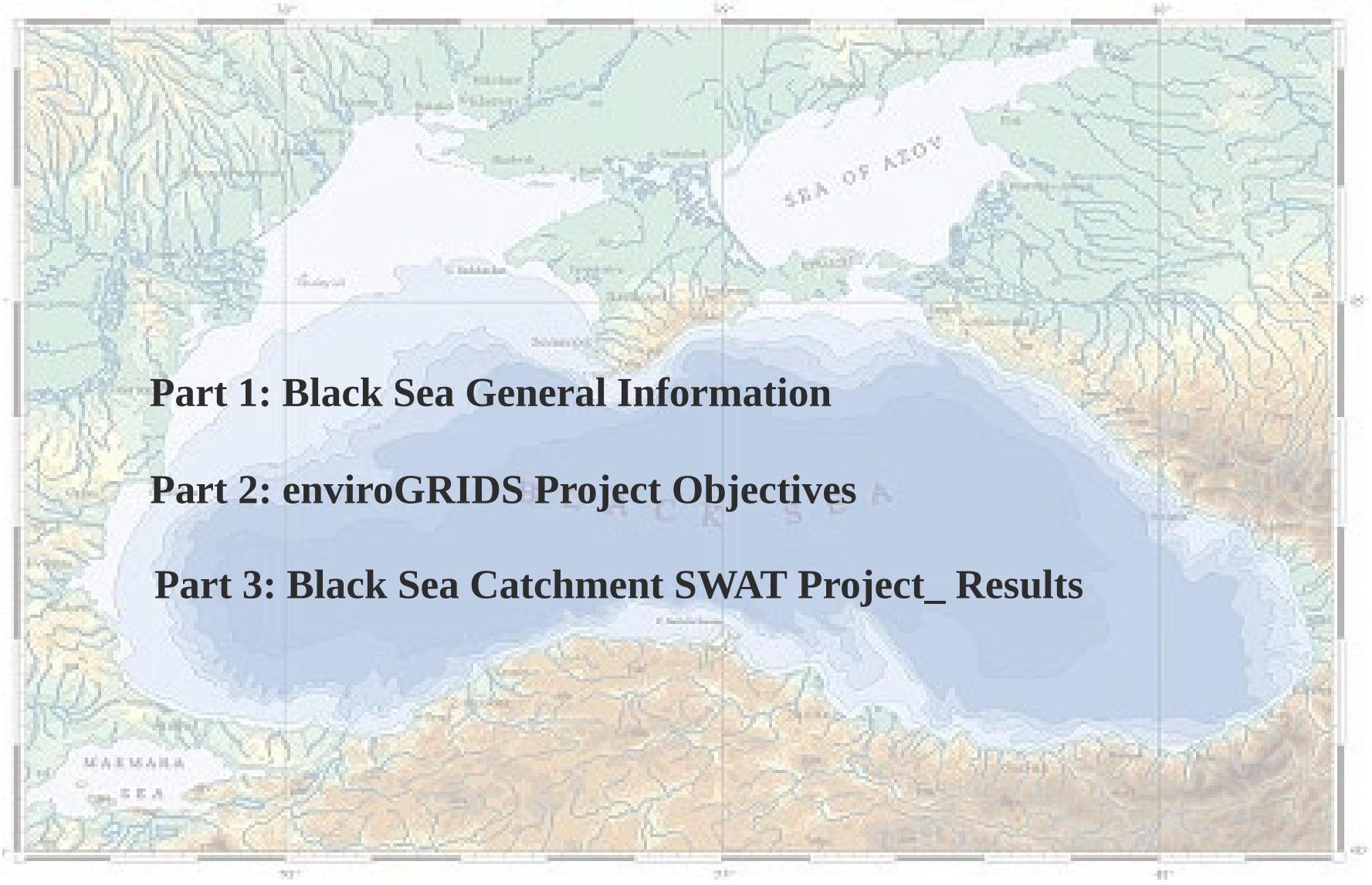
ETH Eidgenössische Technische Hochschule Zürich Swiss Federal Institute of Technology Zurich

**South Korea, August, 2010**

# Content:




**Part 1: Black Sea General Information**

**Part 2: enviroGRIDS Project Objectives**

**Part 3: Black Sea Catchment SWAT Project_ Results**

# Part 1: Black Sea

## Black Sea General Information

# Where is Black Sea

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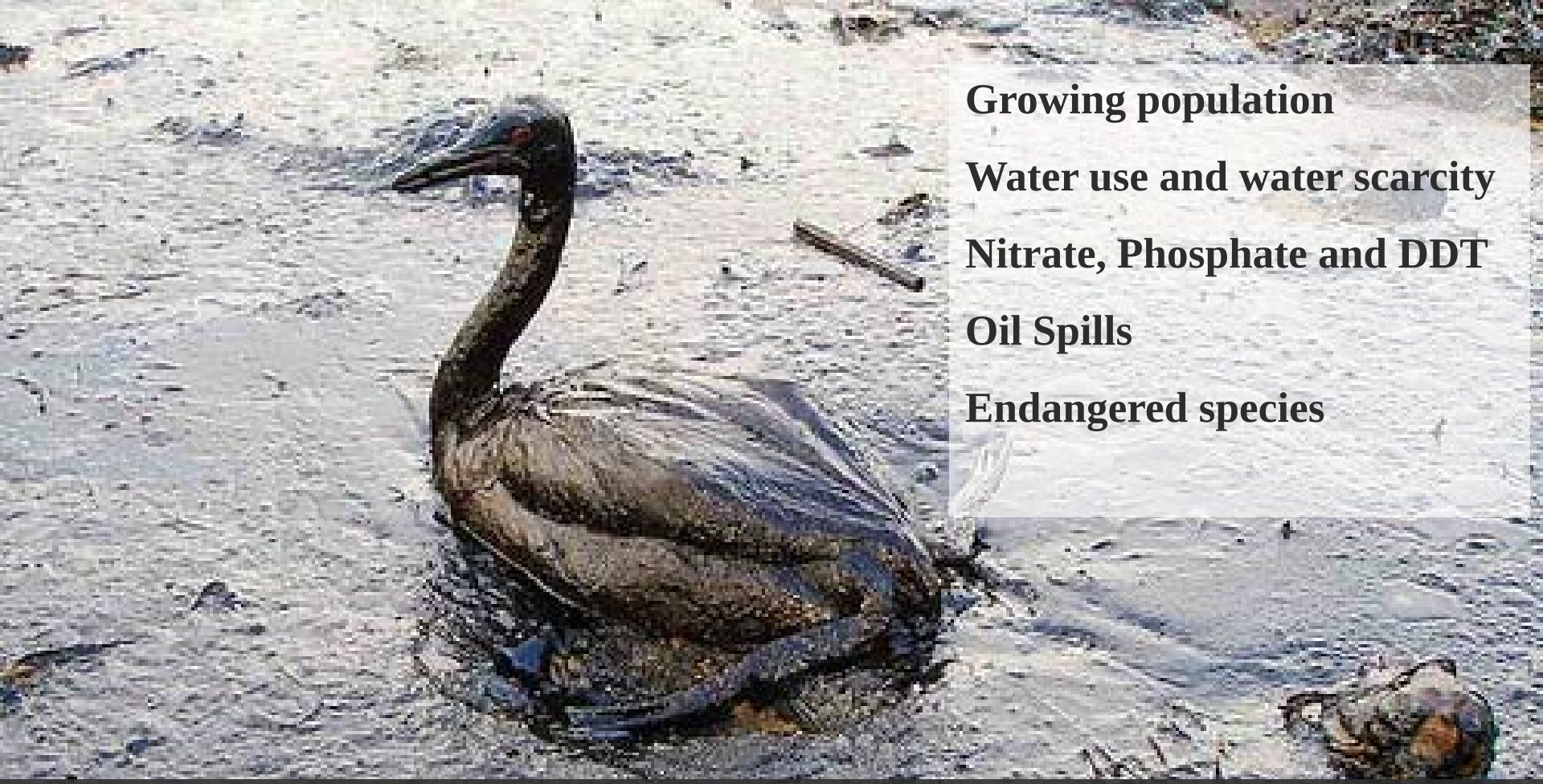

**Growing population**

**Water use and water scarcity**

**Nitrate, Phosphate and DDT**

**Oil Spills**

**Endangered species**

• Black sea has a really badly managed and unsustainable ecosystem and environment.

• With the large population growth and increasing food requirements and the existing fresh water availability and the existing water quality, we have a severe water problem in Black sea region.

• Because of large existing problems in the region,  lots of projects was funded in black sea region.

# Part 2: enviroGRIDS

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## Building Capacity for a Black Sea Catchment Observation and Assessment System supporting Sustainable Development

***Content:***

Introduction to enviroGRIDS

enviroGRIDS Objectives

enviroGRIDS Work packages

3 main Steps in enviroGRIDS project

Analyses Pipeline

enviroGRIDS information dissemination

Coordination team : UNIGE and UNEP/GRID
Coordinator: Dr. Anthony Lehmann
Duration : April 2009- March 2013

Consortium: 27 partners, 15 countries

Total budget: 7.9M€

# Introduction to enviroGRIDS

## A team work by the enviroGRIDS consortium…

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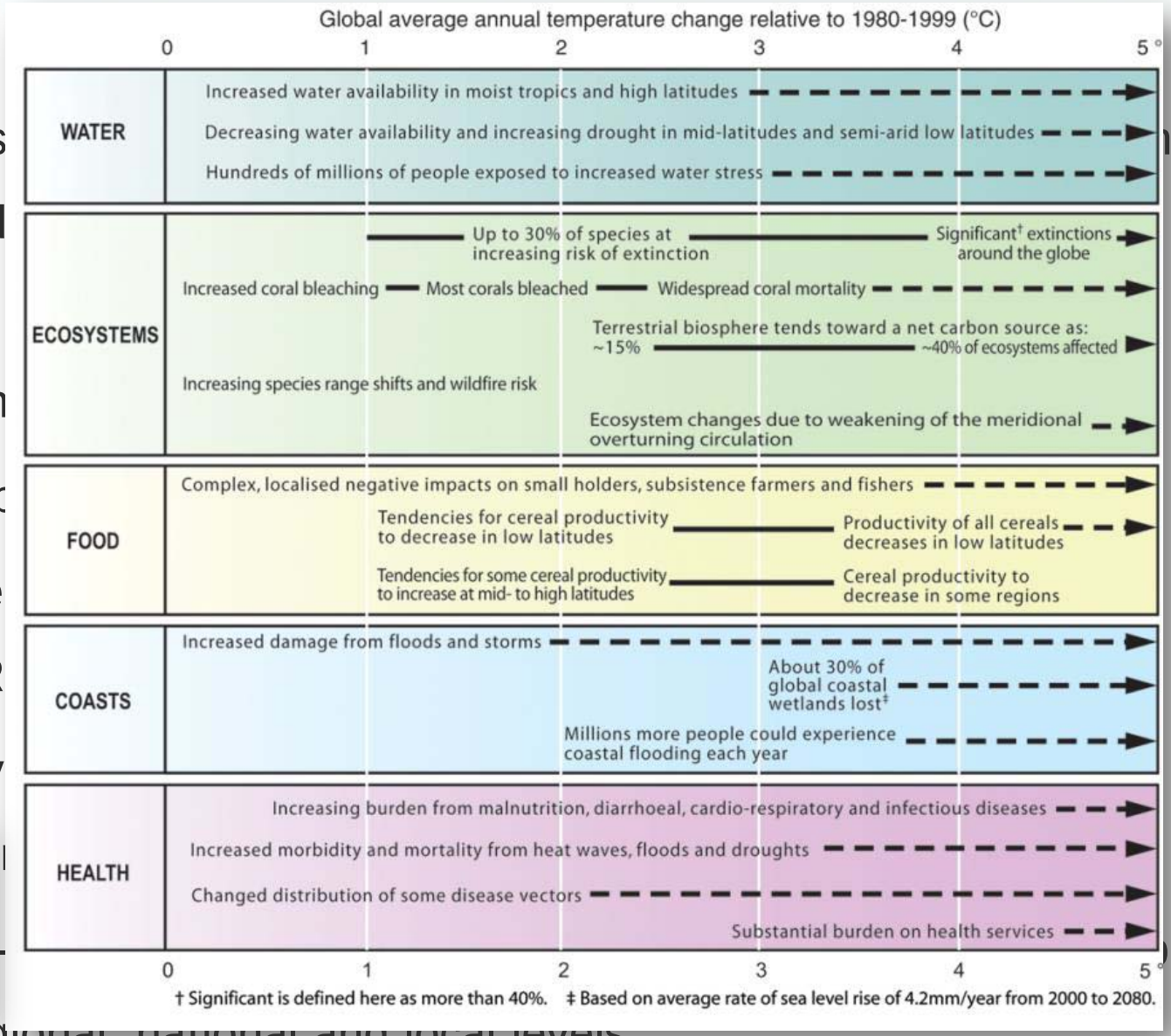
# What is enviroGRIDS about?

...exploring the past, present and future (hydrology) of the Black Sea catchment

...build the capacity of **scientists** to observe the environment, the capacity of **decision-makers** to use it, and the capacity of the **public** to understand the issues at stake

# enviroGRIDS Objectives

## *3 main Steps in enviroGRIDS project*

### *Carrying out the project*

**1. Model the hydrology**

**2. Store and process large amount of data**

**3. Share spatially explicit data**

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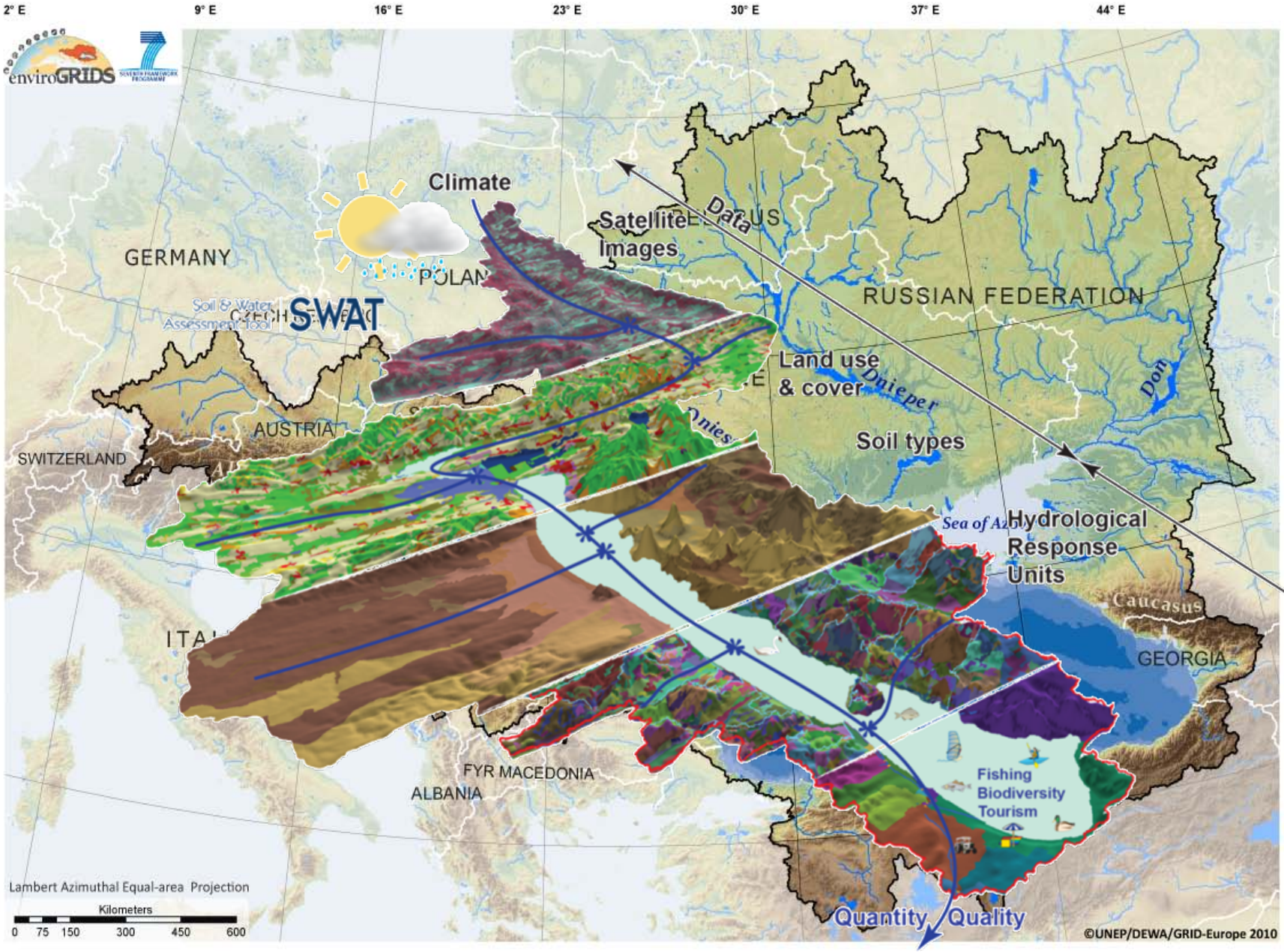
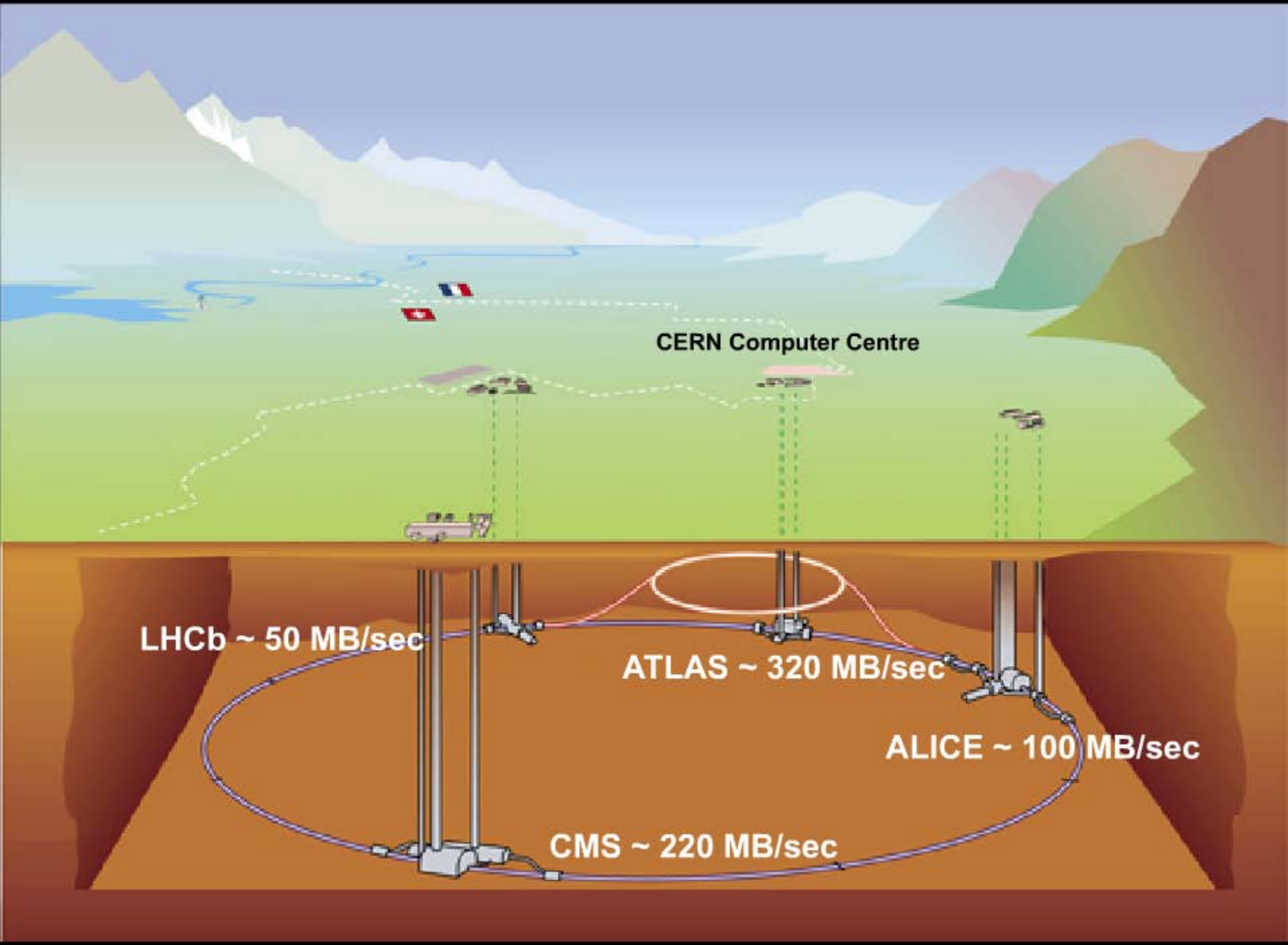
# How can we model the hydrology?

