Using Free and Open Source Solutions in Geospatial Science Education

Tools and ideas for better geospatial science education

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FOSS4G Europe

Free and open source software

Open Source Software Is Now a Norm in Businesses

Katherine Noyes, PCWorld, May 18, 2011

Open Source has Become Mainstream but Still Drives Innovation

Talend Yves de Montcheuil, ZDNet, May 2, 2012

10 of Europe's 15 largest banks are now running [...] Postgres

Sandor Klein said for ZDNet (Toby Wolpe), November 19, 2013

Redmond top man Satya Nadella: 'Microsoft loves Linux'

Neil McAllister, The Register, October 20, 2014

Survey indicates four out of five developers now use open source

Steven J. Vaughan-Nichols, ZDNet, October 29, 2014

64% of internet exchange points are now using [...] an open source solution

Gijs Hillenius, Joinup Open source observatory, June 8, 2015

Open Sourcing Is No Longer Optional, Not Even for Apple

Klint Finley, WIRED, June 9, 2015

Free and open source software

Software [...] developed as part of novel methods is as important for the method's implementation [...] Such software [...] must be made available to readers upon publication.

Nature Methods 4, 189, 2007

The opposite of 'open' isn't closed. The opposite of open is 'broken.'

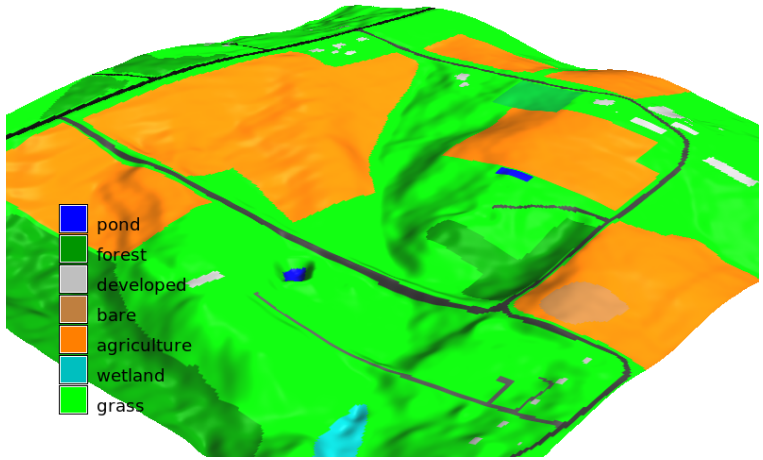
Cable Green (quoting John Wilbanks) at Open Scotland Summit 2013

Image credit: Opensource.com

Courses at North Carolina State University

Geospatial Analysis and Modeling

- started in 2008
- on-campus and distance education
- every semester 30-60 students
- software:
  - GRASS GIS
  - ArcGIS
- workflow for software provided
- students write reports with general theory and methods

