SWAT Interoperability Using Web Service Workflows

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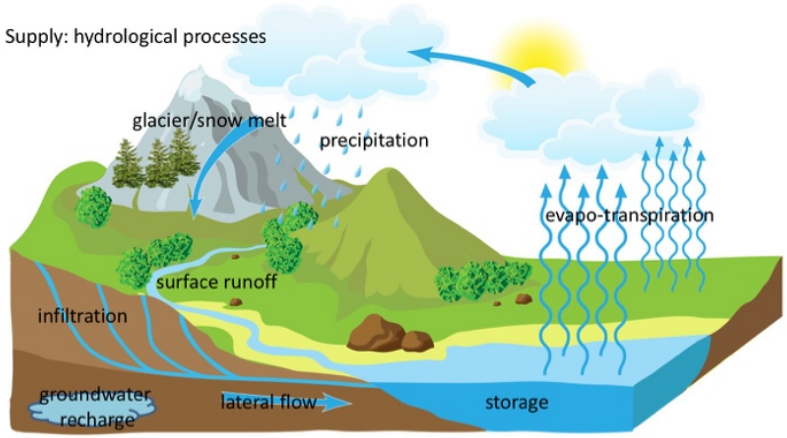
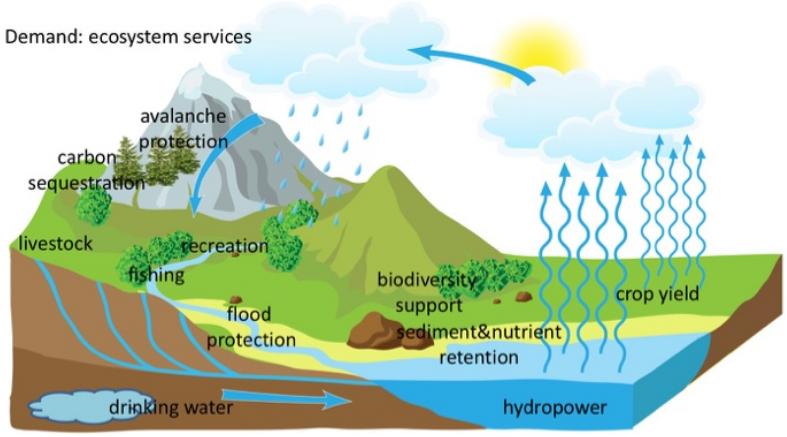
SWATCH21: ES supplies and demands

SWATCH21
Swiss Rivers Services





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

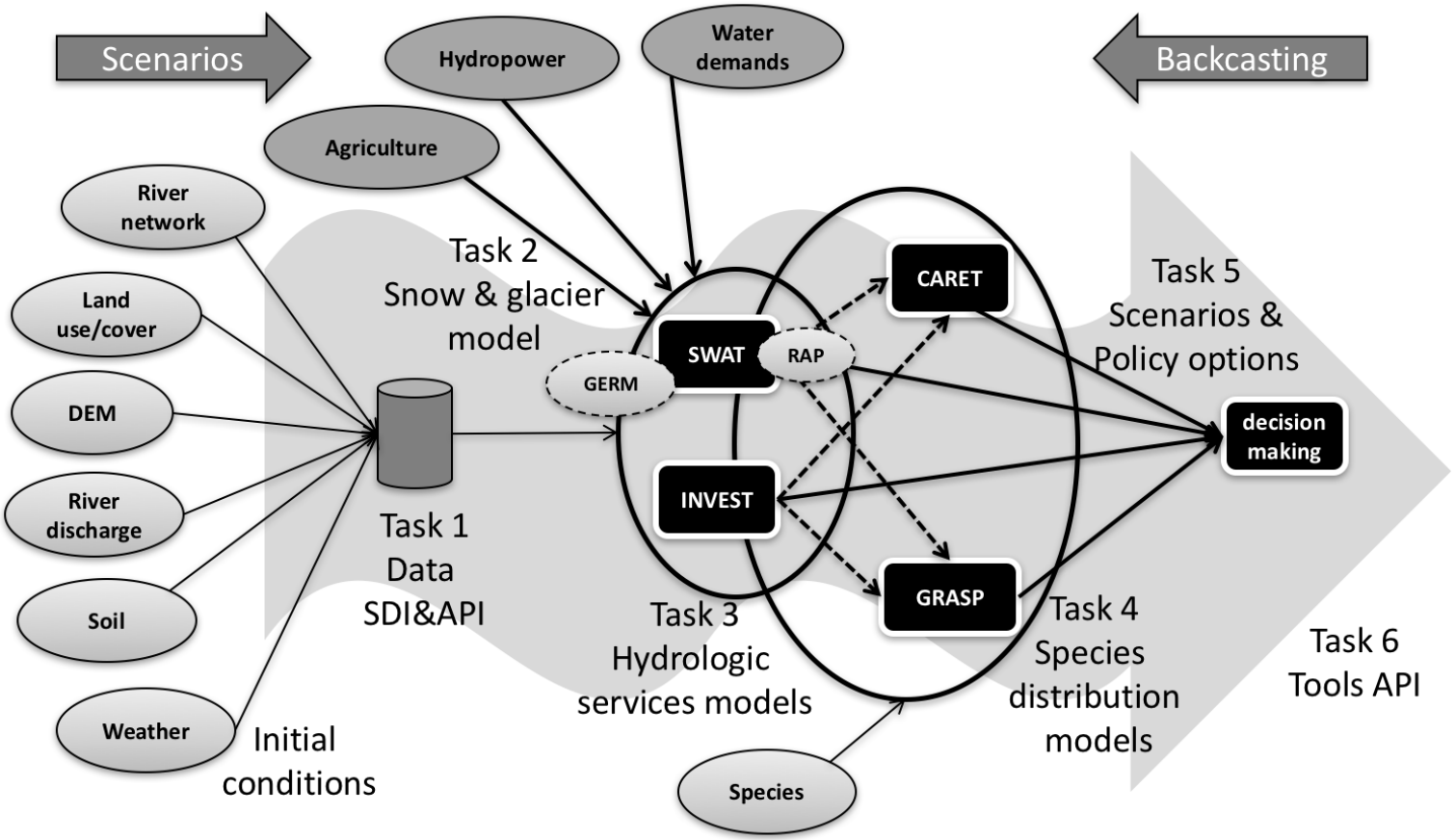
§ Biodiversity: the ecosystem diversity will be assessed by downscaling existing land use information from 100m (geostat) resolution to 25m (Lehmann et al. unpublished).
§ Flood protection: The Critical Consecutive Days Analyzer (CCDA) has been developed at EAWAG (Vaghefi et al. in prep.).
§ Nutrient 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.

SWATCH21: workflow and APIs

SWATCH21
Swiss Rivers Services



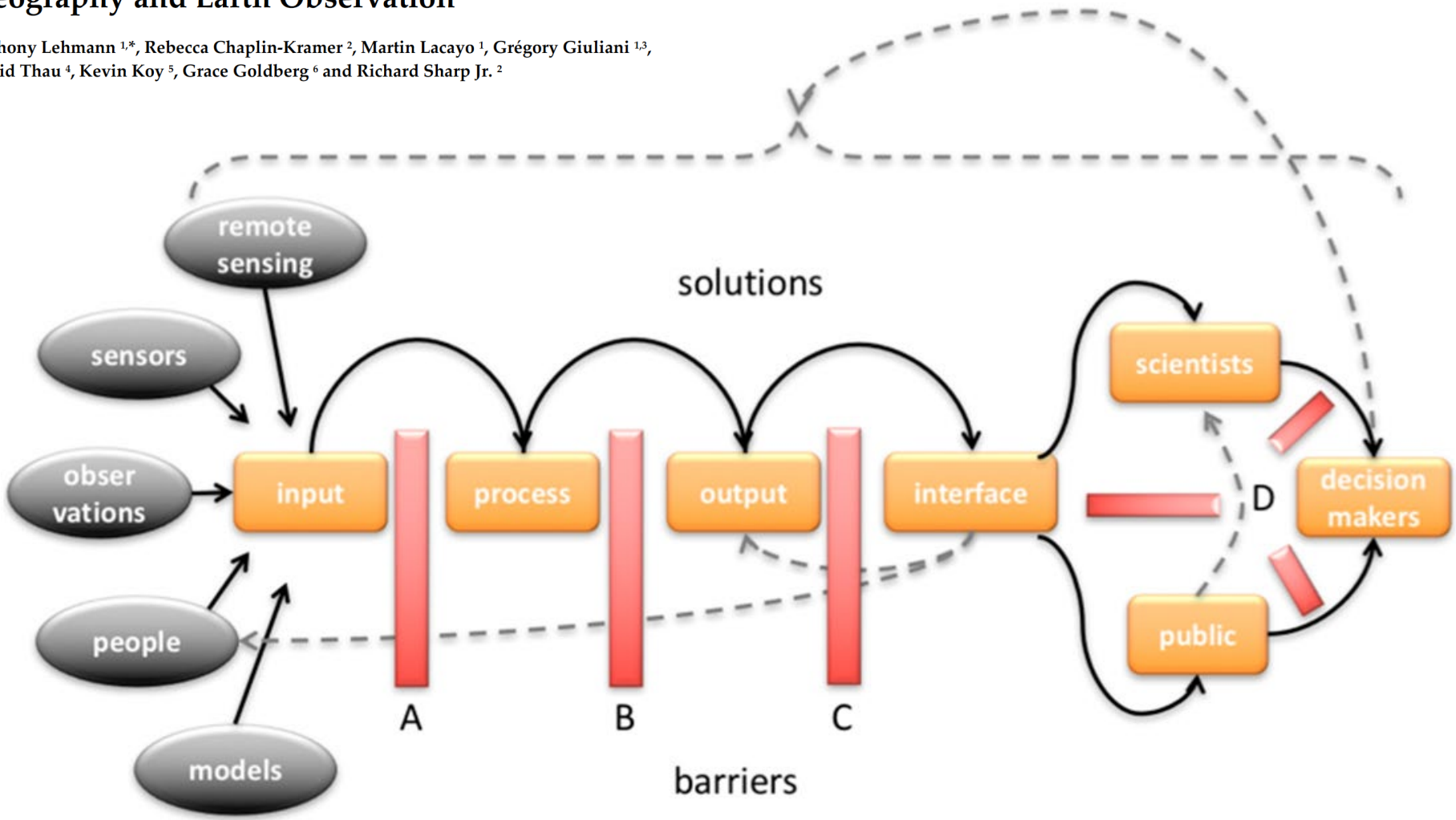
sustainability

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]



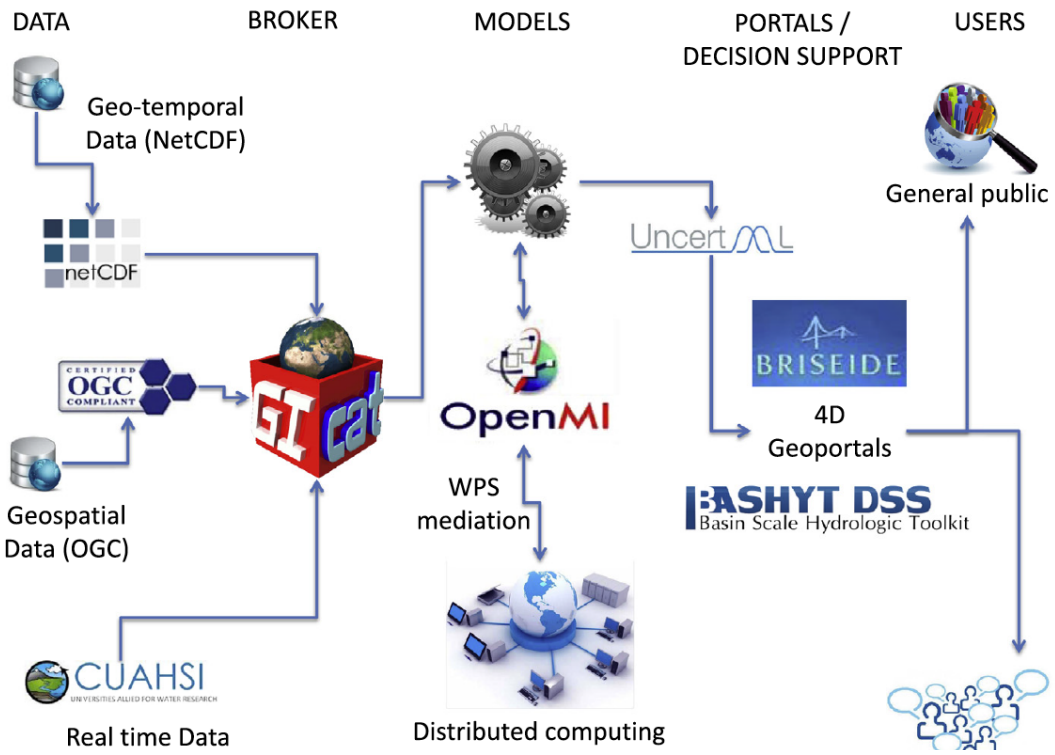
Contents lists available at ScienceDirect