Soil & Water Assessment Tool | SWAT

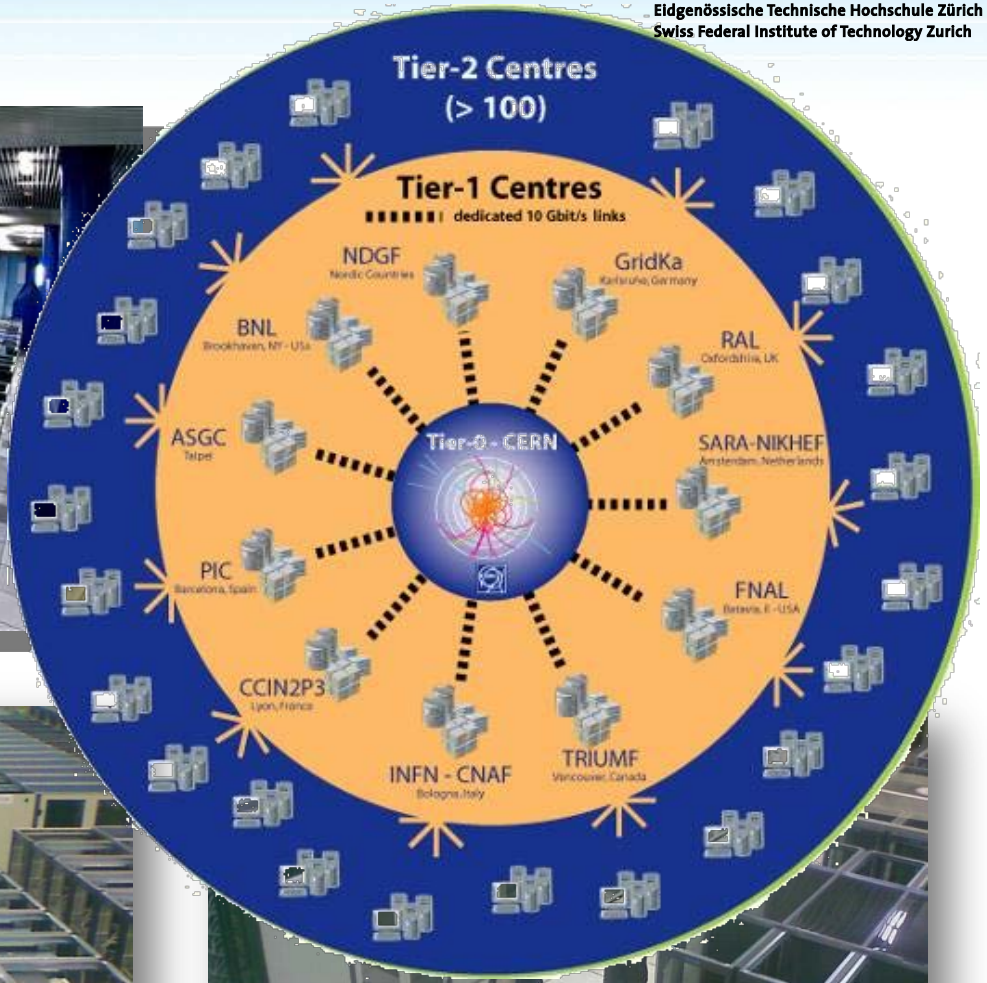

2° E
9° E
16° E
23° E
30° E
37° E
44° E
50° N
45° N
40° N
enviroGRIDS
Climate
Satellite Images
Data
GERMANY
POLAND
RUSSIAN FEDERATION
Soil & Water Assessment Tool
SWAT
Land use & cover
Soil types
Dnieper
Don
AUSTRIA
SWITZERLAND
Sea of Azov
Hydrological Response Units
Caucasus
GEORGIA
ITALY
FYR MACEDONIA
ALBANIA
Fishing
Biodiversity
Tourism
Quantity
Quality
Lambert Azimuthal Equal-area Projection
Kilometers
0 75 150 300 450 600
©UNEP/DEWA/GRID-Europe 2010

# Step 2: GRID technology

How can we store and process large amount of data?


CERN Computer Centre
LHCb ~ 50 MB/sec
ATLAS ~ 320 MB/sec
ALICE ~ 100 MB/sec
CMS ~ 220 MB/sec

# CERN super computer center

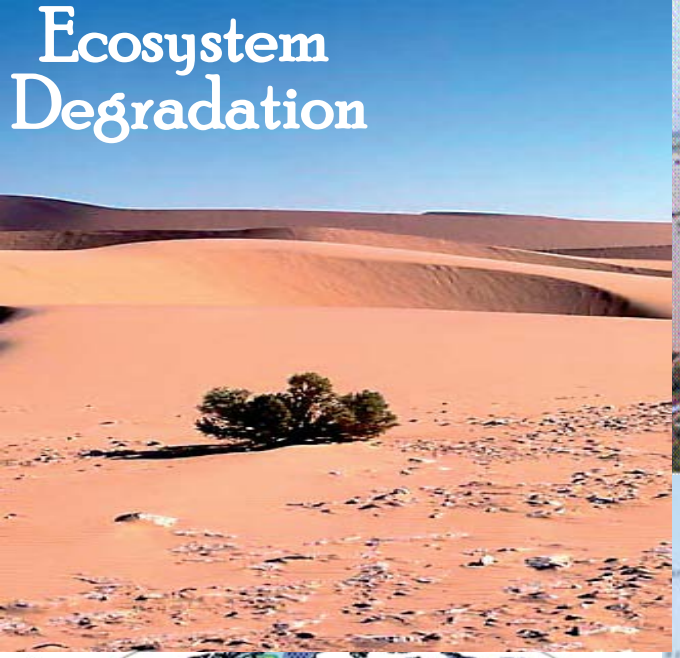



# Step 3: Spatial Data Infrastructure (SDI) & Group on Earth Observation System of Systems (GEOSS)

How can we share spatially explicit data?

GEO GROUP ON EARTH OBSERVATIONS

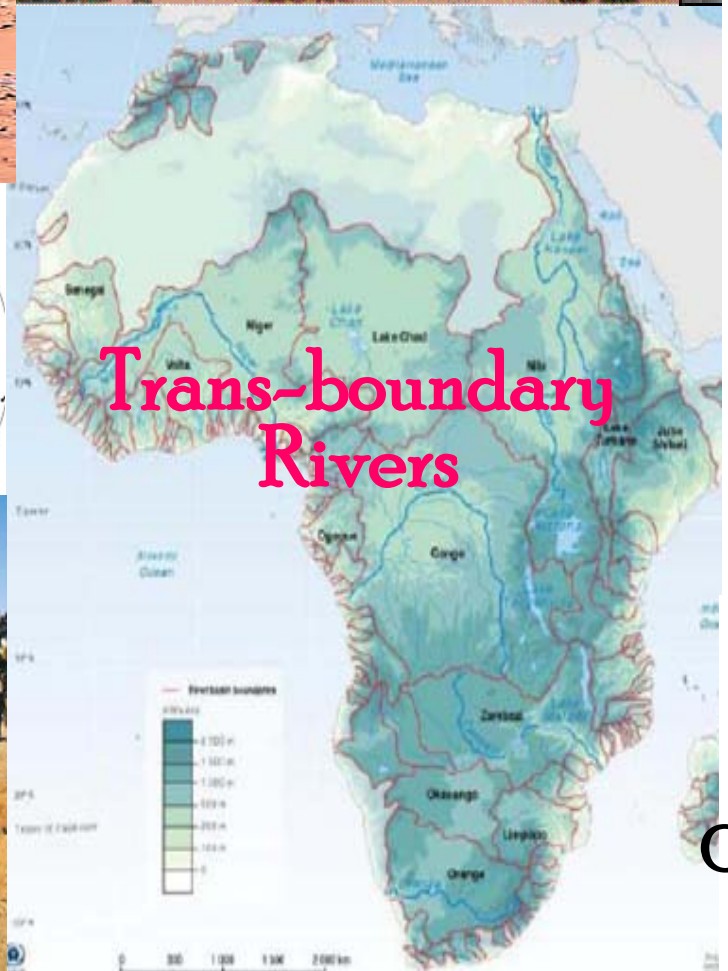
# GEOSS: A Global, Coordinated, Comprehensive and Sustained System of Observing Systems

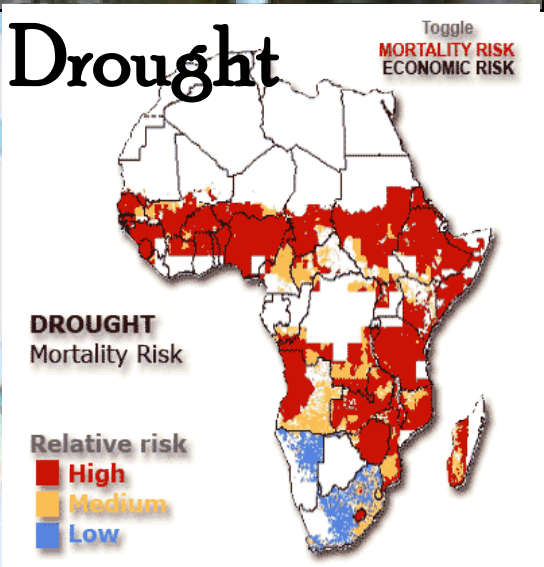

Ecosystem
Degradation

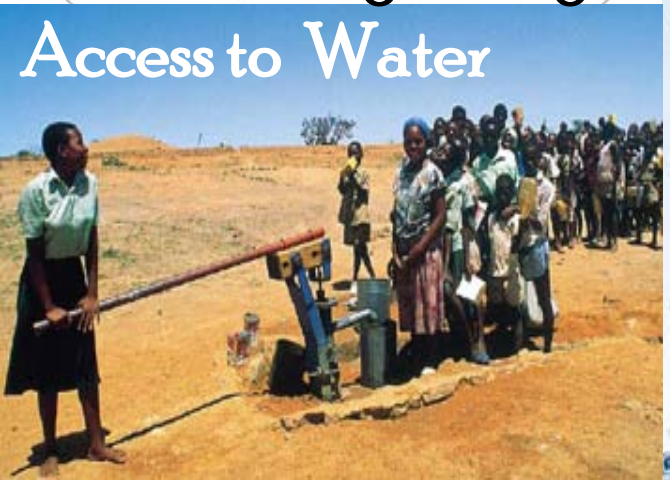

Flood

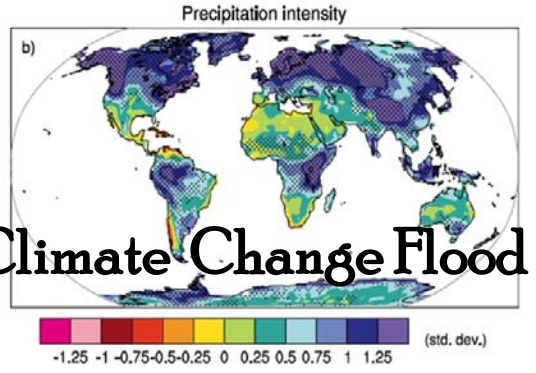

Health


d)
Climate Change Drought


Trans-boundary
Rivers


Drought
Toggle
MORTALITY RISK
ECONOMIC RISK
DROUGHT
Mortality Risk
Relative risk
High
Medium
Low
CLICK HERE FOR RISK MAP EXPLANATION


Access to Water


Precipitation intensity
b)
Climate Change Flood
(std. dev.)
-1.25 -1 -0.75 -0.5 -0.25 0 0.25 0.5 0.75 1 1.25

# Step 3: SDI & GEOSS

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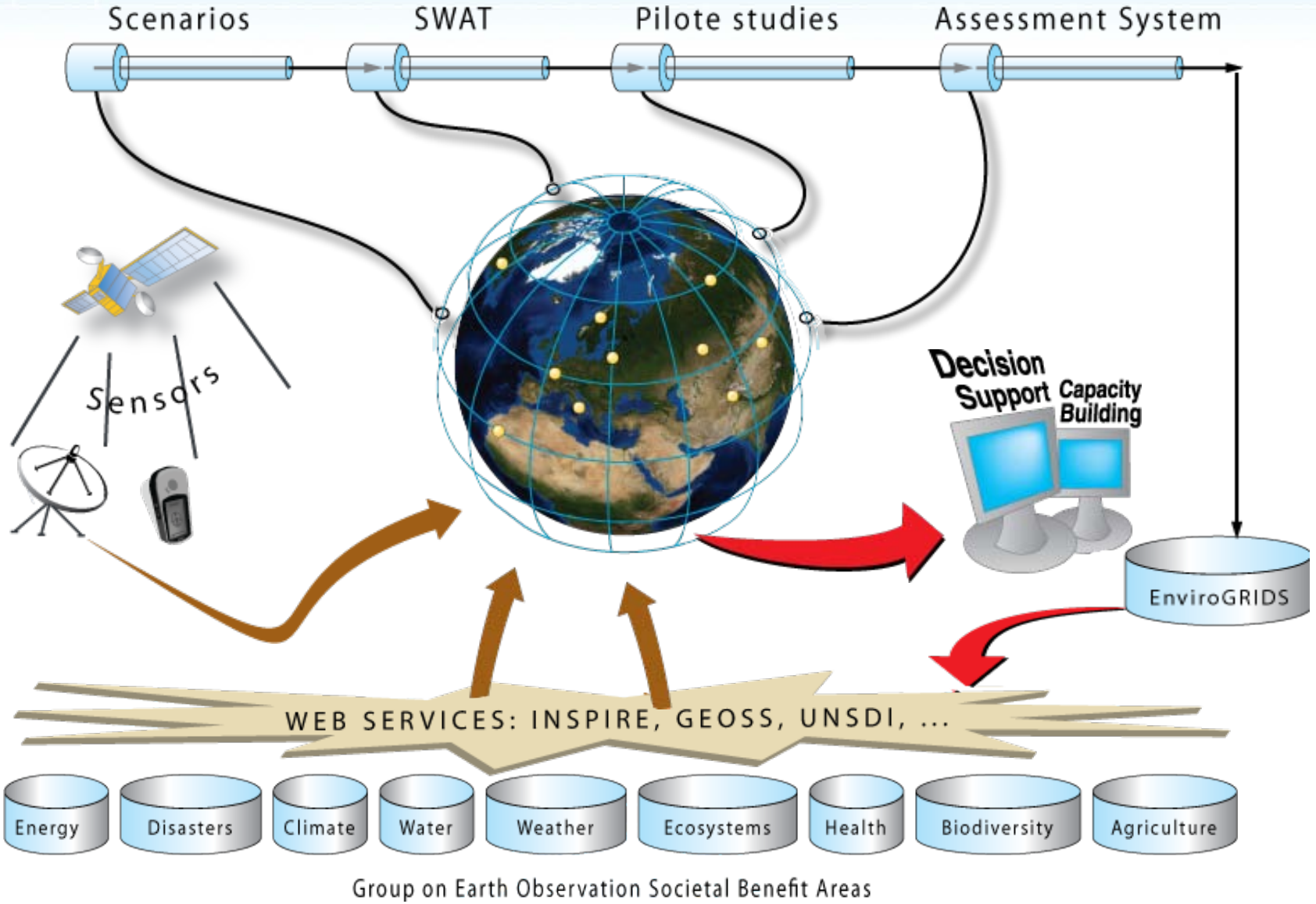
www.earthobservations.org

# Pipeline of analyses



# Part 3: Black Sea Catchment SWAT Project_ Results

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## Building a Hydrologic Model of the Black Sea Catchment

***Content:***

Project Deliverables and Objectives

BSC SWAT Project

Preliminary Results

Future Plans

# *Project Deliverables and Objectives*

**Data collection for SWAT to model spatial distribution of water resources in the BSC**

**Build, calibrate and validate a hydrologic model of BSC with uncertainty analysis using EGEE**

**Quantify the impact of land use and climate change on water quantity and water quality**

**Provide calibration scheme for the grid**

**Provide output visualization on Google Earth**

**Investigation of some issues with large-scale calibration of hydrologic models**

- **Model uncertainties**
- **Parameterization**
- **Input data resolution**
- **Impact of deriving input data (i.e., rainfall, temperature)**

# *Database for BSC*

# SWAT Data Needs

**Basic SWAT data requirement:**

- ✓ Dem
- ✓ Soil
- ✓ Landuse
- ✓ Climate
- ✓ Discharge

**More data requirement:**

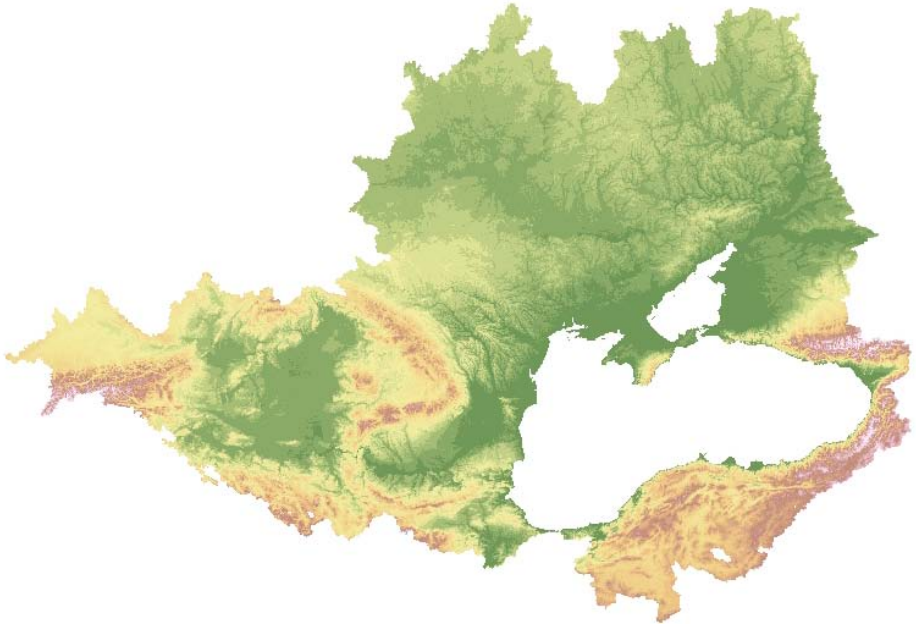
- ➢ Reservoir operation
- ➢ Inlet stations
- ➢ Agricultural management
- ➢ Water management
- ➢ Crop yield data
- ➢ Water quality at hydrometric stns
- ➢ Point sources