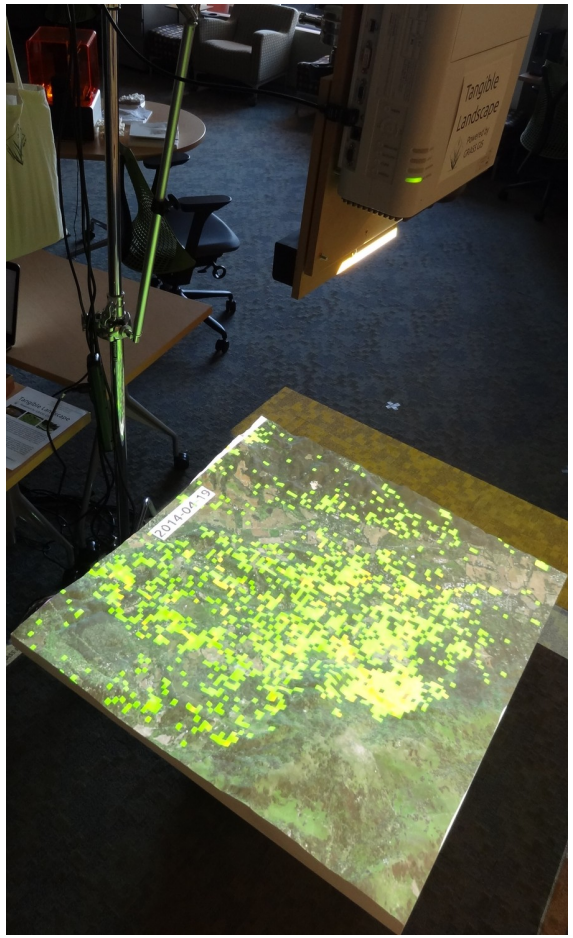


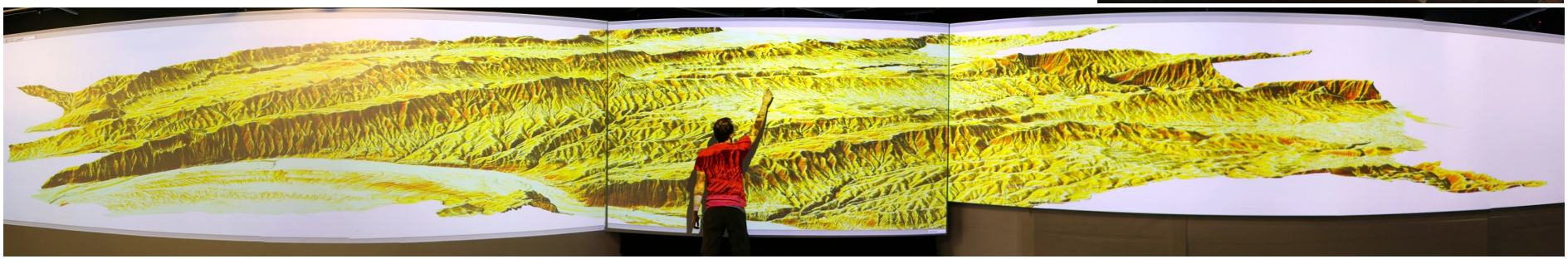
Listing only geospatial courses where presentation authors are involved.

Courses at North Carolina State University

Multidimensional Geospatial Modeling

- software:
  - GRASS GIS often with new features such as Temporal Framework (GRASS GIS 7)
  - + whatever the students need, e.g. XBeach, libLAS or LAStools
- curriculum depends on students projects
- new technologies: Tangible Landscape, NCSU Hunt Lib Teaching and Vis Lab, eye tracking





Courses at North Carolina State University

GIS for Designers

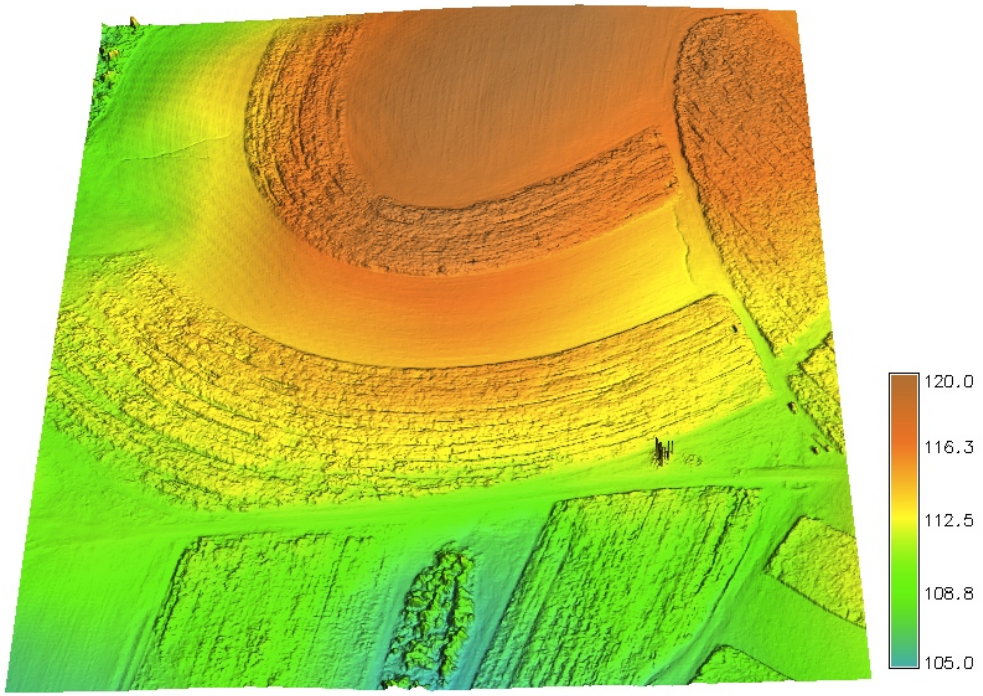
- software in class:
  - ArcGIS
  - GRASS GIS
  - Rhino (Rhinoceros)
- for projects architects and designers combine a lot of tools
  - Tangible Landscape (powered by GRASS GIS) was one of them

Courses at North Carolina State University

UAV/lidar Data Analytics

- under development for this fall semester
- Agisoft PhotoScan in class, OpenDroneMap in projects

Related talk: Flow analysis using sUAS and lidar data (Helena Mitasova)



The idea

- lectures:
  - theory, concepts
  - software-independent
- labs and assignments:
  - relate to given lecture
  - hands-on, practical
  - students use software

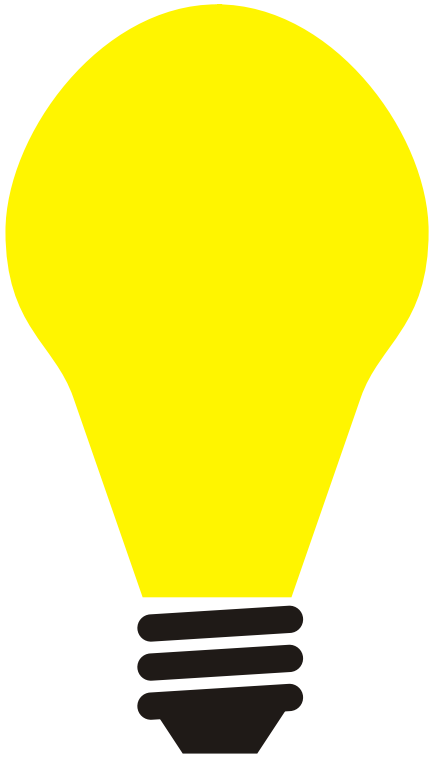


Image credit: Openclipart

The problem

- students are becoming (only) software users instead of scientists
- students mix software details and general concepts
  - saying Shapefile or feature class instead of *vector* data...
- bonding with software limits flexibility
- software promotes software/vendor-specific formats/technologies
- single software choice limits explored algorithms

The solution

- lectures:
  - theory, concepts
  - software-independent
- labs and assignments:
  - relate to given lecture
  - hands-on, practical
  - students use two different software packages, in our case:
    - GRASS GIS (free and open source)
    - ArcGIS (proprietary)
- similar task in both
- opportunity to see what is a general concept and what is specific to a particular software

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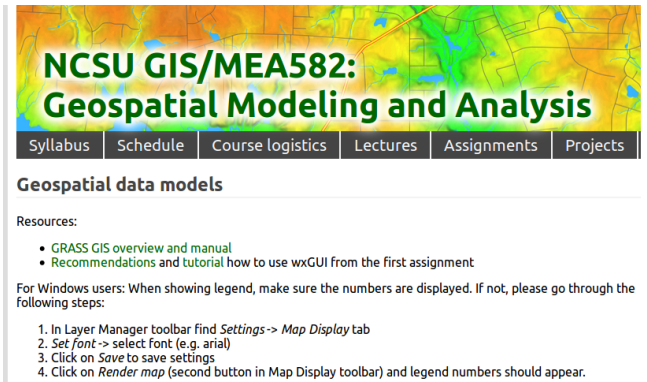
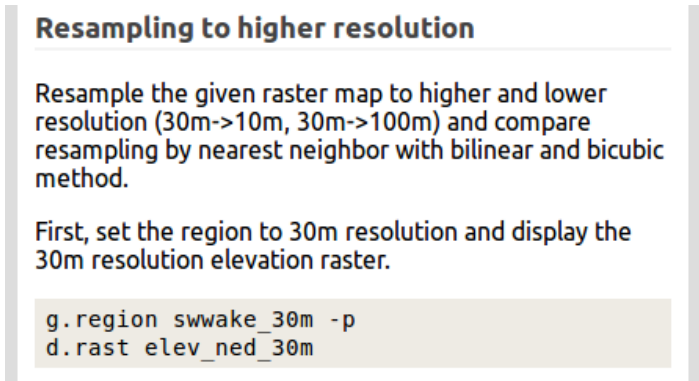
Teaching materials

- file format
  - originally HTML
  - selecting new one
    - Markdown, missing general standard
    - reStructuredText, hot candidate
  - result: HTML (same as delivery format)
  - presentation slides in HTML5 (Reveal.js)
- license: CC BY-SA
- Git (GitHub hosted) for revision control, collaboration and sharing source code

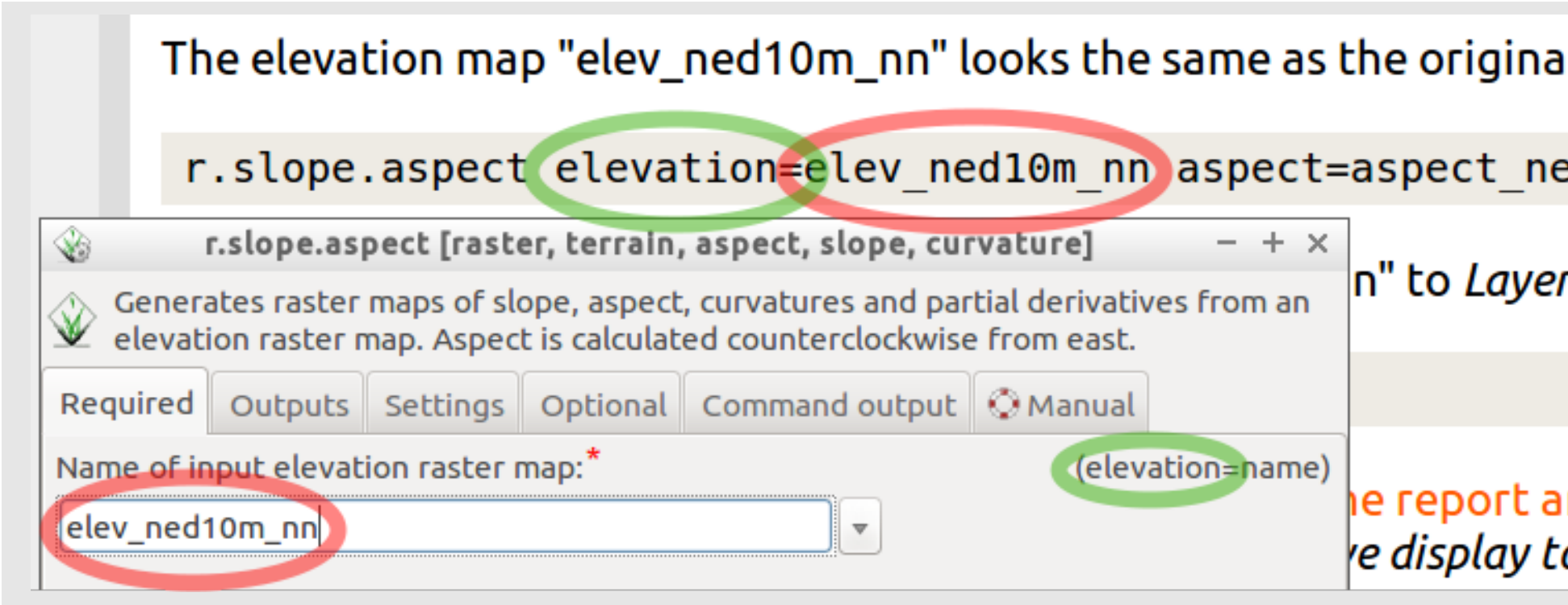
`geospatial.ncsu.edu/osgeorel/courses.html`





GRASS GIS advantage for teaching materials maintenance

- GRASS GIS workflow recorded as commands.
  - Screenshots are hard to update while text is easy to update.
  - GUI dialog filled according to the command.
  - Commands can be automatically extracted and tested.



For ArcGIS we also use just text, but, unlike in GRASS GIS, the names in dialogs are not part of the API, so they change more often. (Course running since 2008.)

Paper

Integrating Free and Open Source Solutions into Geospatial Science Education

Open Access

Vaclav Petras[1,4], Anna Petrasova[1,4], Brendan Harmon[2,4], Ross K. Meentemeyer[3,4], and Helena Mitasova[1,4]

[1]Department of Marine, Earth, and Atmospheric Sciences
[2]Department of Landscape Architecture
[3]Department of Forestry and Environmental Resources
[4]Center for Geospatial Analytics and NCSU OSGeoREL – part of ICA-OSGeo-ISPRS Network (aka Geo for All)
North Carolina State University, Raleigh, USA

