SWAT Interoperability Using Web Service Workflows

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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 unpublished).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. GRASP160,161 or MARS162)
§ 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.
Case Report

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

Anthony Lehmann, Rebecca Chaplin-Kramer, Martin Lacayo, Grégory Giuliani, David Thau, Kevin Koy, Grace Goldberg and Richard Sharp Jr.
Reviewing innovative Earth observation solutions for filling science-policy gaps in hydrology

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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

```python
# 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])
```
import os

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

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

print "Running %s" % cmd
os.chdir(model_path)

os.system(cmd)

Ln: 1 Col: 0

os.chdir(model_path)

sub_path = os.path.join(model_path, "output.sub")

shp_path = "c:\\swat_sample\\sub1.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

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

Ecosystem Services: a Method for Sustainable Development

University of Geneva

About this Course
Ecosystem services are a way of thinking about – and evaluating – the goods and services provided by nature that contribute to the well-being of humans.

This MOOC will cover scientific (technical), economic, and socio-political dimensions of the concept through a mix of theory, case-studies, interviews with specialists and a serious-game. By the end of this course, our aim is to enable you to:

- define the concept of ecosystem services, its principles and limitations
- understand the key services associated with any resource (e.g., fresh water) through readings and case-studies
- appreciate the advantages and potential risks of monetising ecosystem services
- appreciate the social dimensions (power issues, cultural biases) embedded within any method
- integrate tactical advice on mainstreaming this approach into policy and standard government practices
- Optional: learn how to map ecosystem services with GIS tools

This course was developed by instructors from the University of Geneva with the help of numerous researchers and input from the Geneva Water Hub and the Natural Capital Project. The course was financed by the University of Geneva, the Swiss Agency for Development and Cooperation (SDC) via the Geneva Water Hub, and the Luc Hoffmann Institute.

We look forward to you joining us!

https://www.coursera.org/learn/ecosystem-services
Next Summer School: June 2019

www.unige.ch/formcont/casgeomatics

Geomatics for a Sustainable Environment
July > December 2017

Module 1 | MOOC on Ecosystem Services
July-August 2017
Dr Martin Schlappfer, 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 Guizouz, Dr Pierre Lacroix
General Introduction • Basics of GIS • Quantum GIS (QGIS) Software
Remote Sensing | 5 September 2017
Ms Karin Allenhac, Mr Bruno Chalamoux
SDI – Metadata | 6 September 2017
Dr Andrea de Bono, Dr Grégoire Giuliani, Dr Yaniss Guizouz
Spatial Data Infrastructure (SDI) General Introduction • Basics of Metadata • Geonetwork software
SDI – Data | 7 September 2017
Dr Yaniss Guizouz, Dr Pierre Lacroix
GeoServer Software • GeoNode Software
Geoprocessing | 8 September 2017
Dr Grégoire Giuliani, Dr Pierre Lacroix
Overview of Geoprocessing Concepts • Python Language

Module 2B | 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
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) | 19 September 2017

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
THANK YOU