Teaching Spatial Analysis to Ecologists at the Postgraduate Level

Summary of the concluding workshop conducted as part of the project "Building Capacities for Conservation Planning using Open Source Tools", July 26th, 2012

The level of quantitative techniques a postgraduate in ecology is expected to know is growing as the subject moves from natural history and observational to more experimental and hypothesis testing based approaches. Unfortunately syllabi in many institutions teaching ecology haven't caught up with these contemporary needs of the researcher. We explore various spatially explicit as well as non-spatial visualisation techniques to handle data in ecology. This is followed by a discussion on what should be the ingredients of various courses offered in postgraduate institutions teaching ecology and its various branches.

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The Problem

1. Prior coaching at the undergraduate and often school level. Students studying ecological sciences are often from a "biology" background, which in India usually excludes mathematics and statistics, if not at the higher secondary level, almost always at the undergraduate level.
2. Requirements of quantitative at the graduate level can become quite specialised making it difficult to construct a common syllabus.
3. Faculty available for teaching quantitative methods can be very limited. This is both because of the traditional courses lacking a hard quantitative component and because some of the tools are highly specialised or are new to present faculty.
4. The design of courses in ecology often does not contain sufficient emphasis on modern tools, particularly software based tools, but also on quantitative field techniques which go hand in hand with contemporary ecological research.
5. Many programmes in ecology do not have sufficient infusion of current research methods from active researchers. They are run by faculty who are primarily engaged in teaching and are not necessarily abreast of modern tools and techniques.
6. