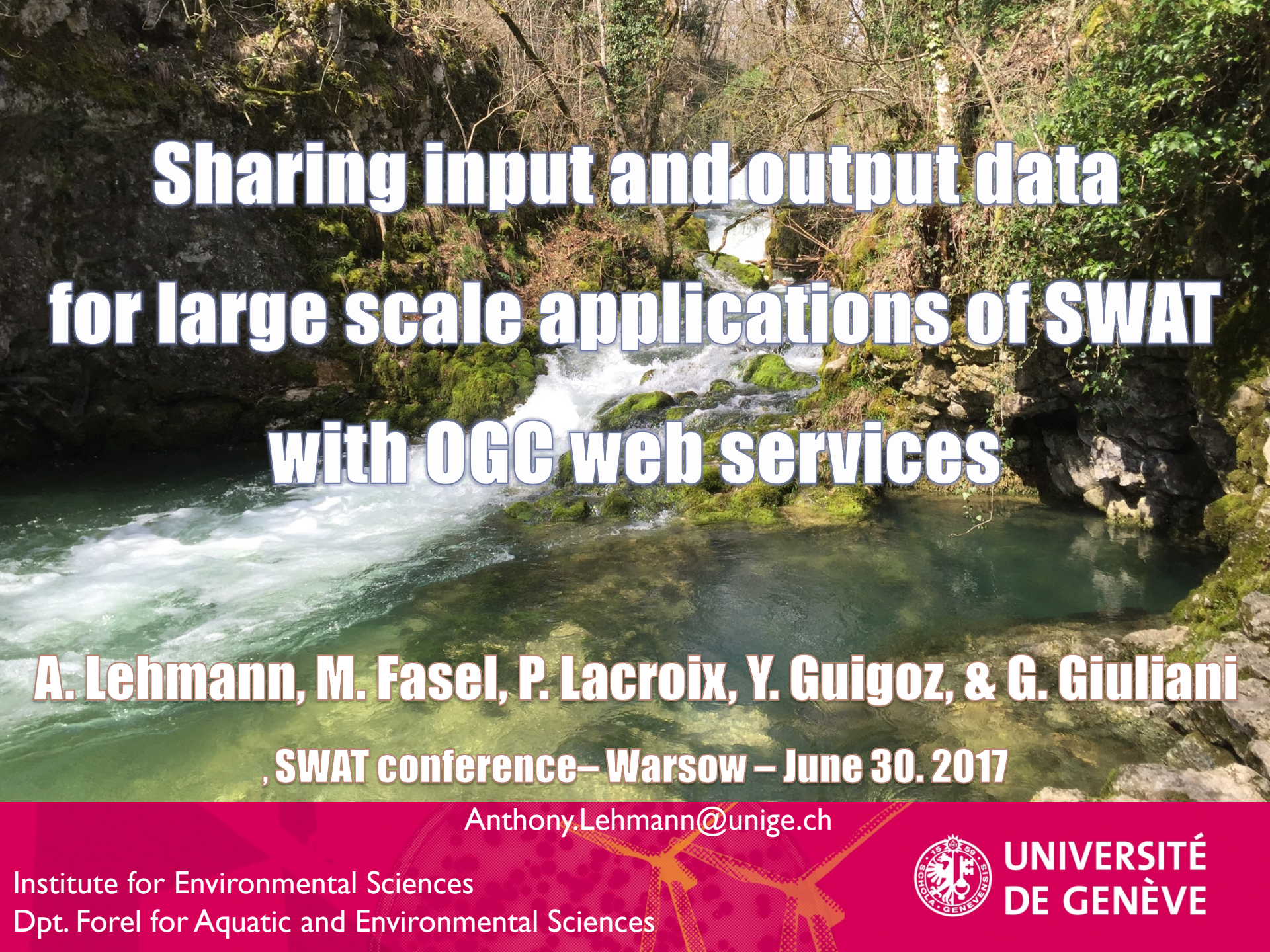


Sharing input and output data for large scale applications of SWAT with OGC web services

A. Lehmann, M. Fasel, P. Lacroix, Y. Guigoz, & G. Giuliani

, SWAT conference– Warsow – June 30. 2017

Anthony.Lehmann@unige.ch

Institute for Environmental Sciences
Dpt. Forel for Aquatic and Environmental Sciences

UNIVERSITÉ DE GENÈVE

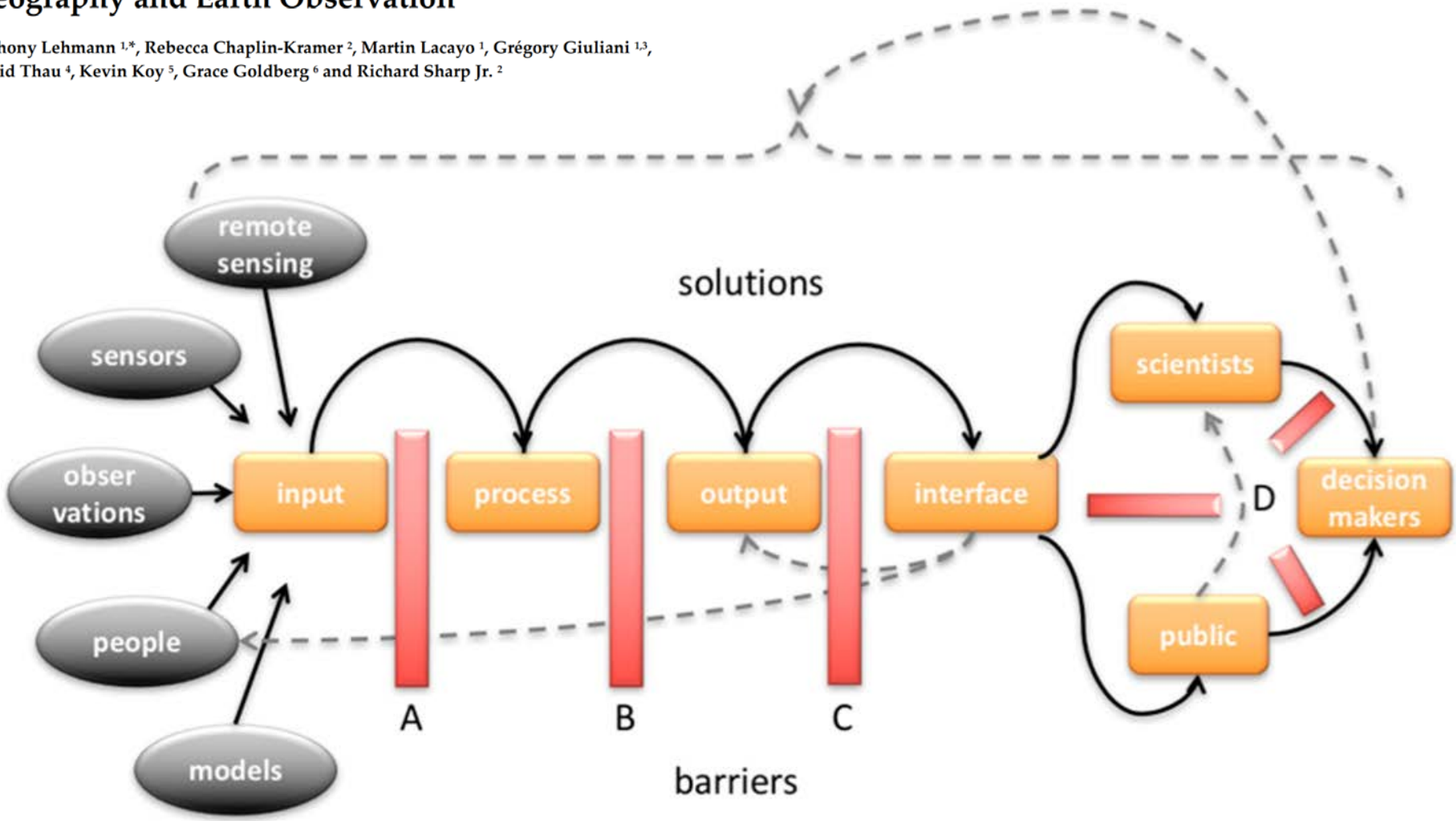
sustainability

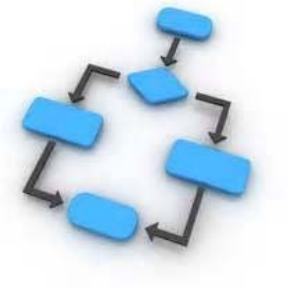
MDPI

Case Report

Lifting the Information Barriers to Address Sustainability Challenges with Data from Physical Geography and Earth Observation

Anthony Lehmann [1,*], Rebecca Chaplin-Kramer [2], Martin Lacayo [1], Grégory Giuliani [1,3], David Thau [4], Kevin Koy [5], Grace Goldberg [6] and Richard Sharp Jr. [2]