Journal of Hydrology

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

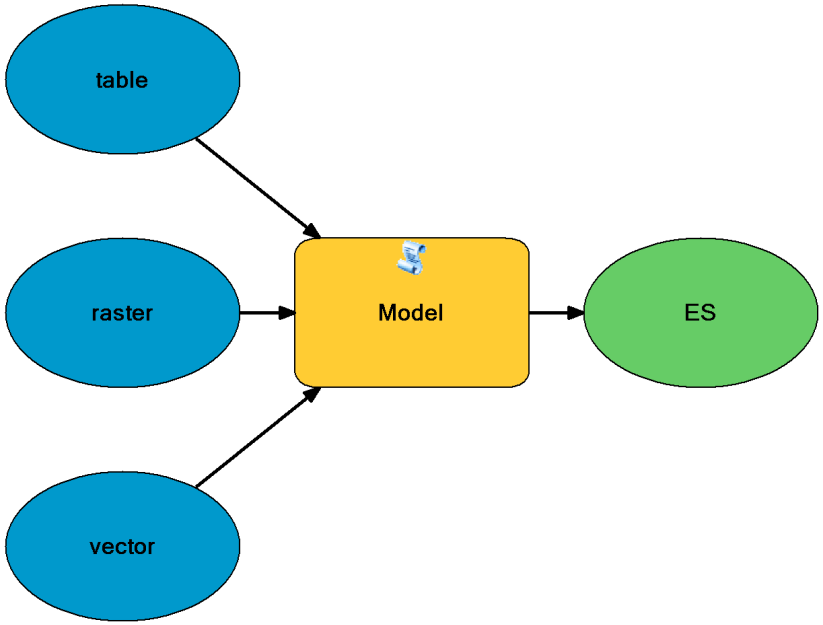
Reviewing innovative Earth observation solutions for filling science-policy gaps in hydrology

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]



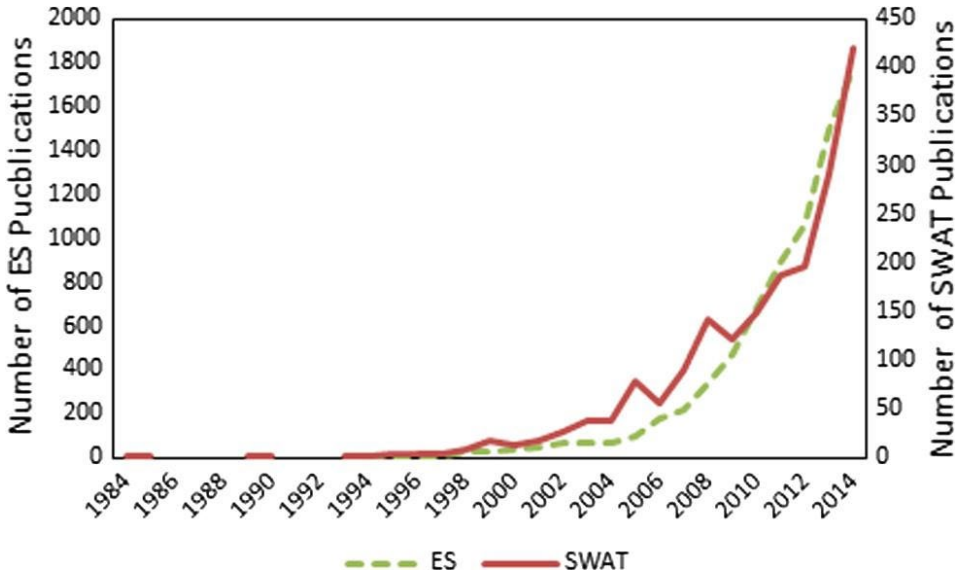
Motivation

- Facilitate scientific analysis
  - Integrate spatially explicit models
- Workflows
  - Reduce human resources
  - Reduce errors
  - Increase accessibility
  - Increase transparency



