Using Free and Open Source Solutions in Geospatial Science Education

How to make education better for science and future

Vaclav Petras (Vashek)

Anna Petrasova, Keren Cepero Perez, Markus Neteler,

Luca Delucchi, Martin Landa, Helena Mitasova

North Carolina State University
Fondazione Edmund Mach
Czech Technical University in Prague and GISMentors

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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

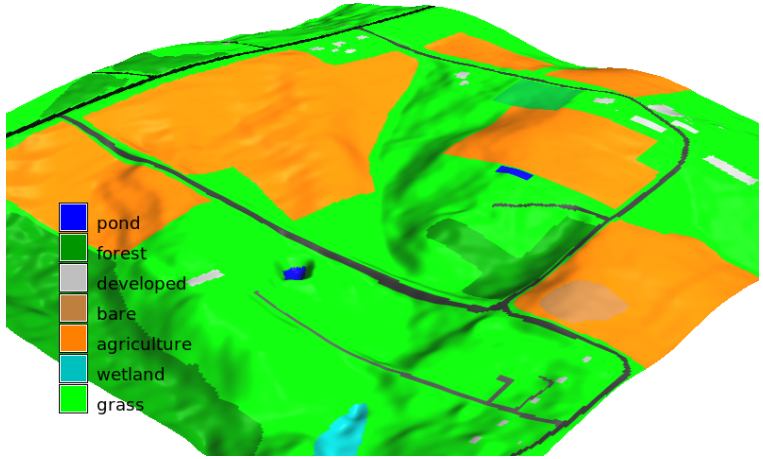
The opposite of 'open' isn't closed. The opposite of open is 'broken.'

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

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

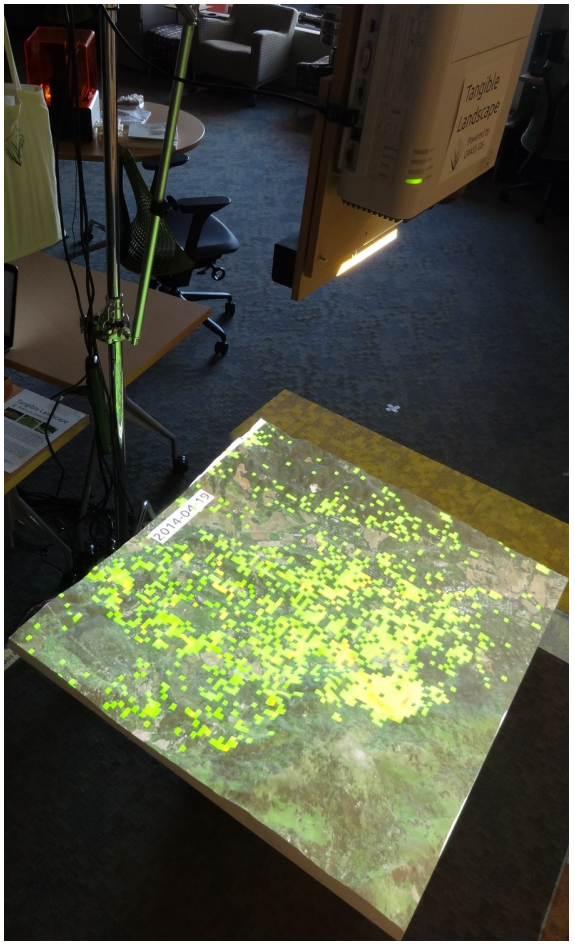


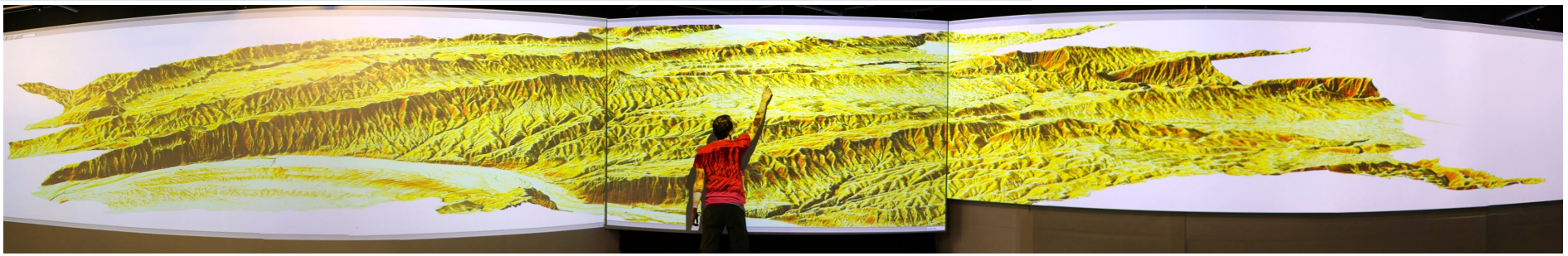
Listing only geospatial courses where presentation authors are involved.

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:
  - eye tracking
  - Tangible Landscape
  - NCSU Hunt Lib Teaching and Vis Lab





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)

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

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.

The idea

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

The problem

- students are becoming software users instead of scientists
- students mix software details and general concepts
  - Shapefile or Feature class instead of Vector data
  - Generic (genericized) trademarks
- software promotes software/vendor-specific formats/technologies
  - teachers end up using them
  - and students end up knowing just them
- single software choice limits explored algorithms
  - *[Part of the assignment was already in] Surface Water Hydrology [class]. In [that class] we used the D8 algorithm exclusively and focused on [...] ArcHydro. In this assignment it was interesting to see the use the Dinf algorithm which considers more direction choices [...]*

The solution

- lectures:
  - theory, concepts
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- labs and assignments:
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  - students use two different software packages, in our case:
    - GRASS GIS (free and open source)
    - ArcGIS (proprietary)
- similar task in both
- students have always at least two different examples to see what is a general concept and whts is specific to a particular software
- they gain flexibility to choose optimal solutions for their future work

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Can I use two open source packages?

Yes, just select different-enough packages.

No:

- GRASS GIS + QGIS with GRASS plugin

Yes:

- GRASS GIS + QGIS with SAGA algorithms in Processing

Maybe:

- QGIS with GRASS plugin + R with spgrass6/rgrass7

Can I use two proprietary packages?

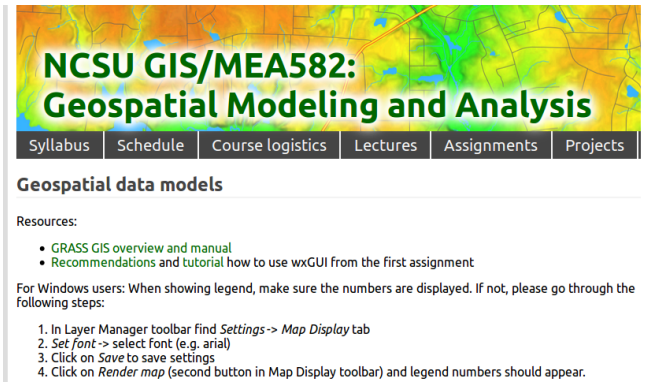
No, at least on of the used packages should be open source.

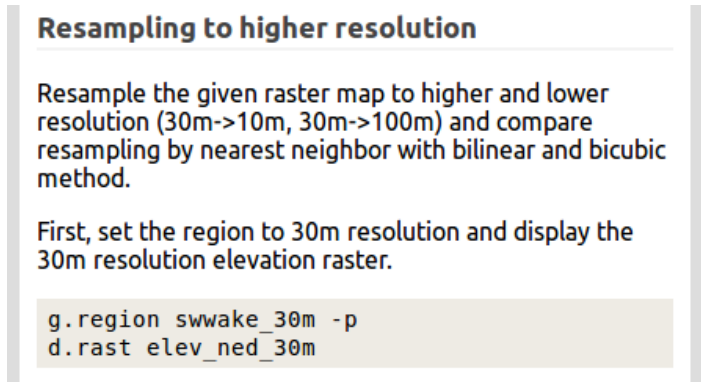
- teaching for future industry, not past
- teaching for science

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

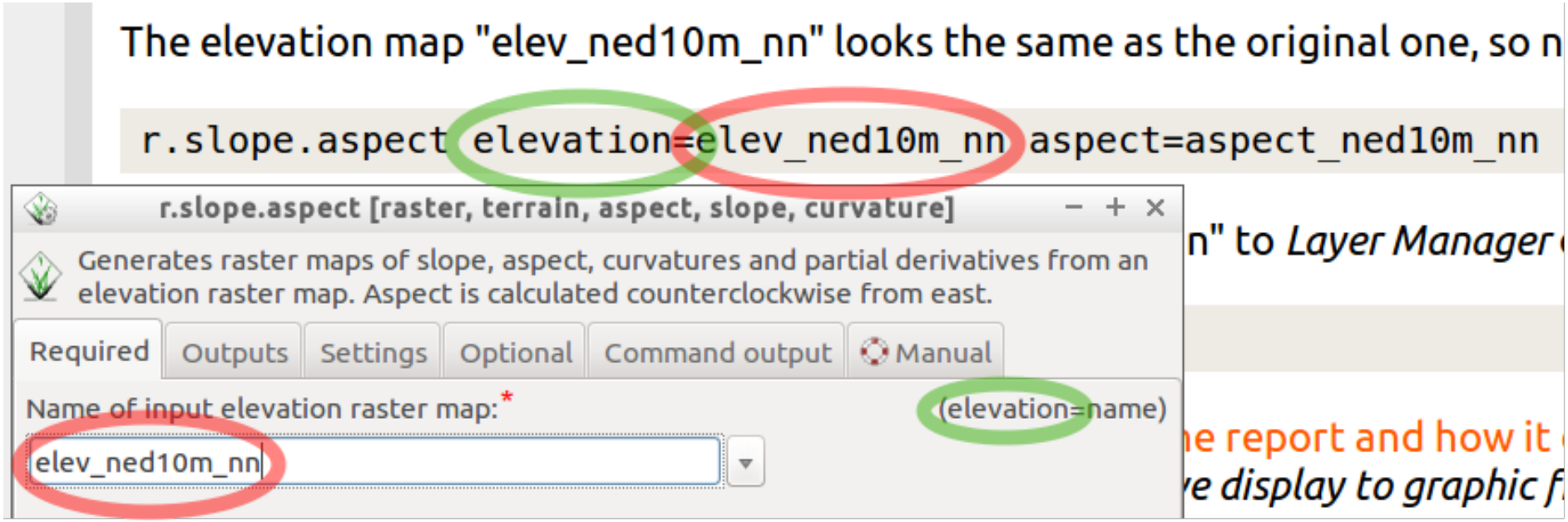
`geospatial.ncsu.edu/osgeorel/courses.html`





GRASS GIS advantage for teaching materials maintenance

- Screenshots are hard to update while text is easy to update.
- GRASS GIS workflow recorded as commands.
- 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

In: *ISPRS International Journal of Geo-Information*. 2015.

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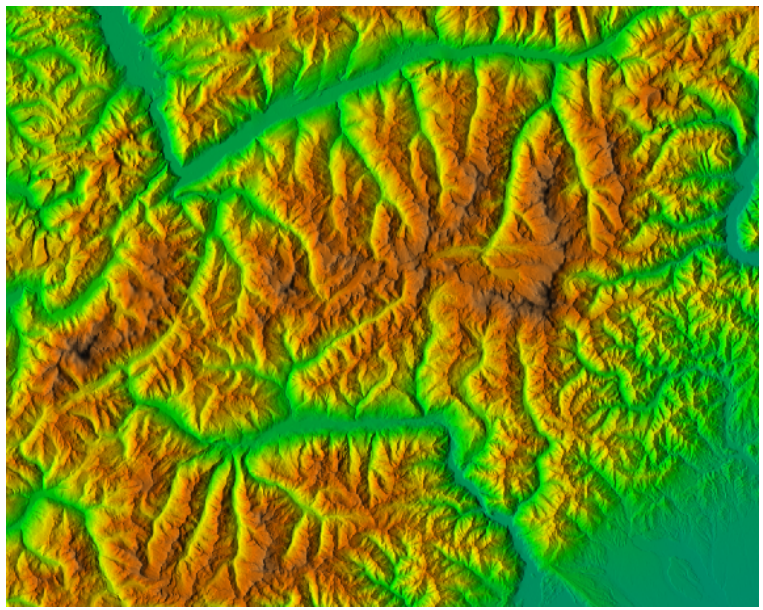
Standardized Sample Dataset

- other regions local datasets
- limits 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*
- challenges:
  - attributes, coordinates, values, extents, resolutions

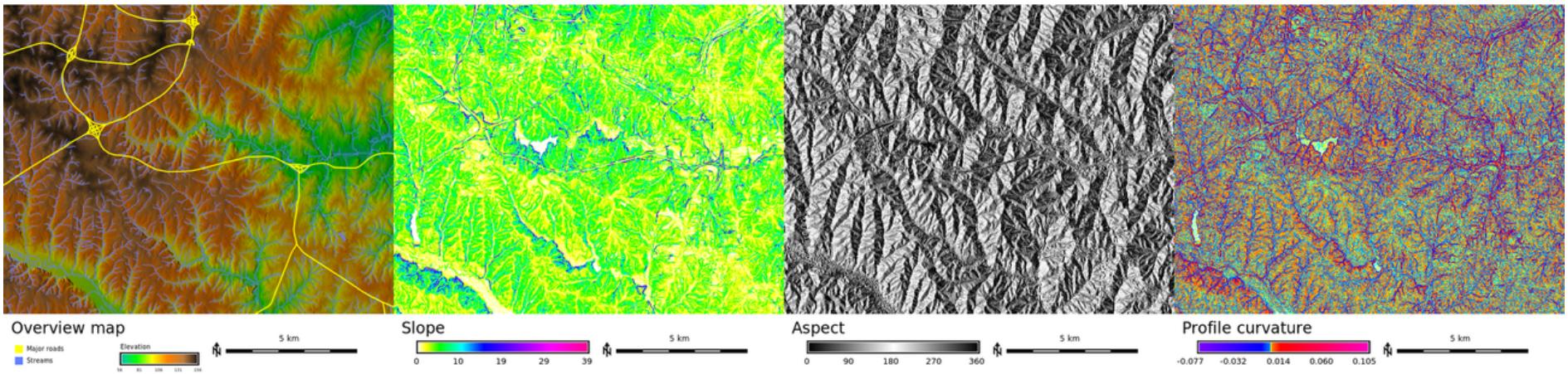
```
g.region raster=elevation
r.relief input=elevation output=shade

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

▶ wiki page



Standardized Sample Dataset: North Carolina, USA

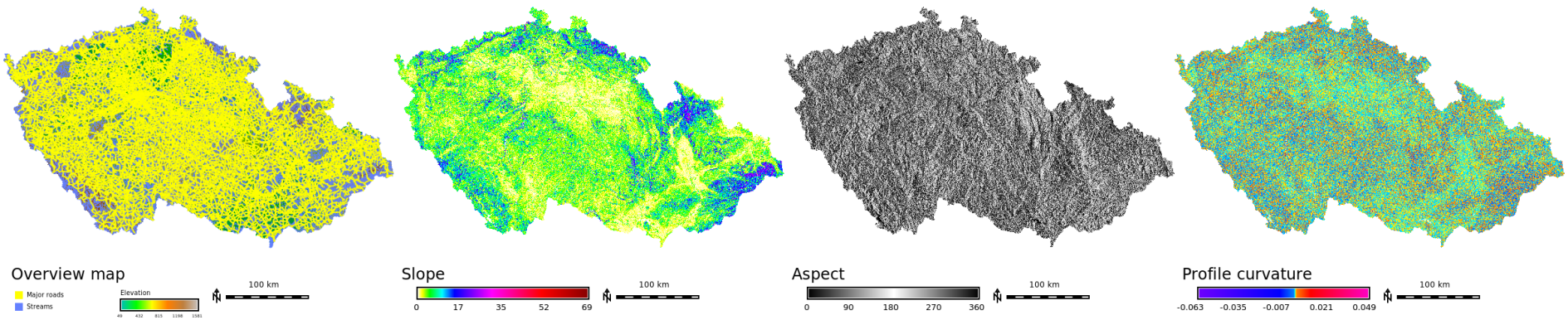


Helena Mitasova[1] and Markus Neteler[2], authors of
Open Source GIS: A GRASS GIS Approach (fourth edition in preparation)

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

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

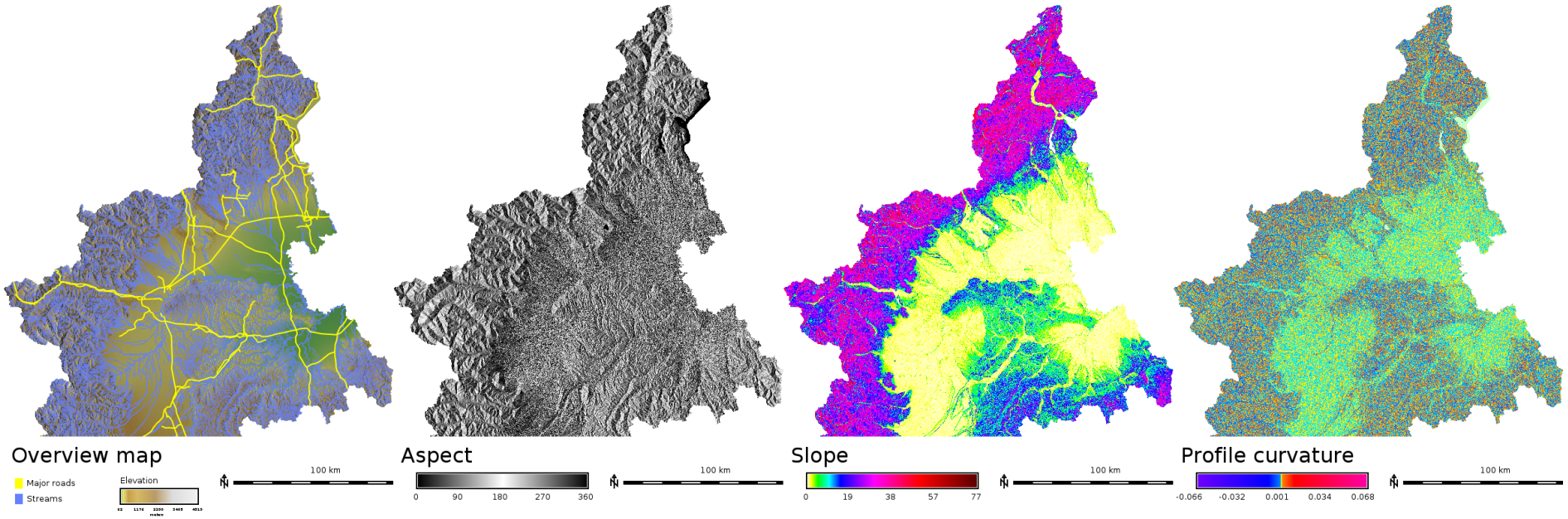
Standardized Sample Dataset: Czech Republic



Martin Landa* and Jachym Cepicky from GISMentors

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

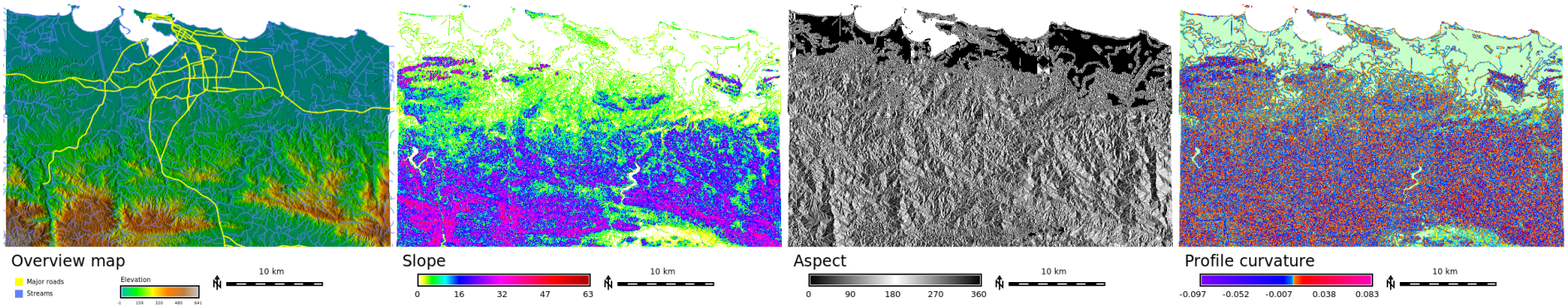
Standardized Sample Dataset: Piedmont, Italy



Markus Neteler and Luca Delucchi

Research and Innovation Centre, Fondazione Edmund Mach, Italy

Standardized Sample Dataset: Puerto Rico



Keren Cepero Perez

IPython Notebook

For workshop:

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

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...
  - *teach next generation of scientists*
- Possible topics:
  - combining SW, e.g. QGIS + GRASS GIS + R + Inkscape
  - Markdown, LaTeX, Git, IPython Notebook, command line, plain text
  - general features and common misconceptions
    - vendor neutrality
    - using open source versus writing code
    - community and support
    - gratis versus libre
    - counteract FUD against open source from past
  - availability of tools even when not used by the university
  - reusability, reproducability (std in FOSS)

Future directions

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

Thank you for your attention.