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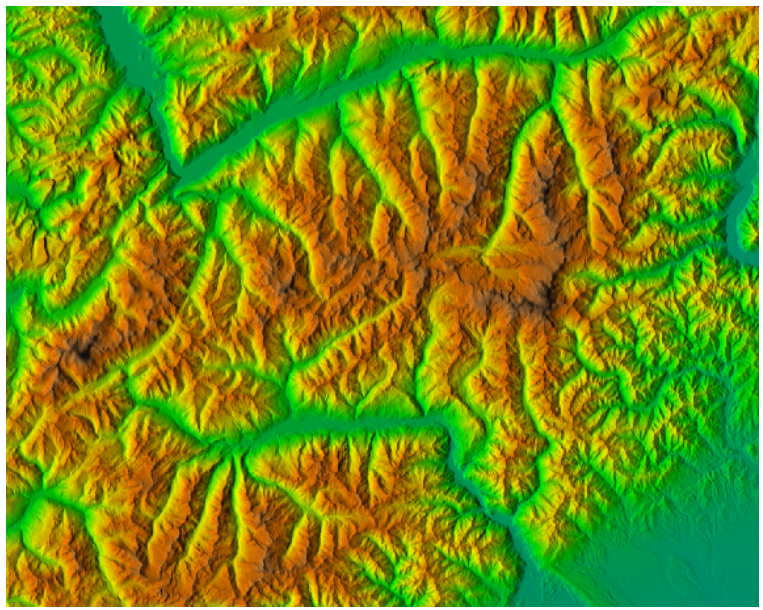
Standardized Sample Datasets

- region specific datasets limit sharing of hands-on teaching material
- new version of North Carolina
  - commonly available data, frequently used in examples
  - standardized names such as *elevation*, *streets*, or *lakes*
    - rather than *srtm*, *dem_10m*, *streets_como*
- different datasets should use the same standardized names
- challenges:
  - attributes, coordinates, values, extents, resolutions

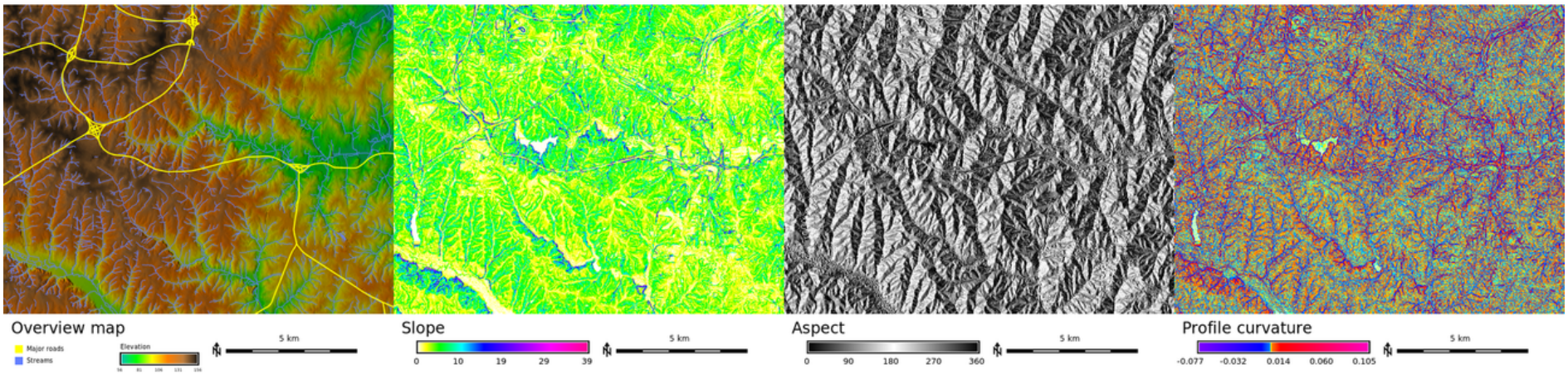
```
g.region raster=elevation
r.relief input=elevation output=shade

d.shade shade=shade color=elevation
```