# SWAT Database

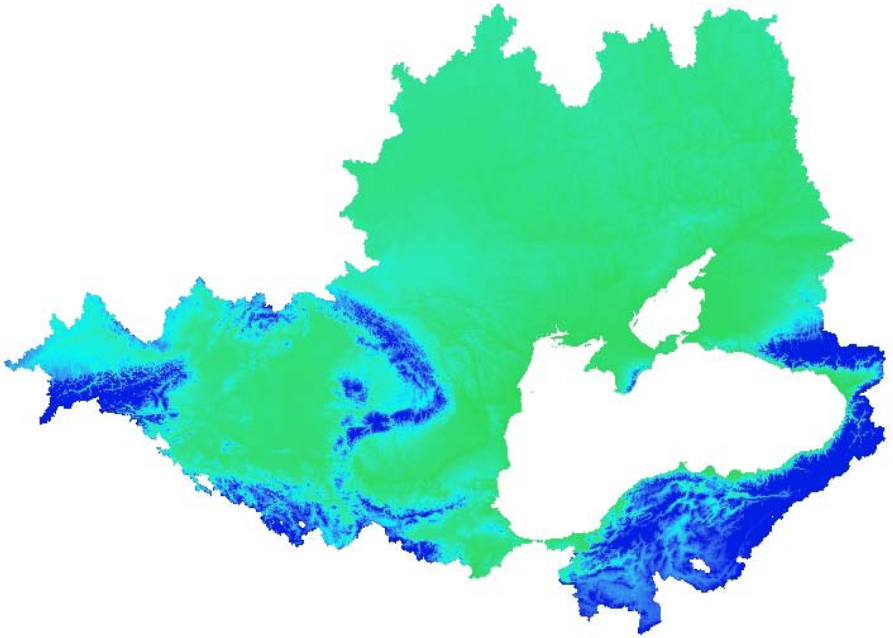
## DEM

**Spatial Resolution 1 km**

**Global DEM GOTOPO 30, USGS**



**Spatial Resolution 90 m (SRTM)**

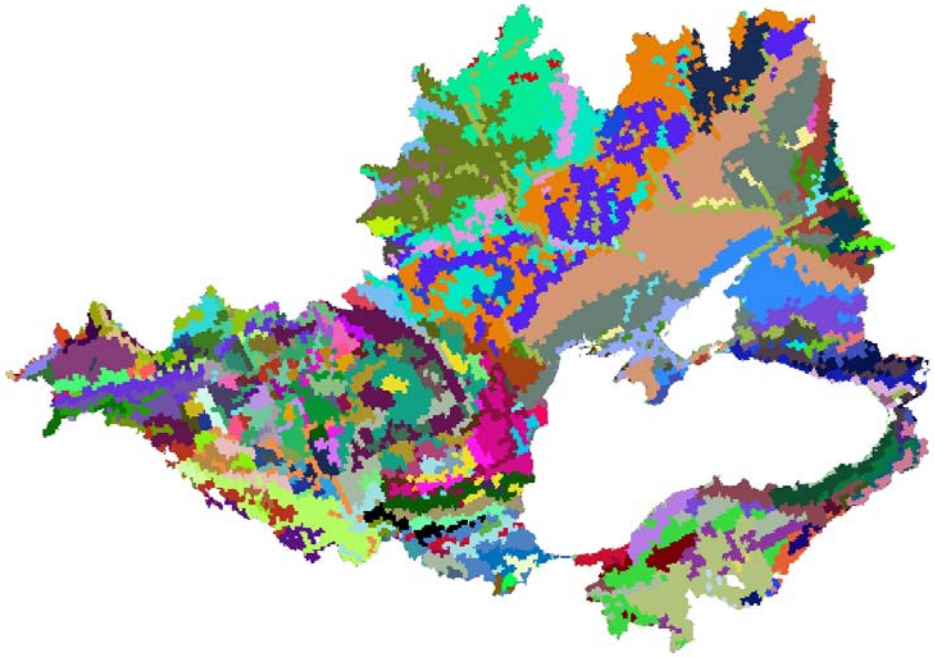


# SWAT Database

## Soil

**Spatial resolution 10 k**

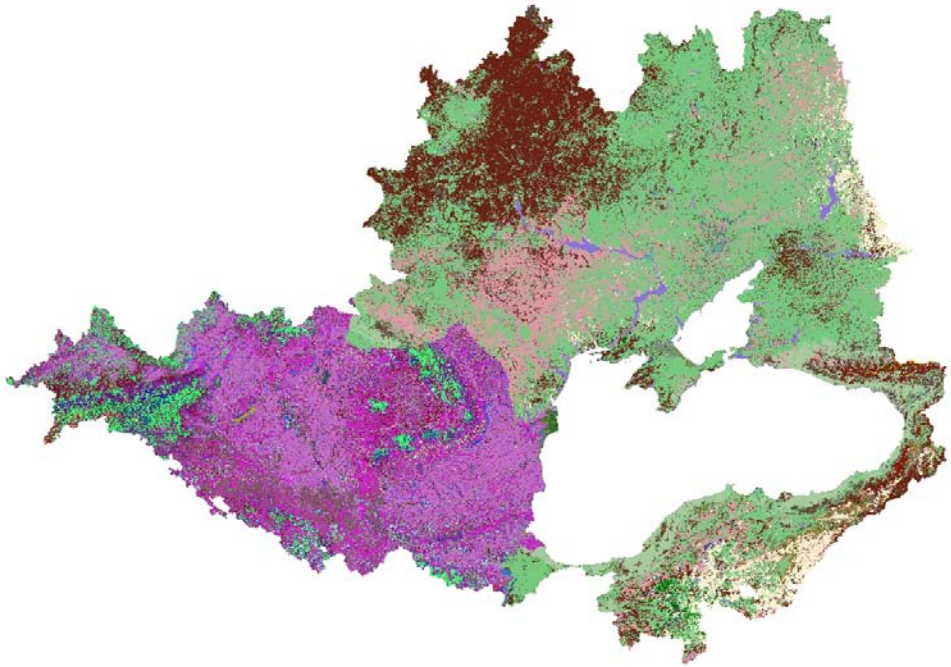
**Global Soil Map (FAO 1995)**



## Landuse

**Spatial resolution 100m – 1000m**

**CORINE + Global USGS**

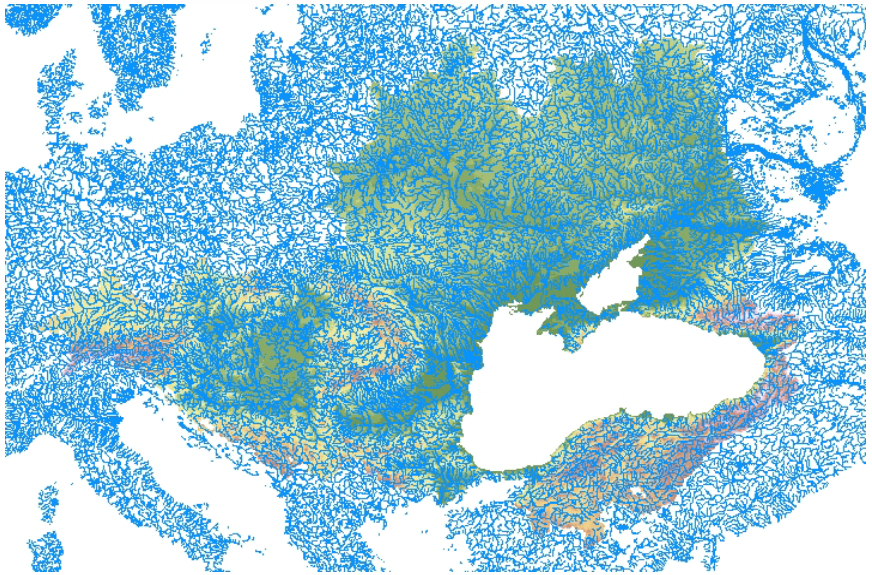


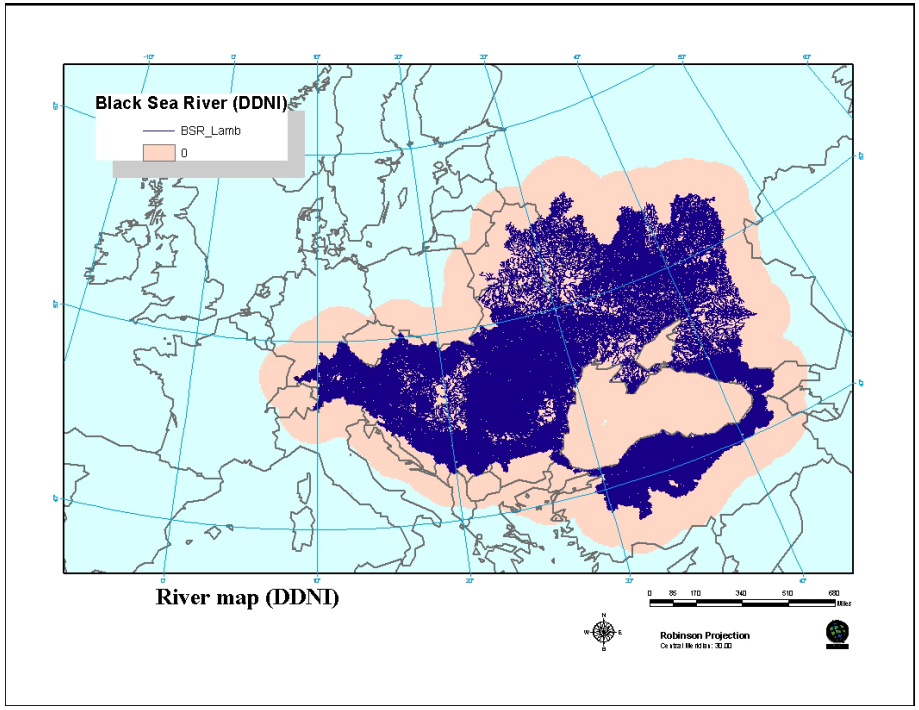
# SWAT Database

## River Map

**Hydro 1K**

**USGS**

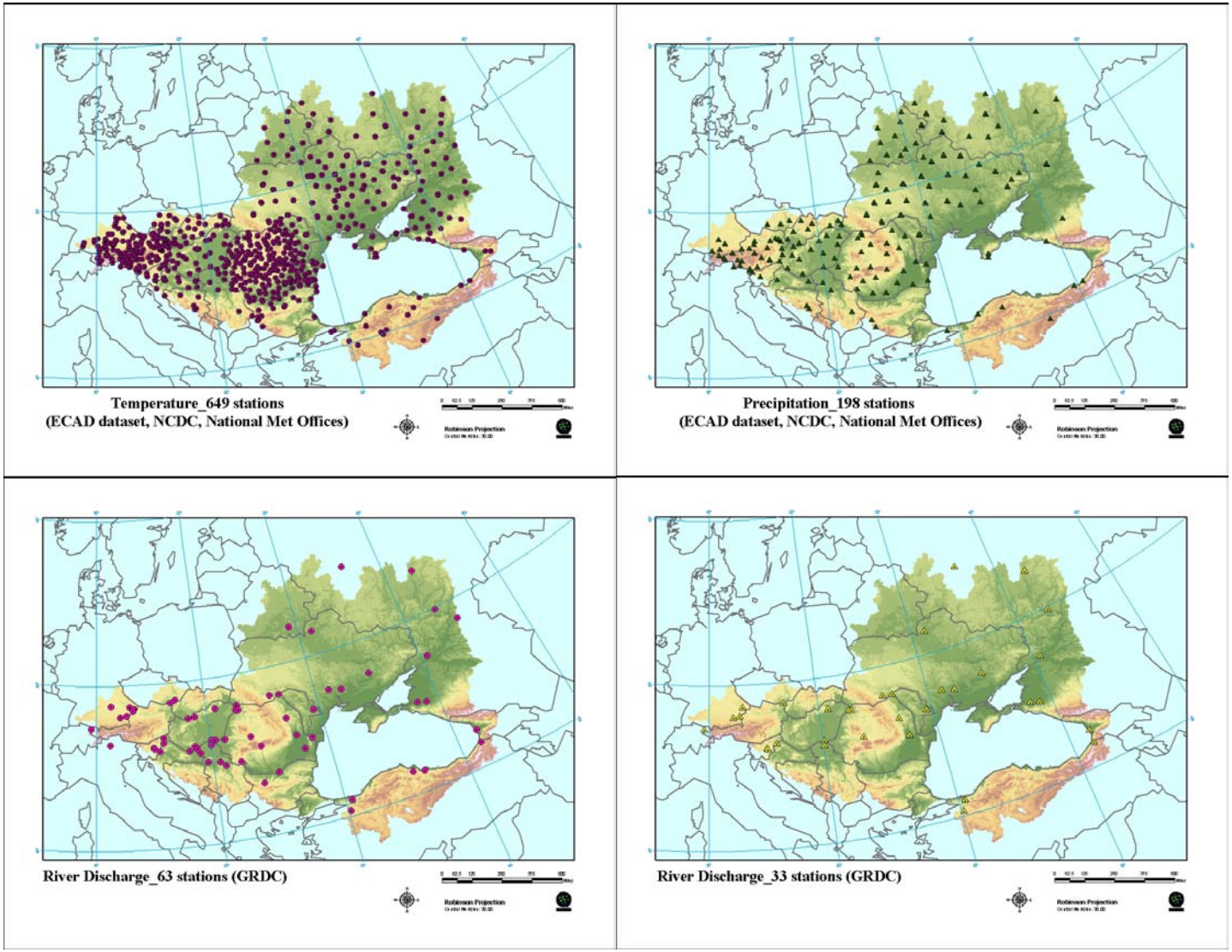





**50 m spatial resolution**

# SWAT Database

## Temperature, Precipitation, River Discharge




Build up a SWAT model for BSC

# SWAT project _ BSC Catchment

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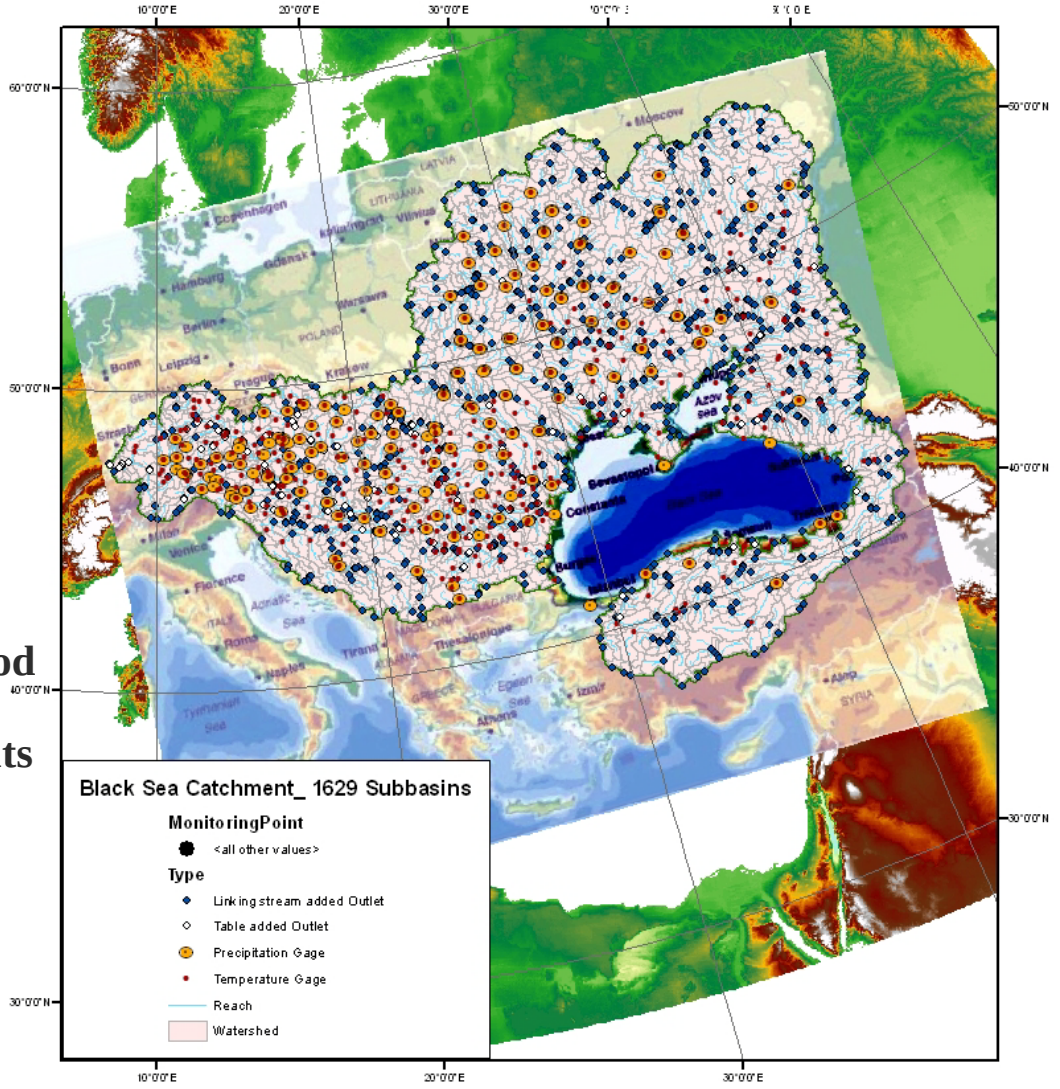