SWAT Ecosystem Services

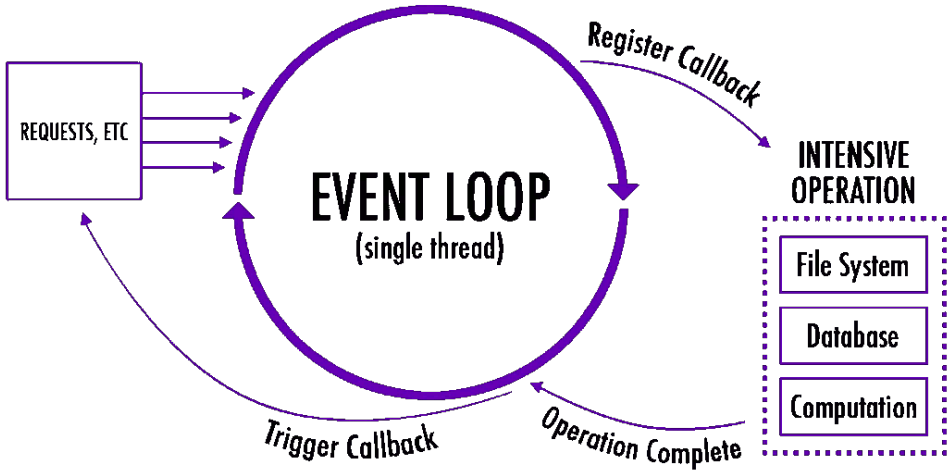
- Water quantity
- Sediment regulation
- Water quality
- Flood regulation
- Carbon sequestration
- Habitat quality



Source: Francesconi et al 2016

Web Service Workflows

- Available through the web (thin client)
- Portable
- Reusable
- Potential
  - Collaborative
  - Transparent
    - Documentation
    - Replication
  - Aware
    - Supervised (curation)
    - Unsupervised (inference)

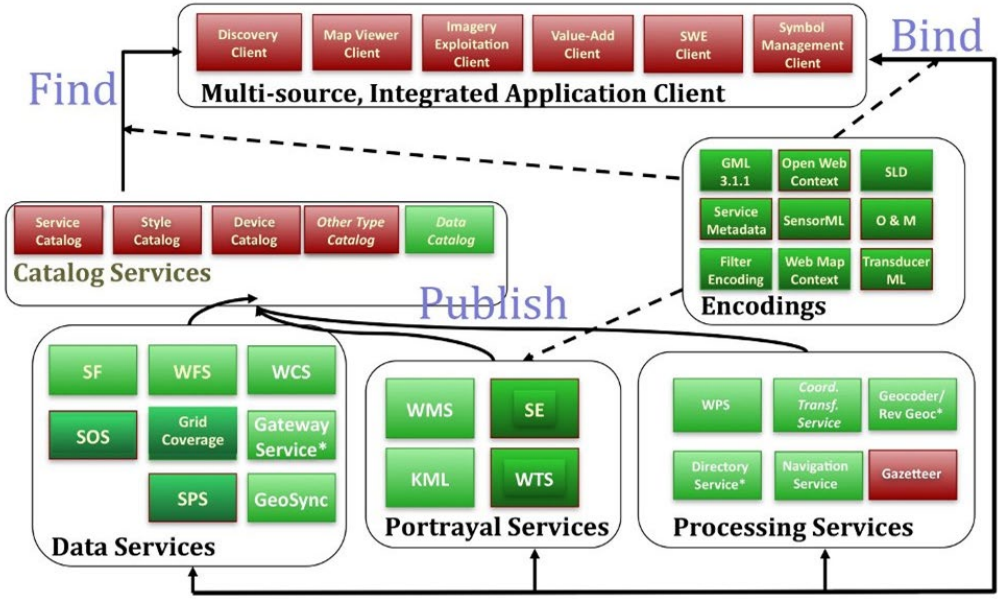


Graphic source: StackOverflow.com/q/21596172

Open Geospatial Consortium Web Services (OWS)

- Web feature service (WFS)
- Web coverage service (WCS)
- Web processing service (WPS)