General modeling workflows with Open Geospatial Consortium (OGC) standards

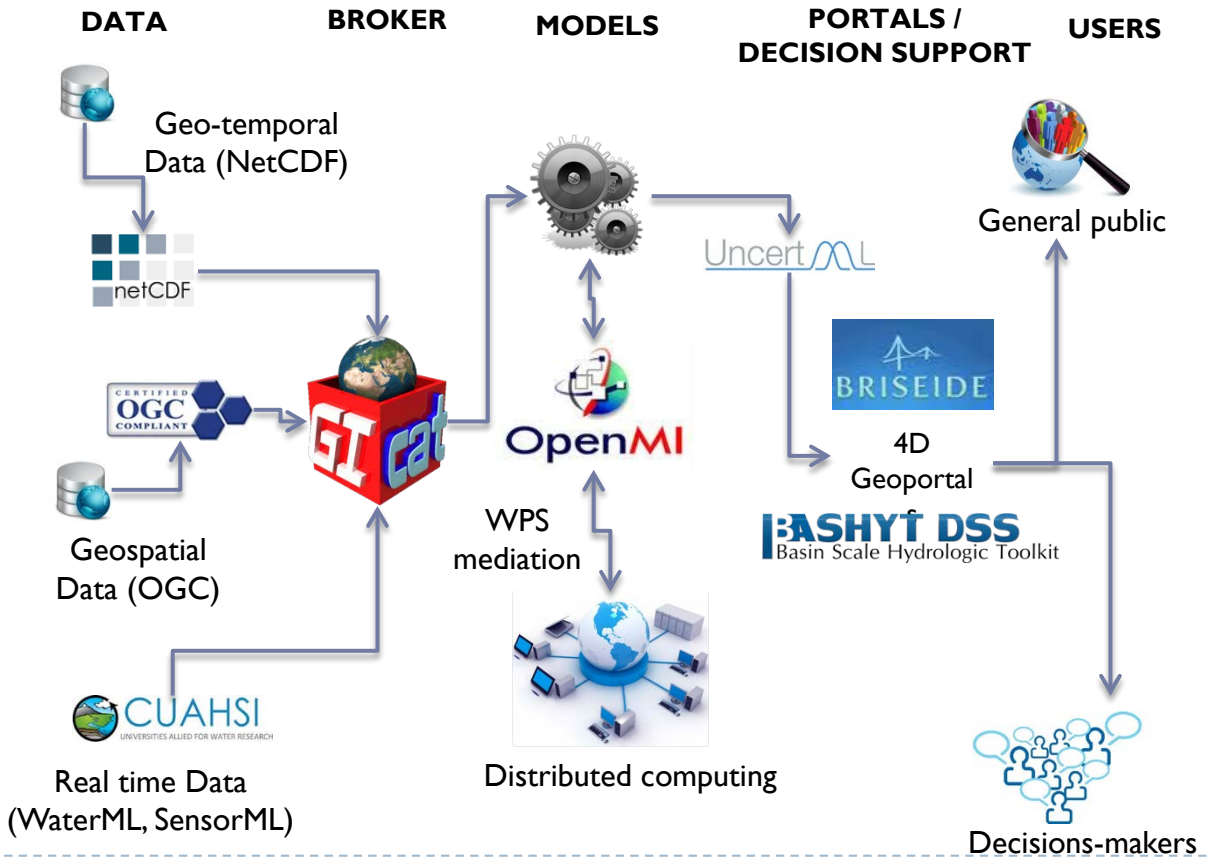
Contents lists available at ScienceDirect

Journal of Hydrology

journal homepage: www.elsevier.com/locate/jhydrol

Reviewing innovative Earth observation solutions for filling science-policy gaps in hydrology

Anthony Lehmann [a,b,*], Gregory Giuliani [b,c], Nicolas Ray [b,c], Kazi Rahman [a,b], Karim C. Abbaspour [d], Stefano Nativi [e], Massimo Craglia [f], Douglas Cripe [g], Philippe Quevauviller [h], Martin Beniston [b]

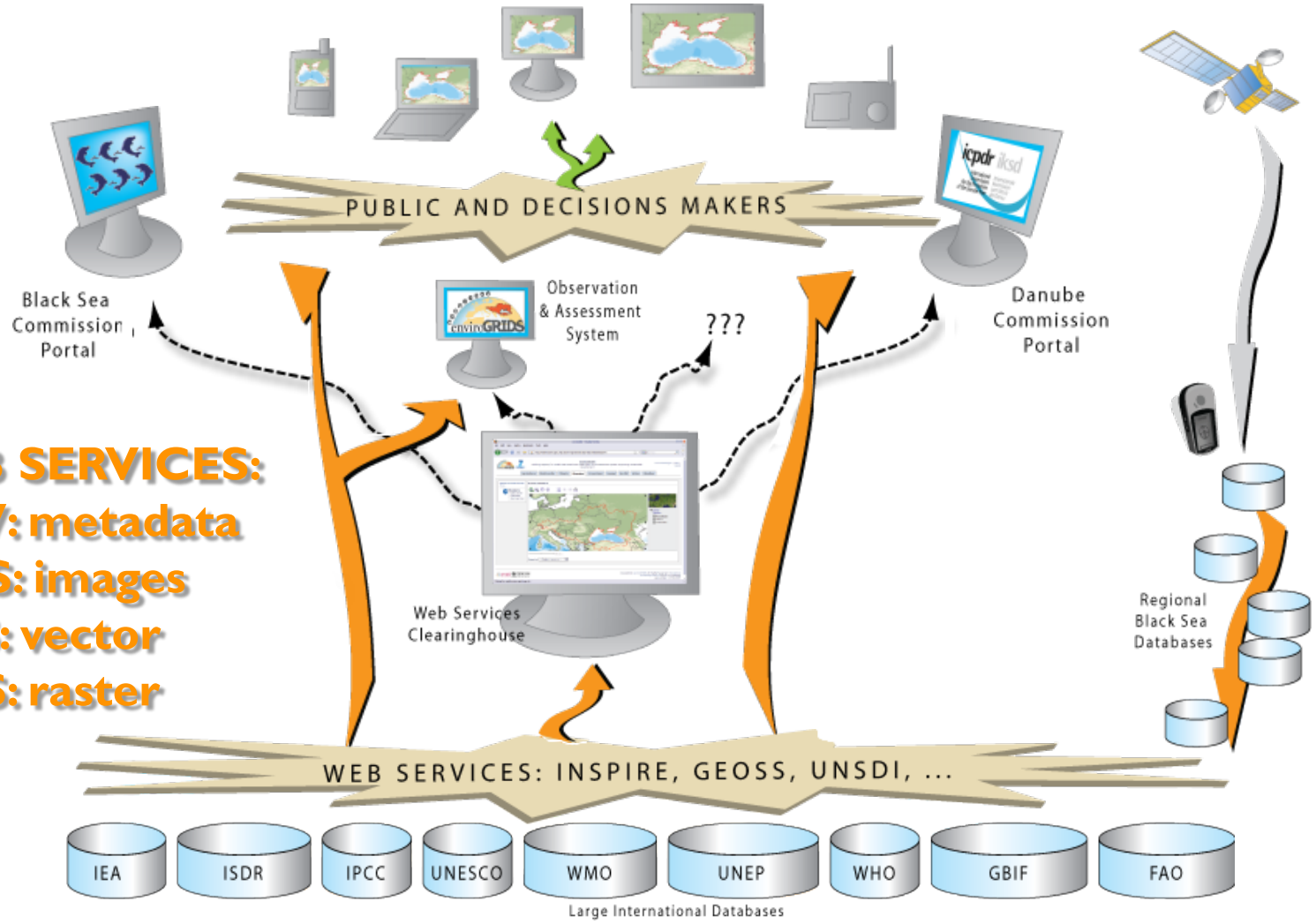


The Black Sea project

Available online at www.sciencedirect.com
ScienceDirect
journal homepage: www.elsevier.com/locate/envsci

Filling the gap between Earth observation and policy making in the Black Sea catchment with enviroGRIDS

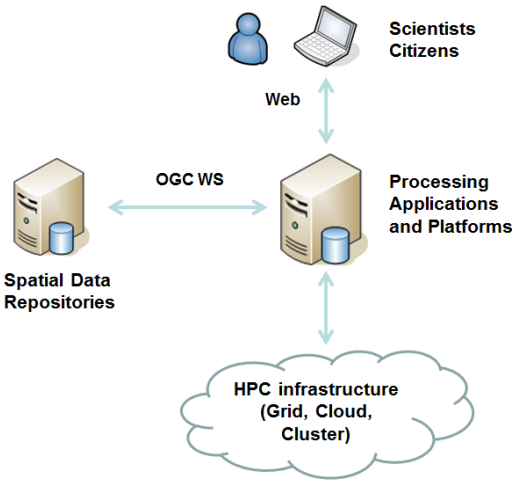
A. Lehmann [a,*], G. Giuliani [a,b], E. Mancosu [c], K.C. Abbaspour [d], S. Sözen [e], D. Gorgan [f], A. Beel [g], N. Ray [a,b]