## Model setup

- 2,000,000 km2 Area
- 1629 sub-basins
- Dominant soil and land use
- ET Calculation based on Hargreavs Method
- Daily Steps Swat Run and Monthly Outputs
- 39 yr simulation period, 3 yr warm up



# Calibration and Gridification

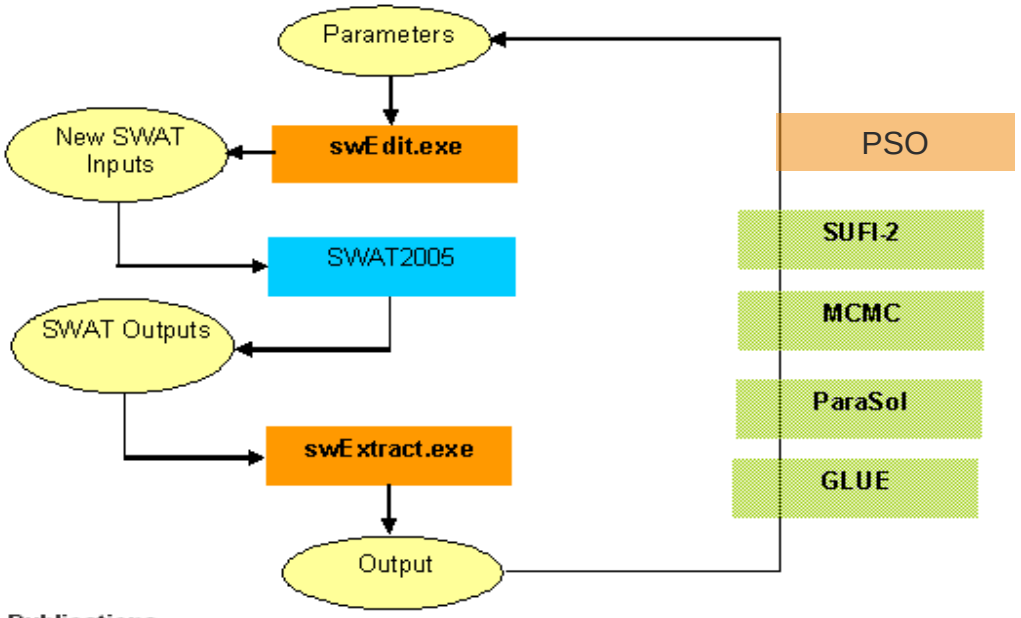
http://www.eawag.ch/organisation/abteilungen/siam/software/swat/index_EN



Department System Analysis, Integrated Assessment and Modelling

# SWAT-CUP

SWAT-CUP is a computer program for calibration of SWAT models. SWAT-CUP is a public domain program, and as such may be used and copied freely. The program links GLUE, ParaSol, SUFI2, and MCMC procedures to SWAT. It enables sensitivity analysis, calibration and uncertainty analysis of a SWAT model. The overall program structure is as shown in the Figure below.