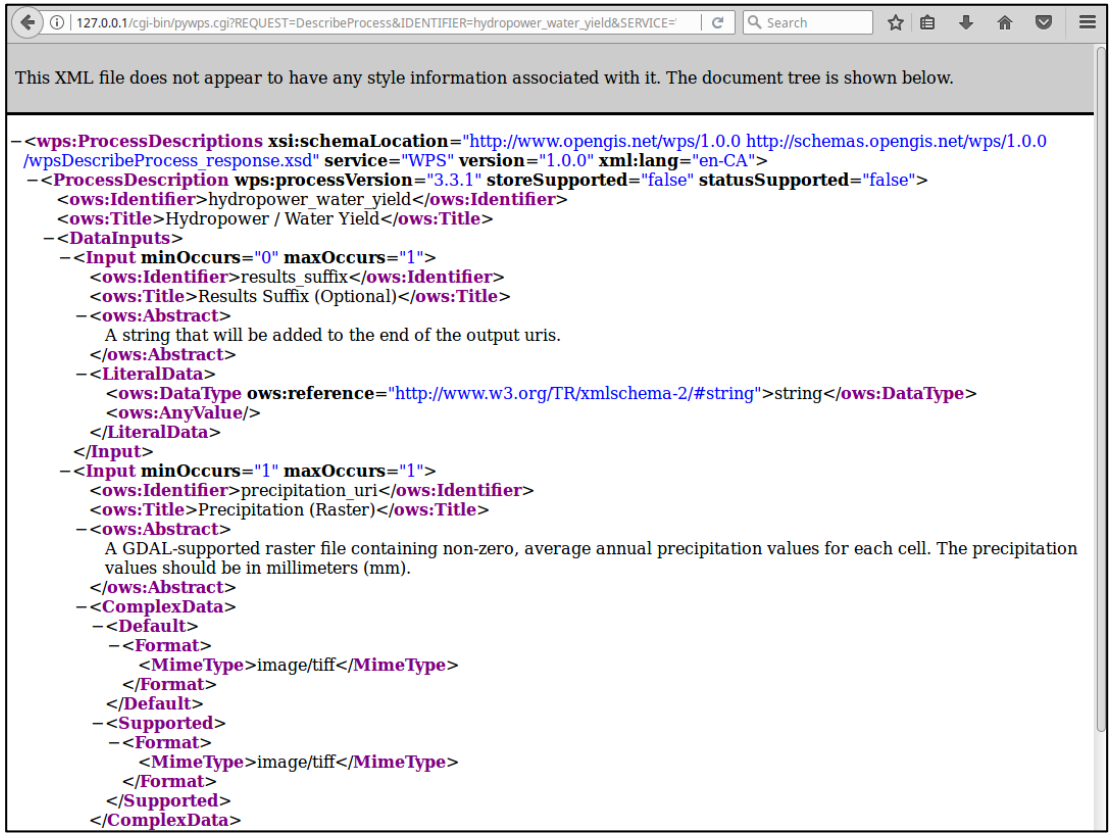
- Table joining service (TJS)
- Catalog service for the web (CSW)
- Web mapping service (WMS)
- WaterML and more!



Source: Open Geospatial Consortium

OWS Usage

- GeoServer
- PyWPS
- OWSLib
- GET HTTP
- POST XML

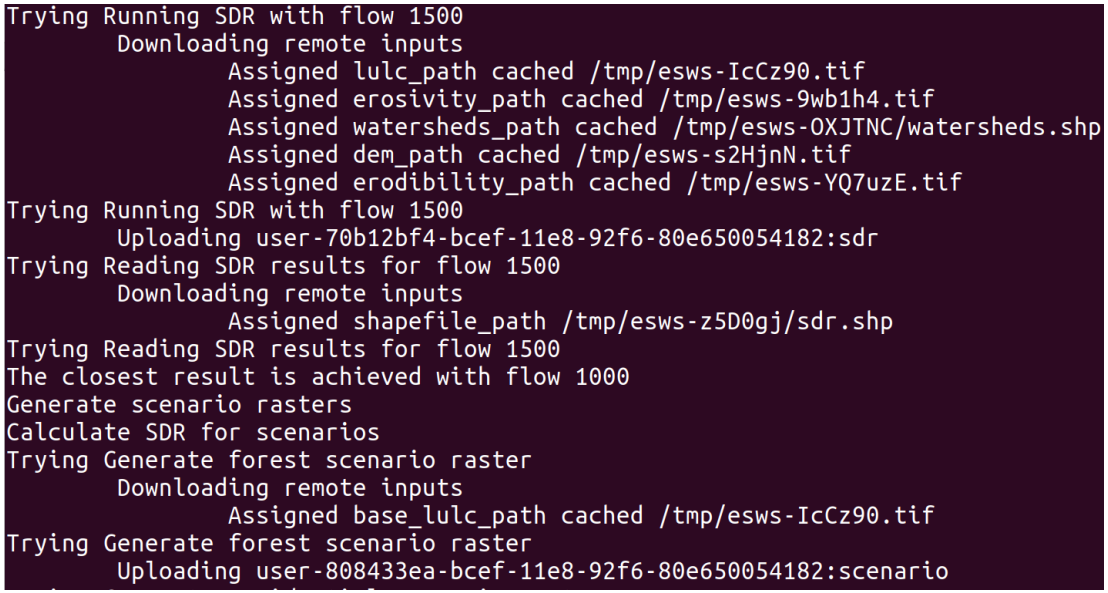


Approaches and Challenges

- Internal process for GeoServer (Jython porting!)
- OWSLib client and PyWPS server (Specification incompatibilities!)
- QGIS plugin (Library version incompatibilities!)