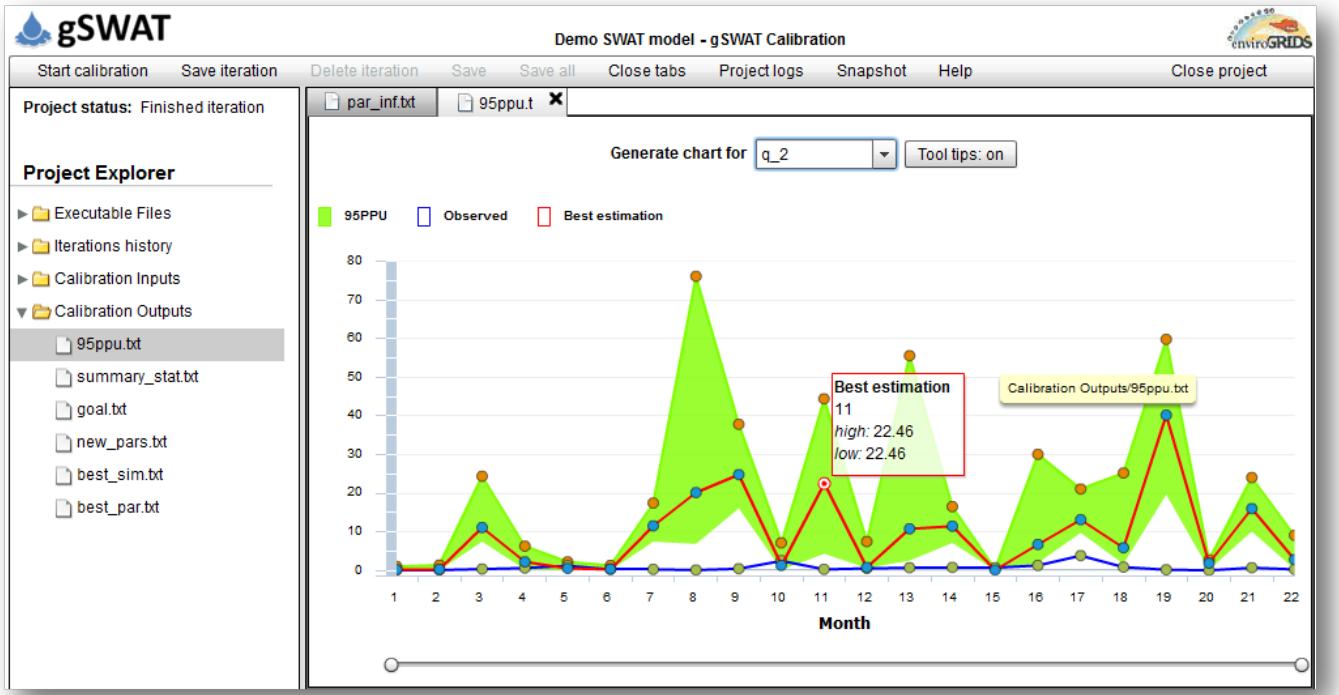
WEB SERVICES:
CSW: metadata
WMS: images
WFS: vector
WCS: raster

Black Sea Catchment Observation System as a Portal for GEOSS Community

Dorian Gorgan[1], Gregory Giuliani[2,7], Nicolas Ray[2,7], Anthony Lehmann[2], Pierluigi Cau[3], Karim Abbaspour[4], Karel Charvat[5], Andreja Jonoski[6]



>>> gSWATCloud



AGU PUBLICATIONS

Water Resources Research

RESEARCH ARTICLE
10.1002/2013WR014132

Water resources of the Black Sea Basin at high spatial and temporal resolution

Elham Rouholahnejad[1,2], Karim C. Abbaspour[1], Raghvan Srinivasan[3], Victor Bacu[4], and Anthony Lehmann[5]

Key Points:
- A high-resolution hydrological model of the Black Sea Basin is built

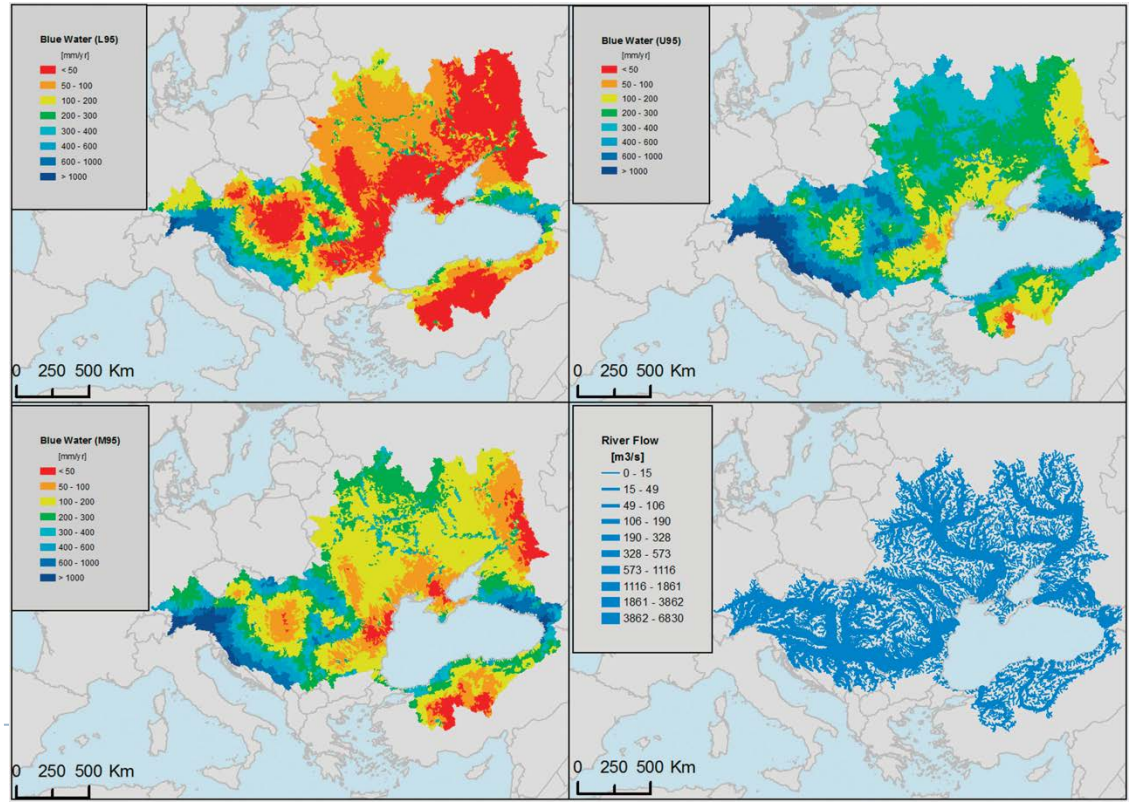
SCIENTIFIC DATA

OPEN

Data Descriptor: A web platform for landuse, climate, demography, hydrology and beach erosion in the Black Sea catchment

Received: 07 October 2016
Accepted: 09 May 2017
Published: xx xx 2017

Anthony Lehmann[1,2], Yaniss Guigoz[3], Nicolas Ray[1,3], Emanuele Mancosu[4], Karim C. Abbaspour[5], Elham Rouholahnejad Freund[6,7], Karin Allenbach[3], Andrea De Bono[3], Marc Fasel[1], Ana Gago-Silva[1], Roger Bär[8], Pierre Lacroix[1,3] & Gregory Giuliani[1,3]



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enviroSPACE

Contributions of enviroGRIDS to GEOSS

Search... Se connecter

ACCUEIL COUCHES CARTES DOCUMENTS PEOPLE RECHERCHER

ENVIROGRIDS - CORE DATASETS

Search, discover, and access enviroGRIDS core datasets.

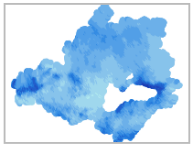
More project datasets available on the EnviroGRIDS portal

Explore Layers

Découvrez les artes

LATEST LAYERS

Total: 228



◇ Monthly mean precipitation (HB1 scenario) 2033-2036 [mm]

Layer from geonodeadm, 7 mois ago

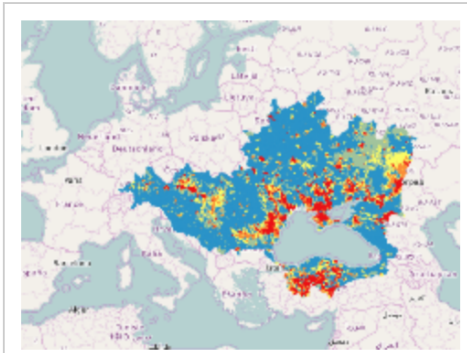
The data consist in a vector map representing the HB1 monthly mean value for precipitation, from 2033 to 2036

24 views | Average rating (0 votes) | Télécharger | Create a map

◇ Monthly mean value for maximum temperature (HB1 scenario) 2069-2072 [°C]

Layer from geonodeadm, 7 mois ago

LATEST MAPS



UNIVERSITÉ DE GENÈVE

http://blacksea.grid.unep.ch

SWAT Input and output data

Breaking Walls Towards Fully Open Source Hydrological Modeling[1]

Kazi Rahman[a, b, *], Nicolas Ray[a, c], Grégory Giuliani[a, c], Chetan Maringanti[d], Chris George[e], and Anthony Lehmann[a]

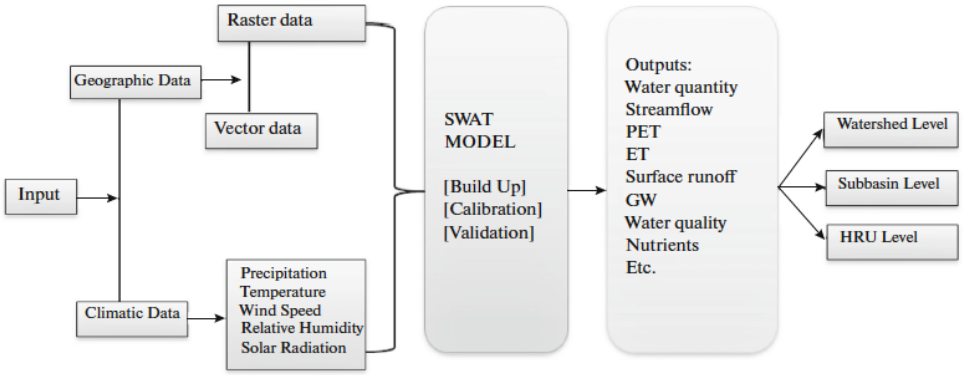


Fig. 1. Flow chart of data and software requirement for SWAT model preparation, calibration and validation.