**Publications**

Abbaspour et al. 2007 (Application of SUFI2 to Thur Watershed in Switzerland) (pdf, 465 KB)

Abbaspour et al. 2004 (Application of SUFI2 to two landfills in Switzerland) (pdf, 1.9 MB)

Schuol et al. 2008 (Application of SWAT in Western Africa) (pdf, 4.6 MB)

Yang et al. 2008 (Comparison of five optimization programs) (pdf, 1.6 MB)

Schuol et al. 2008 (Application of SWAT to Continent of Africa) (pdf, 2.1 MB)

Faramarzi et al. 2009 (Application of SWAT in Iran) (pdf, 1.2 MB)

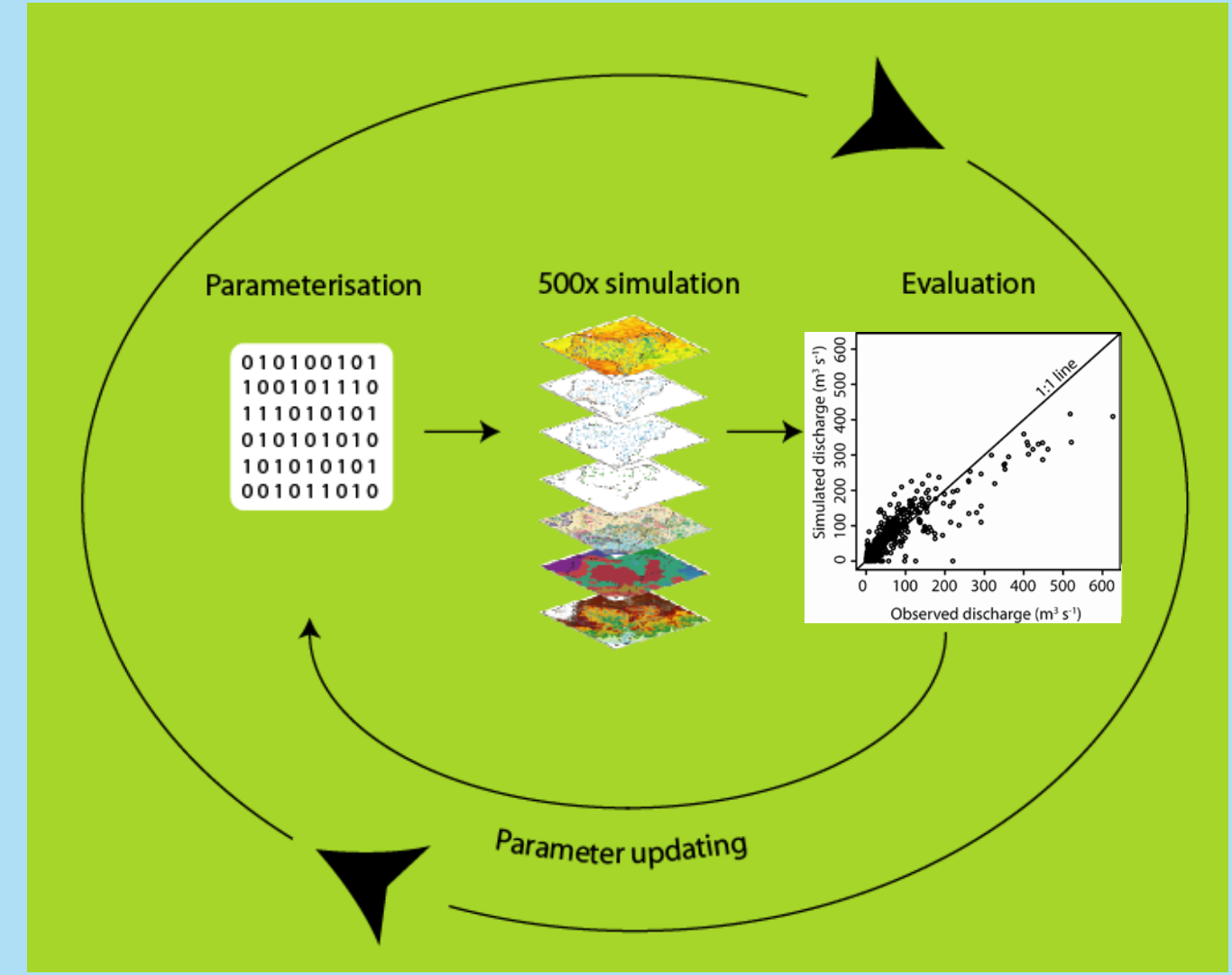
**Contact**

Karim C. Abbaspour (abbaspour@eawag.ch )

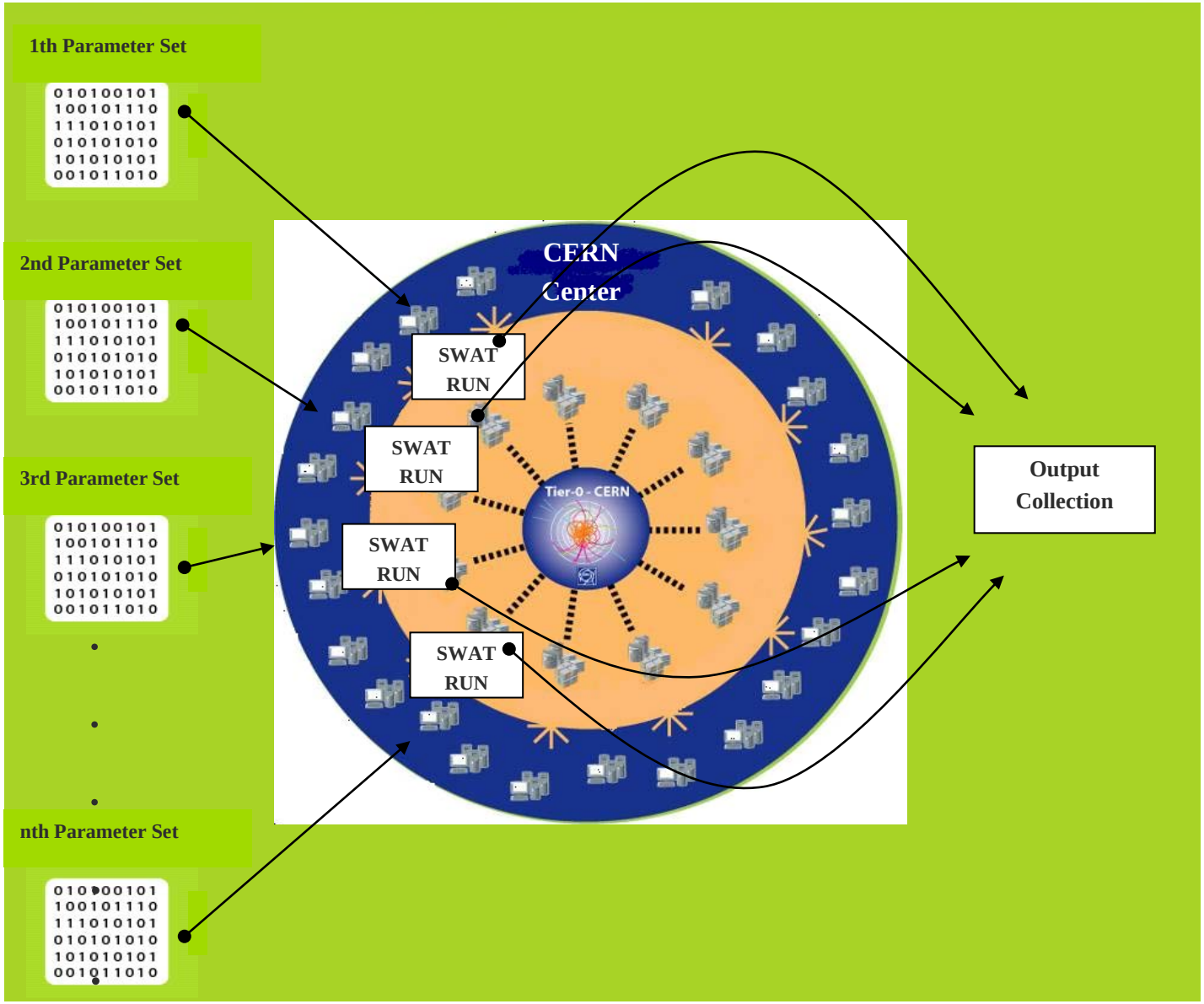
**Downloads**

- Program manual: Usermanual_Swat_Cup.pdf (pdf, 2.4 MB)
- Programme Version 2.1.5 (zip, 68.4 MB) (.... New setup, plus pesticide parameters)