Prototype

- **Work in progress…**
- gsconfig (REST API) uploads
- HTTP downloads
- Python scripts
  - Shapefile input and output with WFS
  - GeoTiff input and output with WCS
  - CSV input and output with HTTP
  - SUB to CSV
  - CSV join with shapefile



Mixed Model Example

gs_ows_example.py - /home/mlacayo/workspace/esws/tools/invest/gs_ows_example.py (2.7....

File Edit Format Run Options Window Help

```
        #run SDR with the current parameters
        #natcap.invest.sdr.execute(args)

        ws = make_named_workspace()

        layer_name = ":".join([ws, "sdr"])

        uploads = {
            layer_name : os.path.join(args[u'workspace_dir'], u'watershed_results_sdr.shp')
        }

        job_queue.append([0,
                          natcap.invest.sdr.execute,
                          args,
                          uploads,
                          "Running SDR with flow %i" % flow])


        args = {
            "shapefile_path" : layer_url(layer_name),
            "key" : flow,
            "csv_path" : csv_path}

        uploads = {}

        job_queue.append([0,
                          extract_wrapper,
                          args,
                          uploads,
                          "Reading SDR results for flow %i" % flow])
```

Ln: 281 Col: 34

SWAT Example

swat.py - /home/mlacayo/workspa...

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```
import os

model_path = "c:\\swat_sample\\model"
swat_exe = "swat.exe"

cmd = os.path.join(model_path, swat_exe)

print "Runnng %s" % cmd
os.chdir(model_path)
os.system(cmd)
```

Ln: 1 Col: 0

swat.py - /home/mlacayo/workspa...

File Edit Format Run Options Window Help

```
os.chdir(model_path)
os.system(cmd)

sub_path = os.path.join(model_path,
                        "output.sub")
shp_path = "c:\\swat_sample\\subs1.shp"