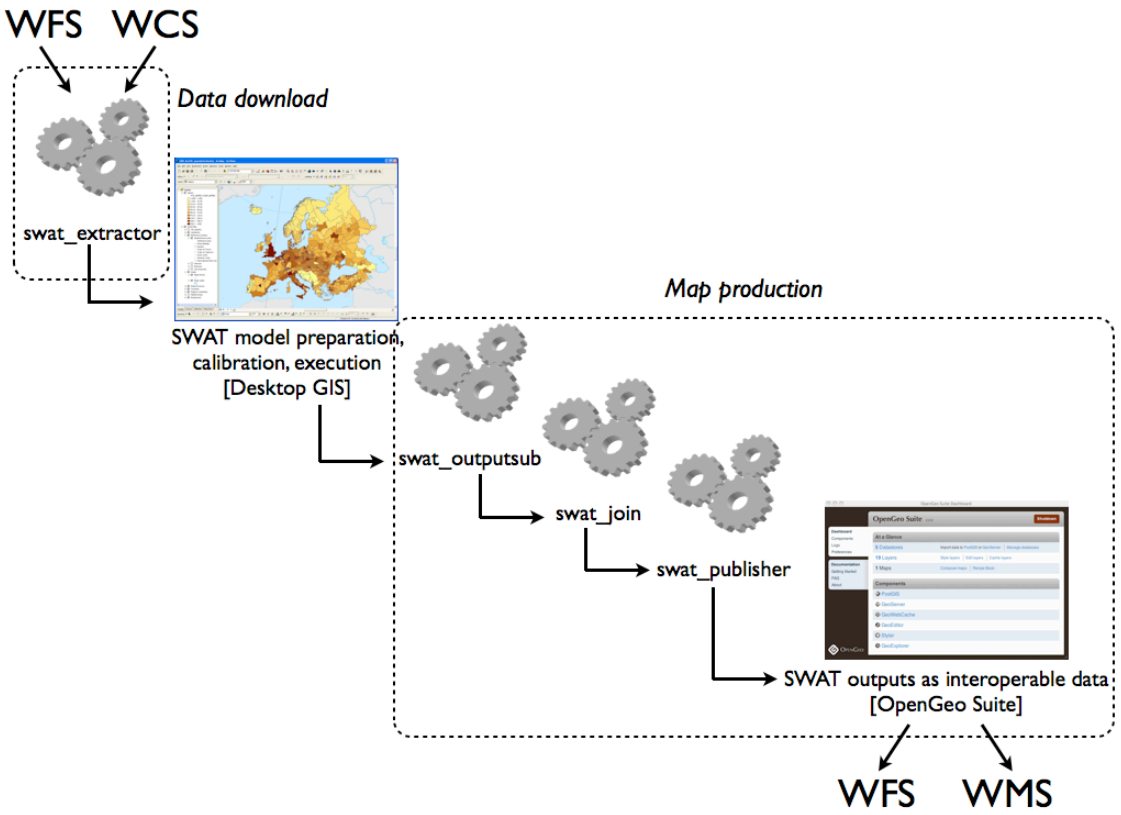
Table 1. Data used for the Mendoza catchment in Argentina

Data Type	Data Sources	Scale/Resolution	Description-Web site
DEM	SRTM	90 m	Elevation http://srtm.csi.cgiar.org
Land use	GlobCover	1000 m	Classified land use such as crop, urban forest water etc. http://ionia1.esrin.esa.int
Soil	FAO	1 : 5000000	Classified soil and physical properties such as sand, silt, clay, bulk density. http://www.fao.org/climatechange/54273/en
Hydrological network	Hydroshed	1 : 25000	River network http://hydrosheds.cr.usgs.gov
River flow	GRDC	–	River discharge http://grdc.bafg.de
Weather	NCDC	–	Precipitation, Temperature, Wind Speed, Solar radiation http://www.ncdc.noaa.gov

ISSN 0097-8078, Water Resources, 2017, Vol. 44, No. 1, pp. 23–30. © Pleiades Publishing, Ltd., 2017.

OWS4SWAT: Publishing and Sharing SWAT Outputs with OGC standards

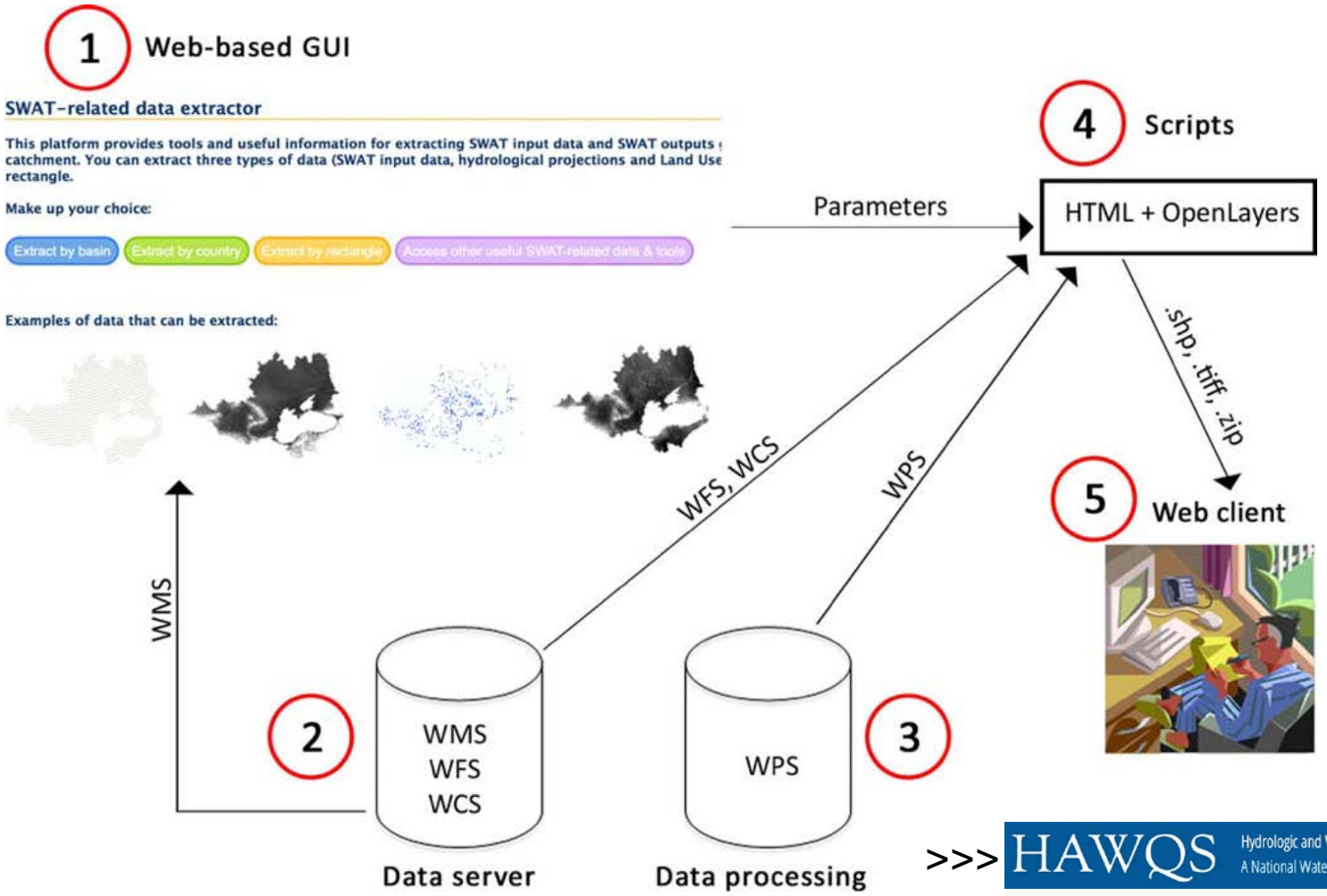
Gregory Giuliani[1,2],Kazi Rahman[1], Nicolas Ray[1,2], Anthony Lehmann[1]
[1]Institute for Environmental Sciences, enviroSPACE University of Geneva 1227 Carouge, Switzerland
[2]United Nations Environment Programme Global Resource Information Database, 1211 Châtelaine, Switzerland
gregory.giuliani@unige.ch



ORIGINAL ARTICLE

WILEY Transactions in GIS

SCOPED-W: SCalable Online Platform for extracting Environmental Data and Water-related model outputs



>>> HAWQS Hydrologic and Water Quality System
A National Watershed and Water Quality Assessment Tool

UNIVERSITÉ DE GENÈVE

Yaniss Guigoz[1,2,*] | Pierre Lacroix[1,2,*] | Elham Rouholahnejad[4] |
Nicolas Ray[1,2] | Grégory Giuliani[1,2,3]