# Calibration, Evaluation & Uncertainty

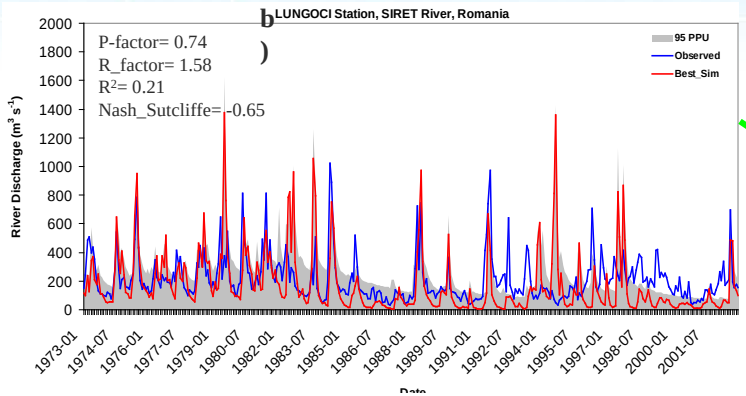


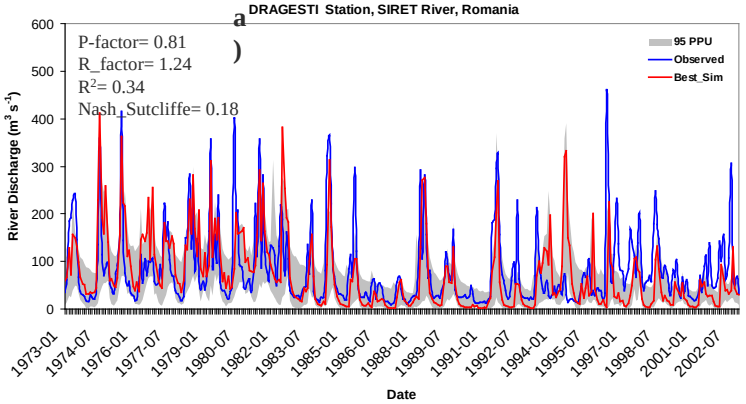
# Gridification on CERN Grids

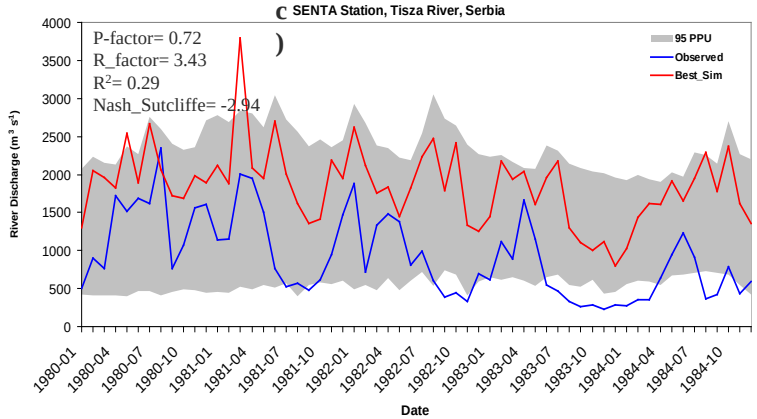


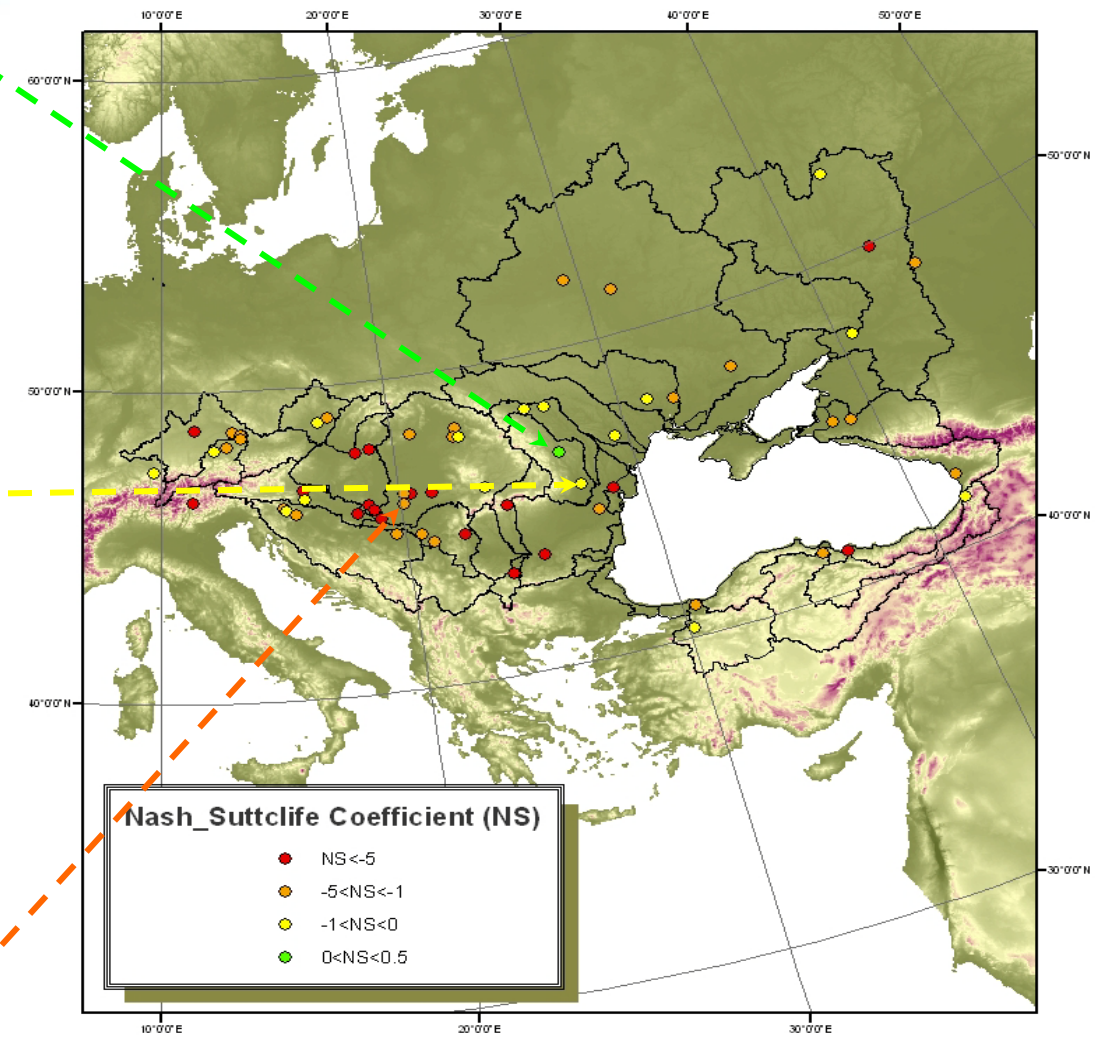
# First run results

# NS Coefficient and 95PPU



# Preliminary Results (longterm average)

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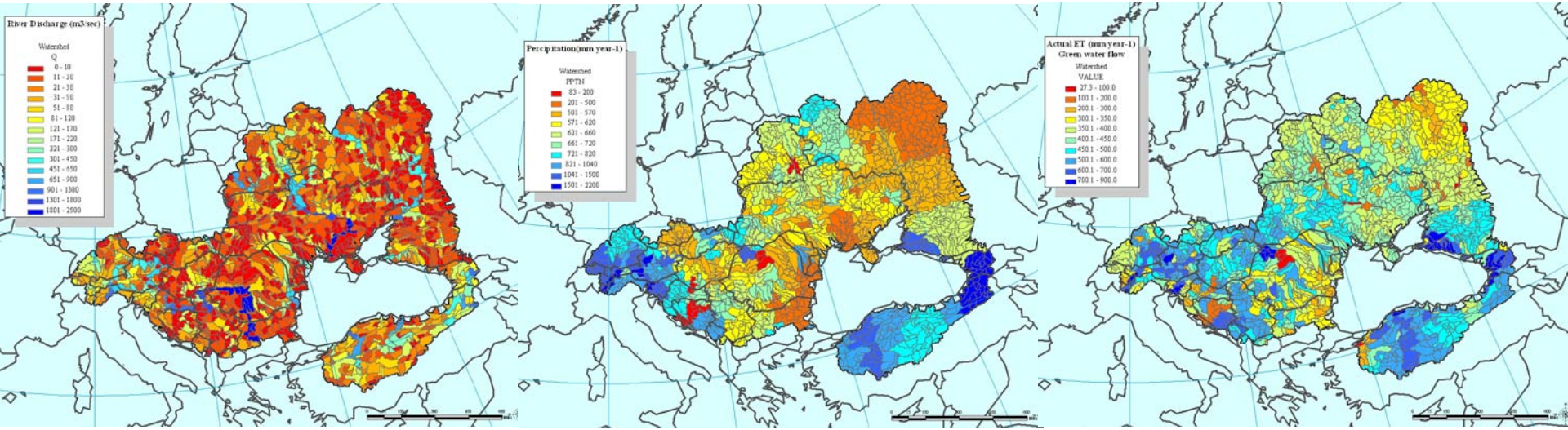
## River discharge

## Precipitation

## Actual ET



# Preliminary Results (longterm average)

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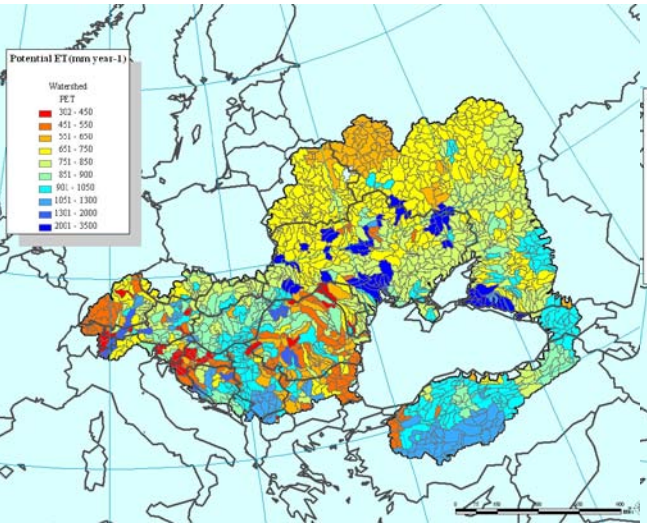
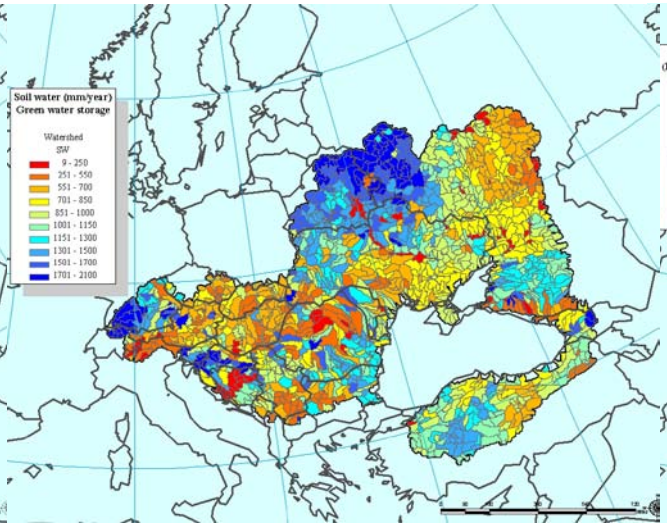
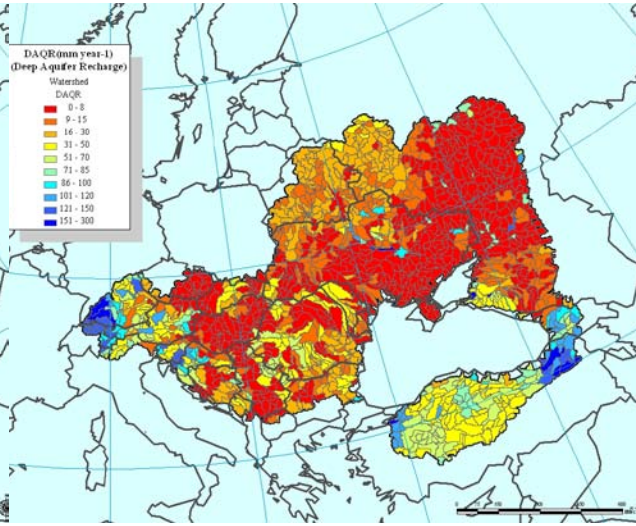
## Potential ET




## Soil Moisture




## Aquifer Recharge



# Future Plans

**Building a finer resolution BSC SWAT model**

- 90-m dem,
- 50-m River,
- More Climate stations
- More Discharge stations (Danube)

**Collaborate with building the Grid application**

**Calibrate, Validate, and perform uncertainty analysis**

**Build a Danube River Basin hydrologic model**

**Compare SWAT and MONERIS**

**Evaluate the impact of landuse and climate change on water resources**

**Help build local SWAT models in Black Sea basin**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# Results on Google Earth