shp_join_sub.join(shp_path, sub_path)
easyows.publish_shp(shp_path)
```

Ln: 19 Col: 0

Summary

- Need for model integration to streamline the data to decision making process
- Web service workflows can achieve this with existing standards
- Implementation can be challenging, but the benefits are worthwhile

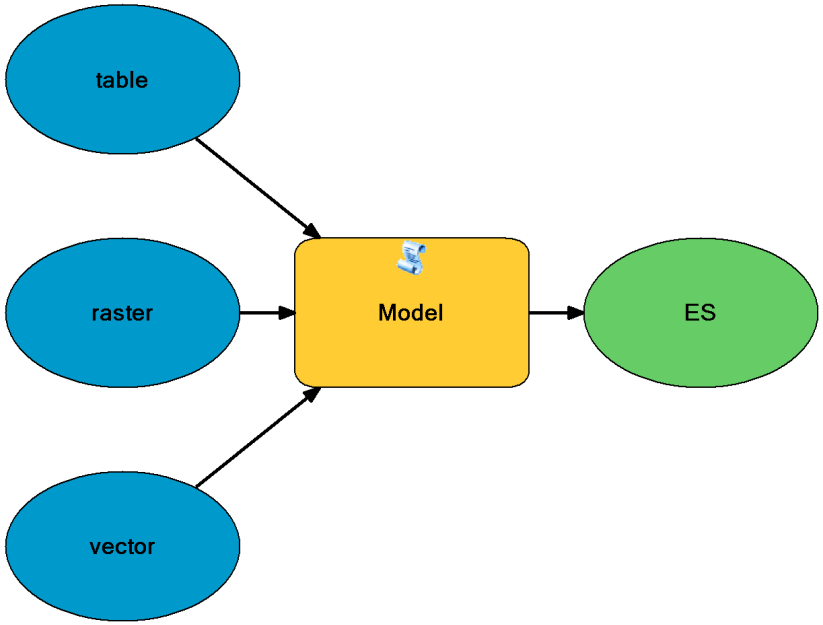
Future Work

6 months

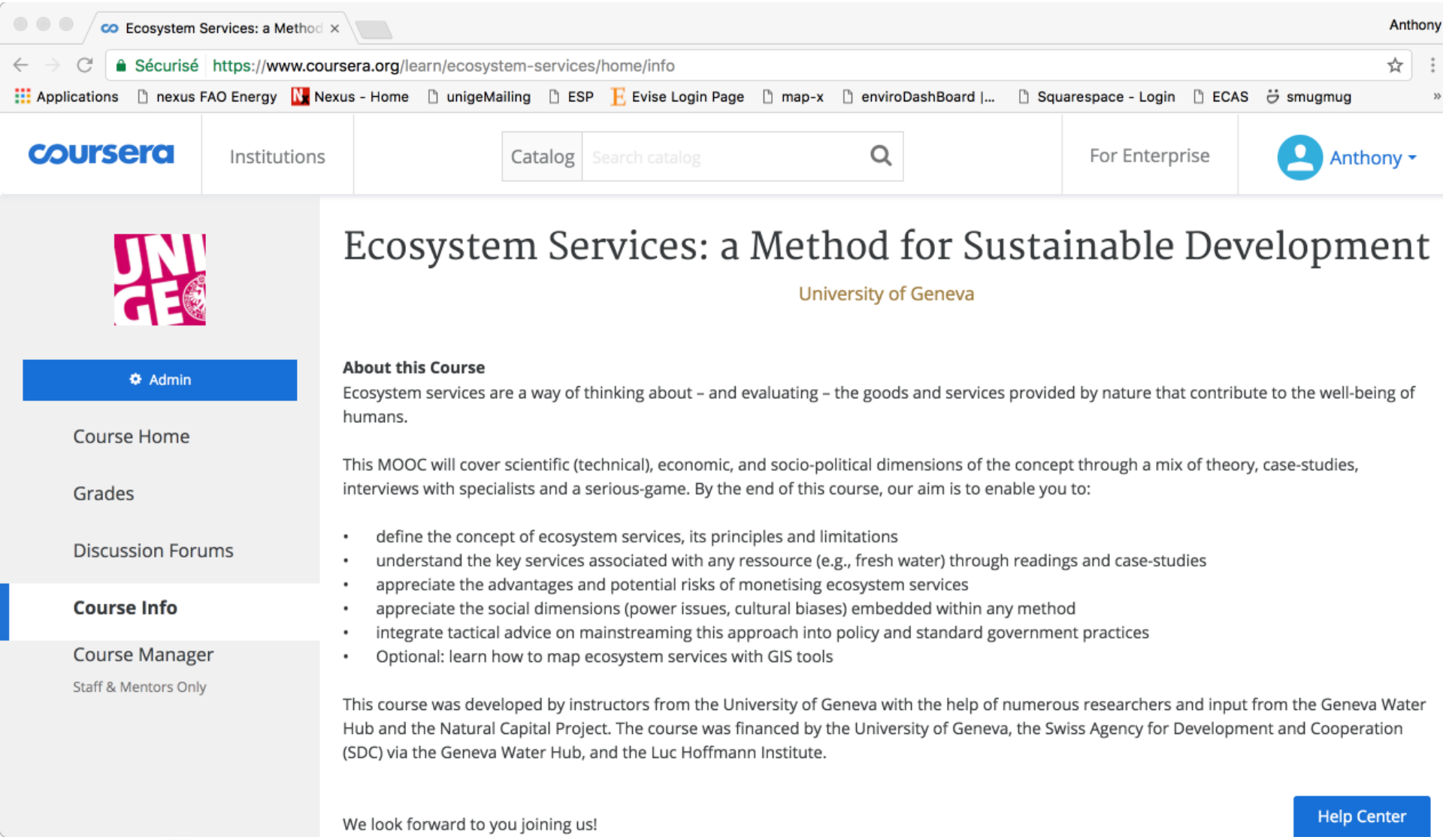
- ~WPS execution
- Python library
- Command line tools
- Documentation

Later

- QSWAT scripting?
- Visual programming environment



New MOOC on Ecosystem services



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https://www.coursera.org/learn/ecosystem-services

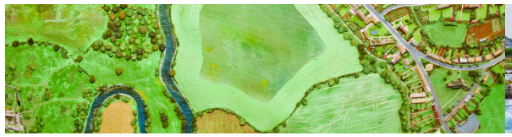
Next Summer School: June 2019

CAS | Certificate of Advanced Studies
Certificat de formation continue

www.unige.ch/formcontinue/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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THANK YOU

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