▶ wiki page



Standardized Sample Dataset: North Carolina, USA

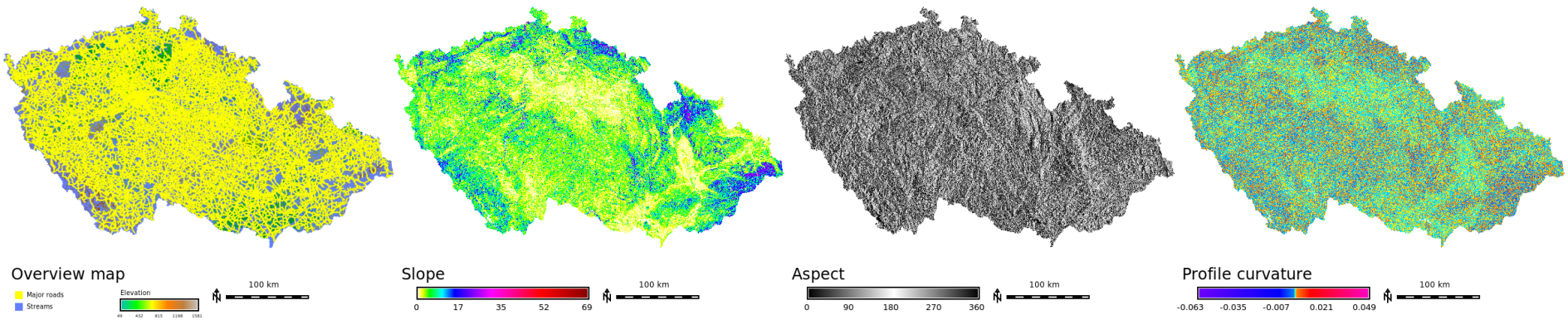


Helena Mitasova[1] and Markus Neteler[2], authors of
Open Source GIS: A GRASS GIS Approach (fourth edition in preparation)

[1]Department of Marine, Earth, and Atmospheric Sciences, North Carolina State University, USA

[2]Research and Innovation Centre, Fondazione Edmund Mach, Italy

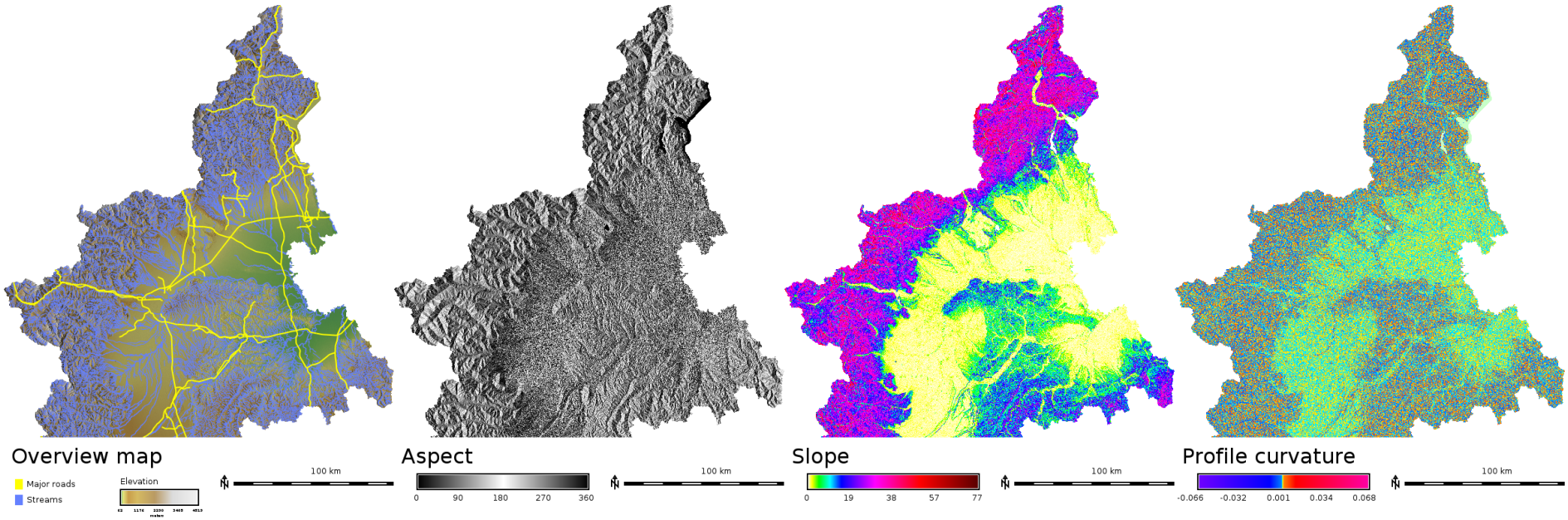
Standardized Sample Dataset: Czech Republic