New projects

1. SWATCH21: workflow and APIs

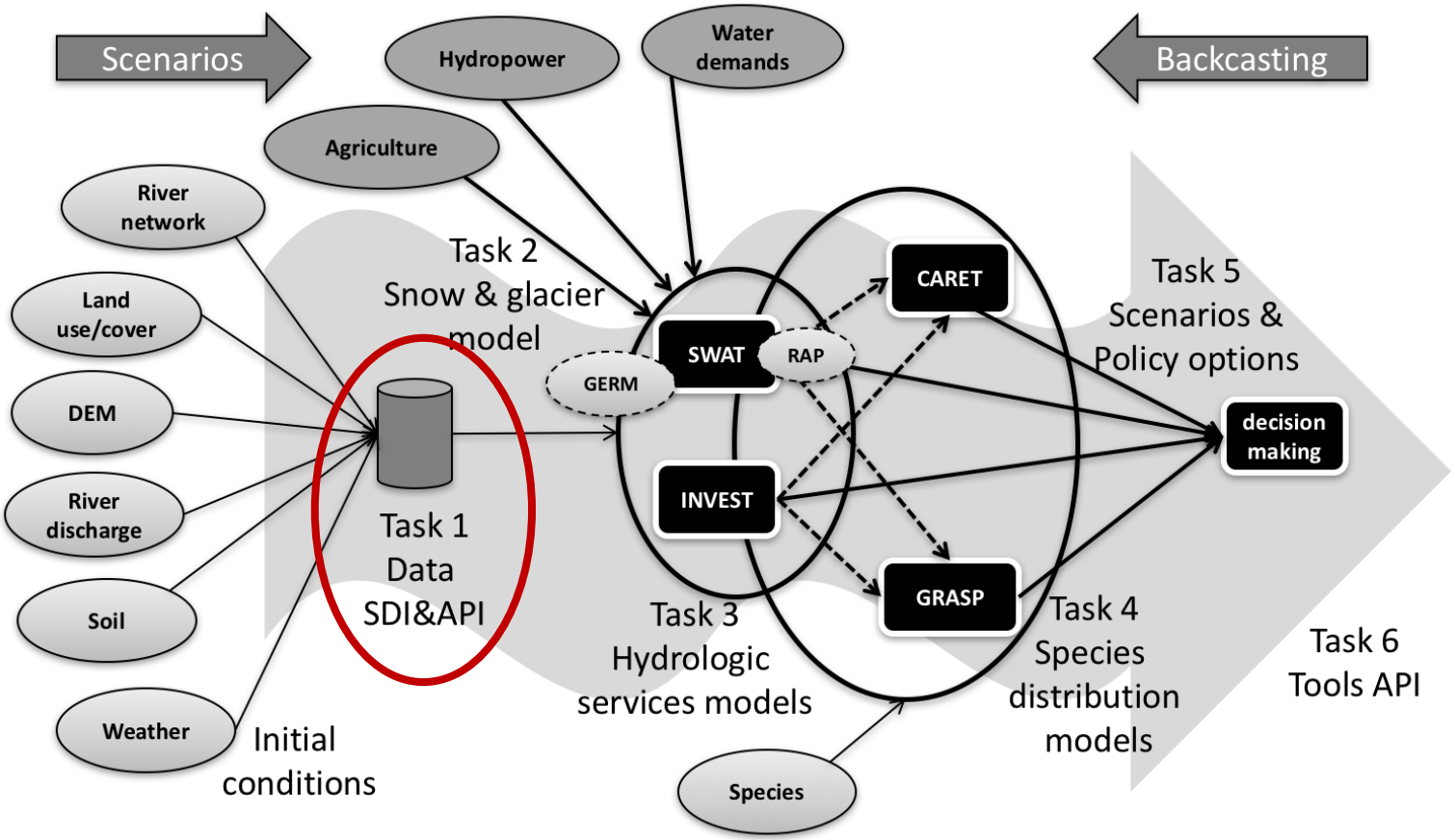
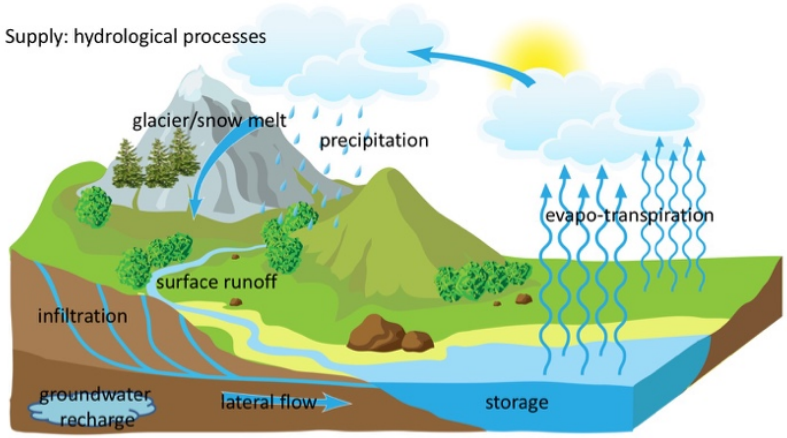
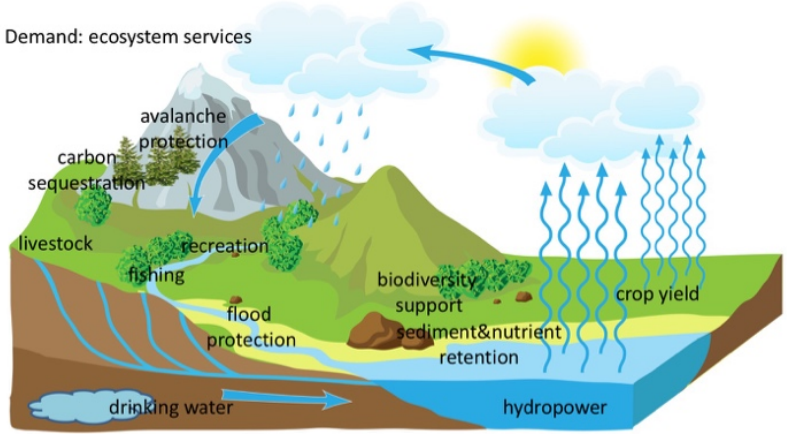


Figure 3 Organistion of the work flow in six main tasks

1. SWATCH21: ES supplies and demands





Provisioning services

- ❖ Agriculture: crop yield will be directly derived from SWAT outputs
- ❖ Drinking water: the amount of blue water used for drinking will be assessed from the population distribution and needs
- ❖ Hydropower: blue water transformed in energy by hydropower will be estimated using the distribution and size of existing dams
- ❖ Water for livestock: blue water available for livestock will be estimated from the distribution of different types of livestocks

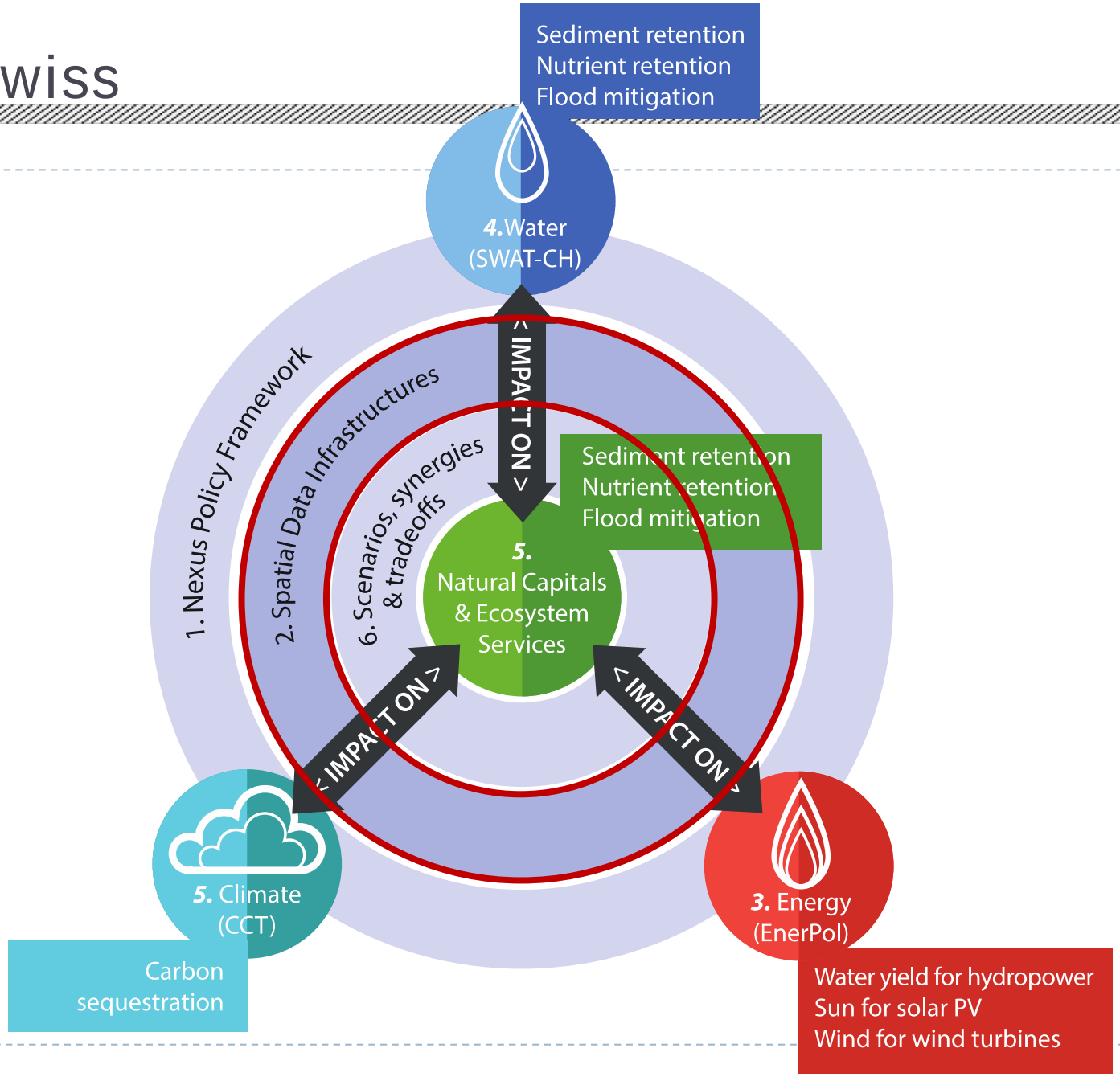
Regulating and maintenance services

- ❖ Biodiversity: the ecosystem diversity will be assessed by downscaling existing land use information from 100m (geostat) resolution to 25m (Lehmann et al. unpublished).
- ❖ Flood protection: The Critical Consecutive Days Analyzer (CCDA) has been developed at EAWAG (Vaghefi et al. in prep.).
- ❖ Nutrient and sediment retention will be directly derived from SWAT outputs
- ❖ Carbon sequestration will be calculated with the InVEST package
- ❖ Avalanche protection: this services will be assessed by GIS analyses as in Grêt-Regamey et al. (2008)[97]

Cultural services

- ❖ Fishing for recreation: this service will be assessed by modelling the species distribution of emblematic fishes species such as trouts using species distribution models (e.g. GRASP[160,161] or MARS[162])
- ❖ Recreation: the recreational value of river beds will be assessed by a combination of GIS analyses of accessibility from roads and walking tracks, and the density of photos made available on Flickr.

2. neXswiss


Sediment retention
Nutrient retention
Flood mitigation
4.Water
(SWAT-CH)
< IMPACT ON >
1. Nexus Policy Framework
2. Spatial Data Infrastructures
6. Scenarios, synergies & tradeoffs
Sediment retention
Nutrient retention
Flood mitigation
5.
Natural Capitals
& Ecosystem
Services
< IMPACT ON >
< IMPACT ON >
5. Climate
(CCT)
Carbon
sequestration
3. Energy
(EnerPol)
Water yield for hydropower
Sun for solar PV
Wind for wind turbines

Contents lists available at ScienceDirect

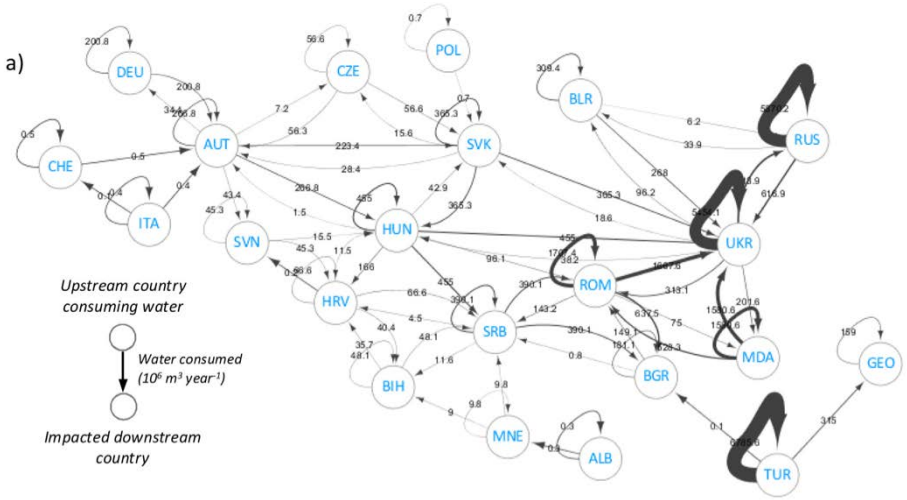
Environmental Science & Policy

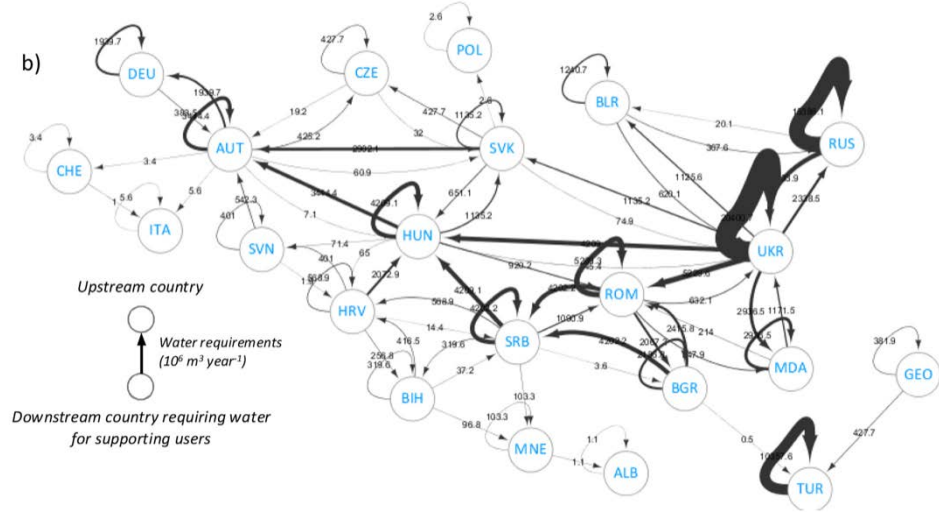
journal homepage: www.elsevier.com/locate/envsci

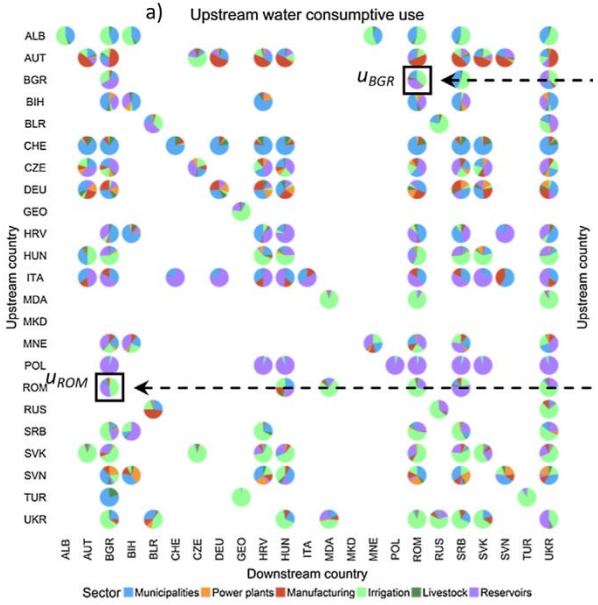
Blue water scarcity in the Black Sea catchment: Identifying key actors in the water-ecosystem-energy-food nexus

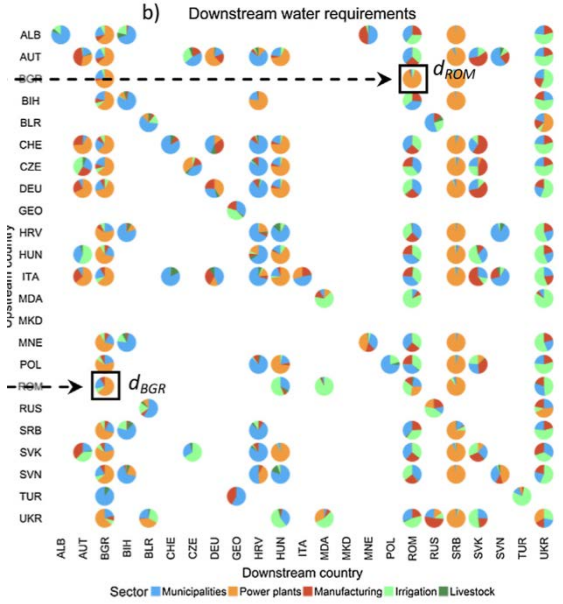
M. Fasel[a,*], C. Bréthaut[a], E. Rouholahnejad[b], M.A. Lacayo-Emery[a], A. Lehmann[a]

[a] University of Geneva, Institute for Environmental Sciences, Bd. Carl-Vogt 66, CH – 1211, Geneva, Switzerland
[b] Department of Environmental Systems Science, ETH Zurich, Universitaetstrasse 16, CH – 8092, Zurich, Switzerland

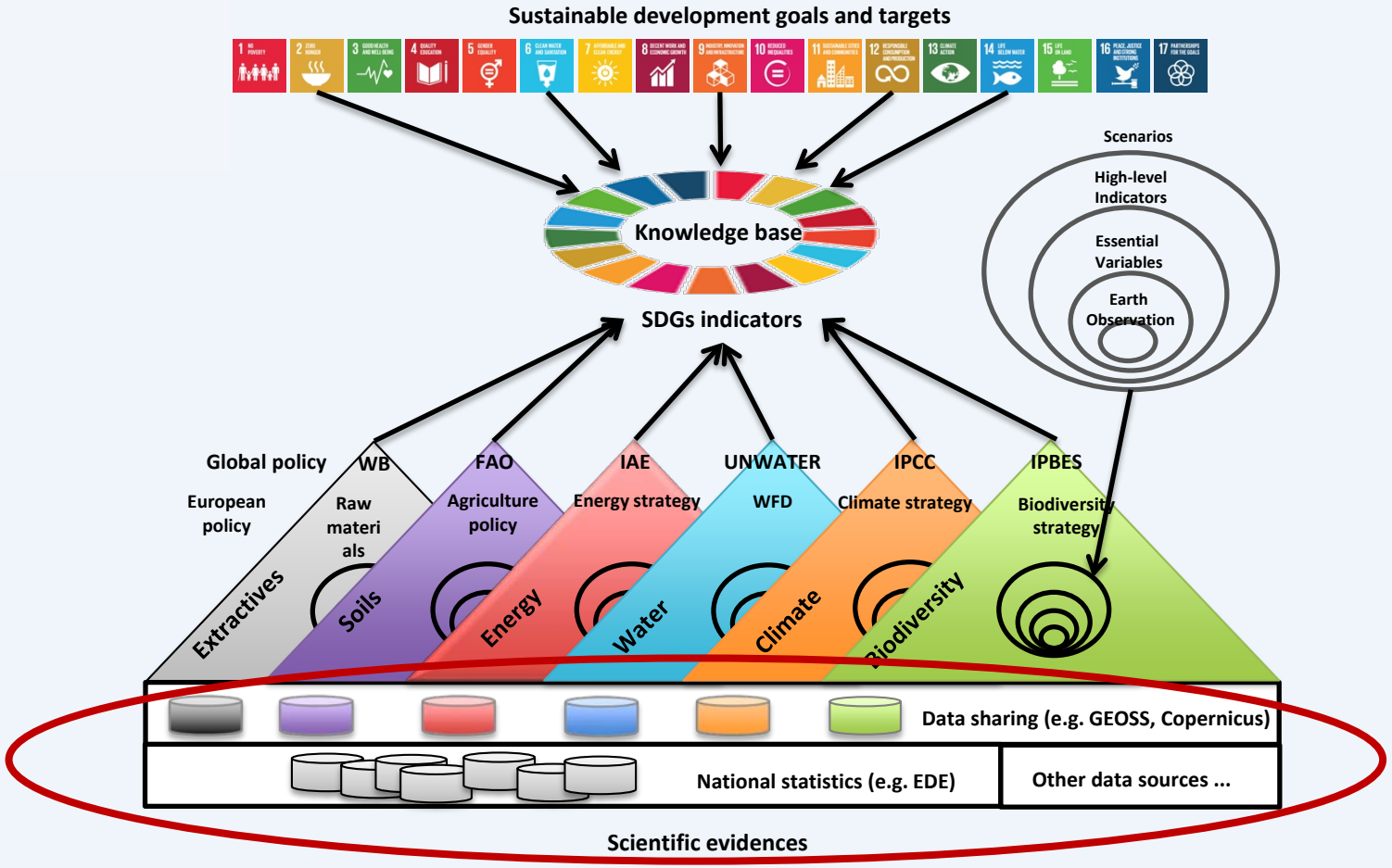








3. GEOessential: Essential X Variables



Horizon 2020
Call: H2020-SC5-2015-one-stage
Topic: SC5-15-2015
Type of action: ERA-NET-Cofund
Grant agreement no: 689443
Proposal acronym: ERA-PLANET

3. Essential Water Variables

Areas of application

Essential Water Cycle Variables (Structured following the Water SBA analysis as being of approximately high priority when averaged across all user sectors. Some variables/parameters have been combined for simplicity)	Water Cycle Monitoring	Water Cycle Modelling/Prediction	Decision Support--Agriculture	Decision Support--Biodiversity	Decision Support--Climate	Decision Support-- Ecosystems	Decision Support--Energy	Decision Support--Geohazards	Decision Support--Health	Decision Support--Land Management	Decision Support&Oceans (Coastal)	Decision Support--Socio-Economic	Decision Support--Water Management	Decision Support--Weather	Cross-Ref.--ECVs as per UNFCCC, IPCC)	
Precipitation	X	X	X	X	X	X	X	X	X	X	X		X	X	X	SWAT inputs
Evaporation and evapotranspiration	X	X	X	X	X	X							X			SWAT outputs
Snow cover (SWE, depth, freeze thaw margins)	X	X			X	X	X	X	X	X			X	X	X	SWAT inputs
Soil moisture/temperature	X	X	X	X	X	X		X		X			X		X	SWAT outputs
Groundwater	X	X	X					X	X				X		X	SWAT outputs
Runoff/streamflow/river discharge	X	X	X	X	X	X	X	X	X		X		X		X	SWAT outputs
Lakes/reservoir levels and aquifer volumetric change	X	X			X	X	X		X				X		X	SWAT outputs
Water quality	X	X		X		X			X	X	X	X	X			SWAT outputs
Water use/demand	X	X	X				X		X	X	X	X	X		P	SWAT inputs
Glaciers/ice sheets	X	X			X		X		X				X		X	SWAT inputs
Supplementary Variables																
Surface meteorology	X	X	X		X			X						X	X	SWAT inputs
Surface and atmospheric radiation budget	X	X	X		X										X	SWAT inputs
Cloud and aerosols	X				X									X	X	???
Land Cover and vegetation/ land use	X	X	X	X	X	X				X		X	X		X	SWAT inputs
Permafrost	X	X			X										X	???
Elevation/topography and geological stratification		X	X	X				X		X			X			SWAT inputs

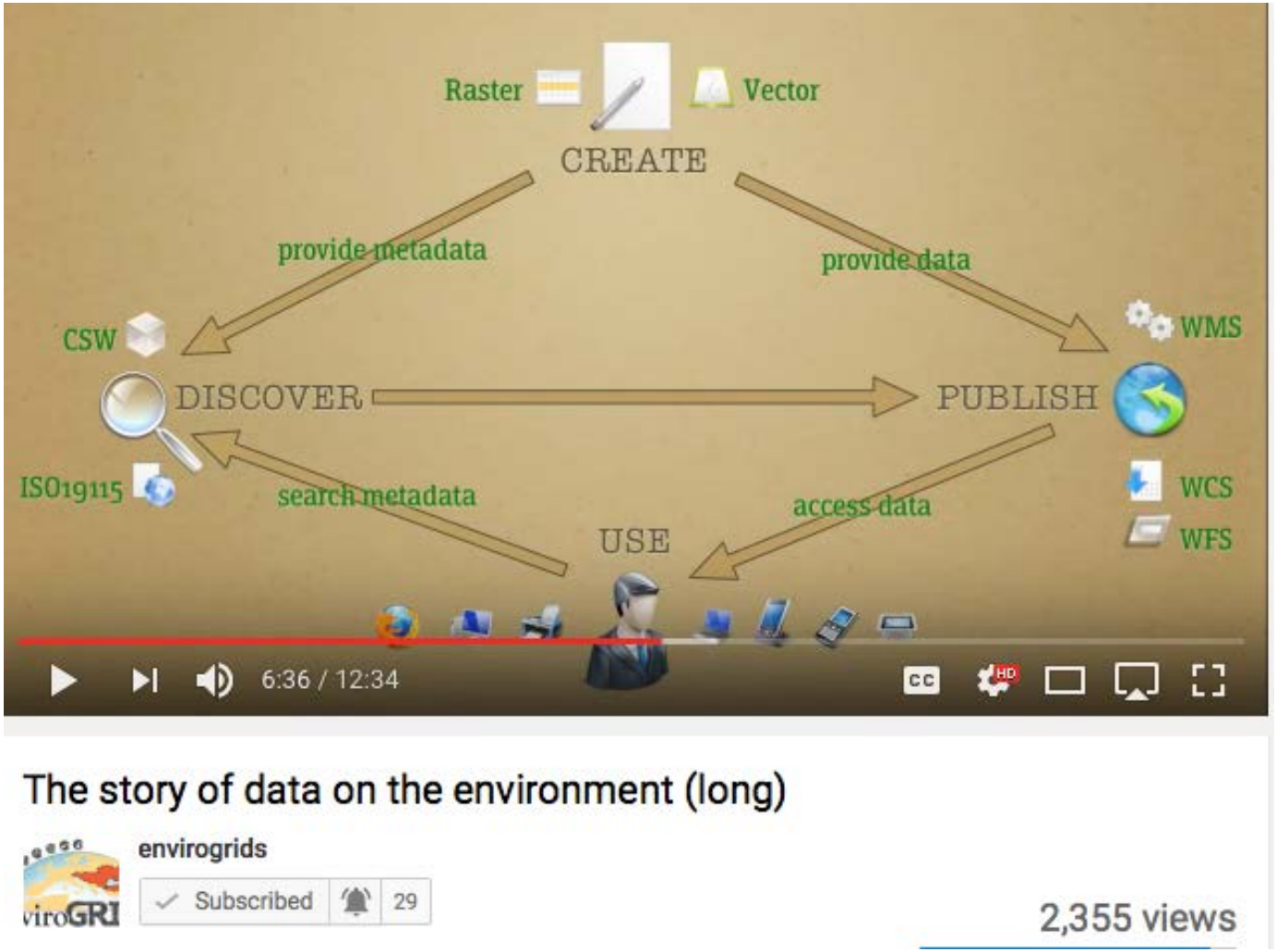
Primary Essential Water Variables

Supplementary Essential Water Variables

In ConnectinGEO: from Lawford, R. (ed.), 2014. The GEOSS Water Strategy: From Observations to Decisions.

More on OGC web services…

More on OGC web services…



https://www.youtube.com/watch?v=9SKOwQDFhYI

OGC working and standards groups

Hydrology DWG

Chair(s):
Zaslavsky, Ilya (University of California, San Diego Supercomputer Center)
Boston, Tony (National Computational Infrastructure)
Pecora, Silvano (World Meteorological Organization (WMO))

Group Description:
The Hydrology Domain Working Group is a Joint Working Group of the World Meteorological Organisation (WMO) and the OGC

OGC network Common Data Form (netCDF) standards suite

1) Overview
2) Downloads
3) Related News

1) Overview
netCDF is a set of software libraries and self-describing, machine-independent data formats that support the creation, access, and sharing of array-oriented scientific data. The conventions for climate and forecast (CF) metadata are designed to promote the processing and sharing of netCDF files. The conventions define metadata that provide a definitive description of what the data represents, and the spatial and temporal properties of the data.

WaterML 2.0 SWG

Chair(s):
Sheahan, Paul (Australian Bureau of Meteorology)

Group Charter:
Download Charter document

Group Description:
WaterML 2.0 Standards Working Group

WaterML 2.0 Part 1 is an Open Geospatial Consortium encoding standard (opengeospatial.org/standards/waterml) for the representation of hydrological observations data, with a focus on time-series. Theis work activities defined in this charter extends WaterML 2.0 with the inclusion of WaterML2 Part 2 - Ratings, Gaugings and Sections.

Sensor Observation Service

1) Overview
2) Downloads
3) Official Schemas
4) Related News

1) Overview
The SOS standard is applicable to use cases in which sensor data needs to be managed in an interoperable way. This standard defines a Web service interface which allows querying observations, sensor metadata, as well as representations of observed features. Further, this standard defines means to register new sensors and to remove existing ones. Also, it defines operations to insert new sensor observations. This standard defines this functionality in a binding independent way; two bindings are specified in this document: a KVP binding and a SOAP binding.

OGC WaterML 2: Part 4 – GroundWaterML 2 (GWML2)

1) Overview
2) Downloads
3) Official Schemas
4) Related News

1) Overview
This standard describes a conceptual and logical model for the exchange of groundwater data, as well as a GML/XML encoding with examples.

OGC® Open Modelling Interface (OpenMI) Interface Standard

1) Overview
2) Downloads
3) Related News

1) Overview
The purpose of the Open Modelling Interface (OpenMI) is to enable the runtime exchange of data between process simulation models and also between models and other modelling tools such as databases and analytical and visualization applications. Its creation has been driven by the need to understand how processes interact and to predict the likely outcomes of those interactions under given conditions. A key design aim has been to bring about interoperability between independently developed modelling components, where those components may originate from any discipline or supplier. The ultimate aim is to transform integrated modelling into an operational tool accessible to all and so open up the potential opportunities created by integrated modelling for innovation and wealth creation.

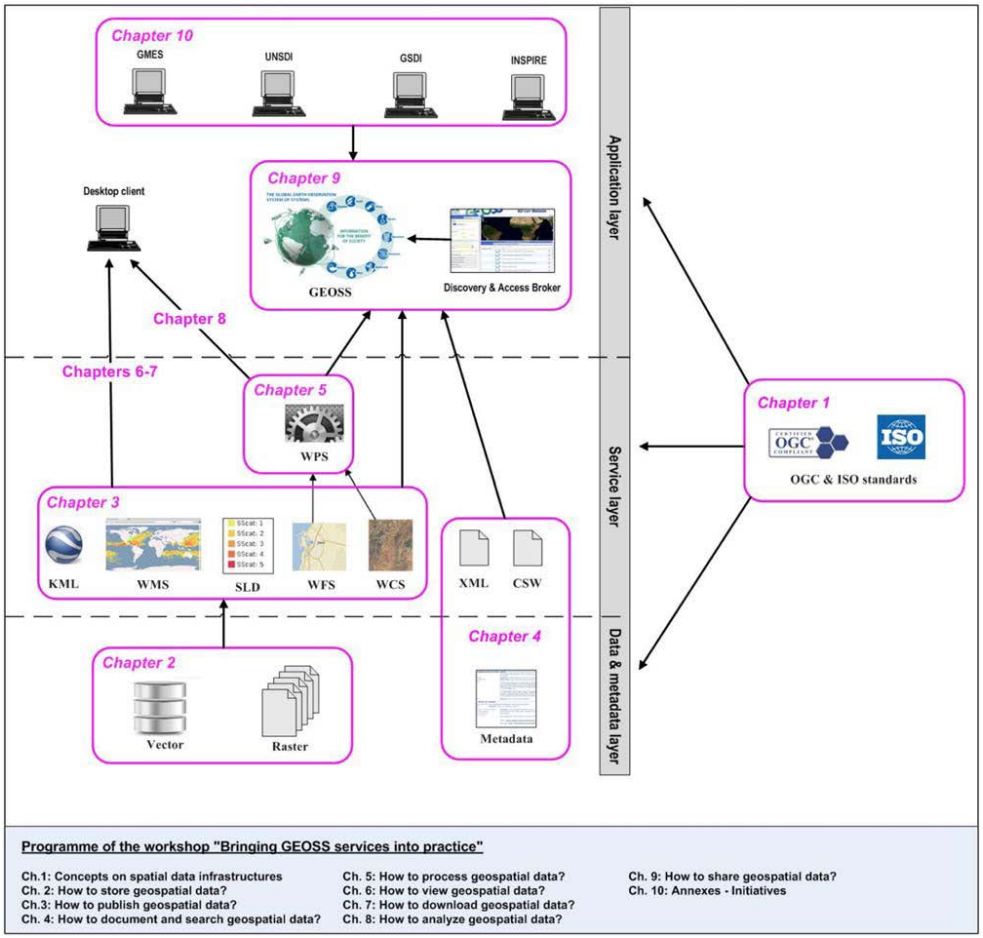
Transactions in GIS

Short Technical Note

Transactions in GIS, 2016, 00(00): 00–00

Bringing GEOSS Services into Practice: A Capacity Building Resource on Spatial Data Infrastructures (SDI)

Gregory Giuliani,* Pierre Lacroix,* Yaniss Guigoz,* Roberto Roncella,† Lorenzo Bigagli,† Mattia Santoro,† Paolo Mazzetti,† Stefano Nativi,† Nicolas Ray* and Anthony Lehmann*



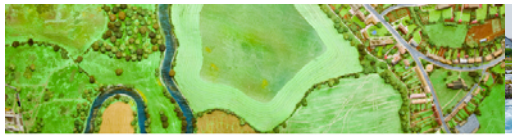
New Summer School: 4-15 septembre 2017

CAS | Certificate of Advanced Studies
Certificat de formation continue

www.unige.ch/formcont/casgeomatics

Geomatics for a Sustainable Environment

July > December 2017




Presential and Distance Learning

Module 1 | **MOOC on Ecosystem Services**
July-August 2017
Dr Martin Schlaepfer, Prof. Juliet Fall, Prof. Lehmann

- Basics of Ecosystem Services
- Understanding of the key services associated with any resource
- Mapping of the ecosystem services with GIS tools

MOOC available at: coursera.org/learn/ecosystem-services

Module 2A | **Summer School in Presence at University of Geneva**

GIS Introduction | 4 September 2017
Prof. Lehmann, Dr Yaniss Guigoz, Dr Pierre Lacroix
General Introduction • Basics of GIS • Quantum GIS (QGIS) Software

Remote Sensing | 5 September 2017
Ms Karin Allenbach, Mr Bruno Chatenoux
Basics of Remote Sensing • Open Source Remote Sensing Software: GRASS GIS

SDI – Metadata | 6 September 2017
Dr Andrea de Bono, Dr Grégory Giuliani, Dr Yaniss Guigoz
Spatial Data Infrastructure (SDI) General Introduction • Basics of Metadata • Geonetwork software

SDI – Data | 7 September 2017
Dr Yaniss Guigoz, Dr Pierre Lacroix
Geoserver Software • GeoNode Software

Geoprocessing | 8 September 2017
Dr Grégory Giuliani, Dr Pierre Lacroix
Overview of Geoprocessing Concepts • Python Language

Statistics and Geostatistics | 11 September 2017
Prof. Anthony Lehmann
Overview of Statistics and Geostatistics Concepts • Programming Statistics in R

Species Distribution Modeling | 12-13 September 2017
Prof. Anthony Lehmann, Prof. Antoine Guisan
Introduction to Species Distribution Modeling and Biodiversity Assessment • Modeling in R
OR
Soil and Water Assessment | 12-13 September 2017
Dr Karim Abbaspour, Mr Marc Fasel
Introduction to Hydrological Modeling • Preparing a SWAT Model with QGIS • Calibrating a SWAT Model with SWAT-CUP

Ecosystem Services Assessment | 14-15 September 2017
Prof. Anthony Lehmann, Mr Martin Lacayo
Introduction to Ecosystem Services • Assessing Ecosystem Services with InVEST • Assessing Ecosystem Services with Python

Field trip (optional) | 9 September 2017

Module 2B | **Integrative Work**
September-November 2017

- Personal project based on the theme defined during the enrollment and validated during the summer school, using the knowledge and tools acquired during the training
- The personal project should include some concepts learnt during the modules 1 and/or 2A
- The professional or research topic will be discussed individually during the summer school

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Conclusions

- Data sharing through **Spatial Data Infrastructures** (SDI) is needed to access faster the necessary data for hydrological modeling and publish the outputs
- Integrated hydrological models such as **SWAT and Ecosystem services** assessment can serve as a central concept for the **Nexus** approach to allow for tradeoffs and synergies analyses
- **Essential Water Variables** need to be clarified for policy purposes and SWAT can beneficiate from them as inputs and contribute to model them as outputs

The combination of these elements can significantly improve the connection between: **Data > Model > Decision making**

It would help if data web services included metadata (like NetCDF) and were searchable on the Internet as regular web pages

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