Martin Landa* and Jachym Cepicky from GISMentors

*OSGeoREL at Czech Technical University in Prague, Faculty of Civil Engineering

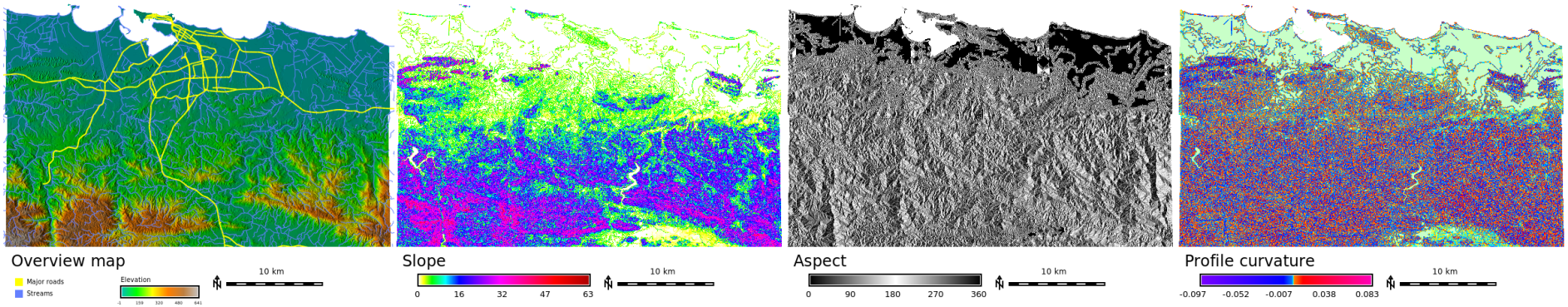
Standardized Sample Dataset: Piedmont, Italy



Luca Delucchi and Markus Neteler

Research and Innovation Centre, Fondazione Edmund Mach, Italy

Standardized Sample Dataset: Puerto Rico



Keren Cepero Perez

Department of Marine, Earth, and Atmospheric Sciences, North Carolina State University, USA

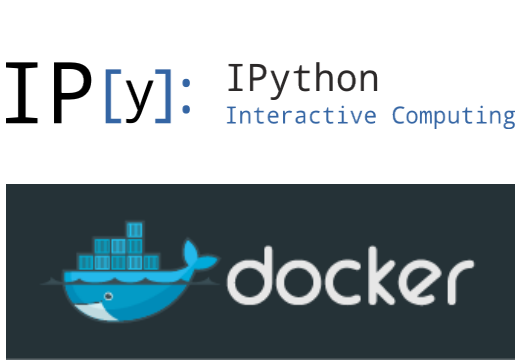
Future directions: IPython Notebook

Used in workshop *How to write a Python GRASS GIS 7 addon*

- `https://github.com/wenzeslaus/python-grass-addon`

Solution

- Docker + GRASS GIS + IPython Notebook
- Dockerfile:
  - `https://github.com/wenzeslaus/grass-gis-docker`



NCSU OSGeoREL workshops and tutorials

Introduction to GRASS GIS

Delivered at NCSU

Spatio-temporal data handling and visualization in GRASS GIS

FOSS4G 2014 (Portland) workshop, also delivered at NCSU

Soil erosion and deposition modeling

Part of a broader project; workflows for GRASS GIS and ArcGIS

How to write a Python GRASS GIS 7 addon

FOSS4G Europe 2015 (Como) workshop, also delivered at NCSU

Workshops are a way how to experiment with what to teach and how.

Future directions: Tools for open science course

- Course dedicated to
  - exploring important role FOSS plays in science
  - overview of tools and methods common in FOSS and desperately needed in science
  - open access, open data, open standards, open...
  - reusability and reproducibility are standard in FOSS

Image credit: Opensource.com

Future directions: Software, technologies and platforms

- OpenStreetMap, TeachOSM, LearnOSM
  - for introduction to geography or GIS
  - as an example of community-based project
  - as data source in advanced courses
- MapStory for student projects
- GIS.lab for easy lab setup
- IPython/Jupyter, JupyterHub, tmpnb
- desktop to browser: GTK+ Broadway, noVNC (to get something like rollApp)
- web-based tool to explore algorithm behavior in teaching materials
- link teaching materials, standard user manual and the source code

Summary

- improve students' geospatial skills by teaching 2 software packages
- use available tools like Git and HTML to create teaching materials
- create a dataset with standardized names for your region

`github.com/wenzeslaus/foss-in-geospatial-science-education`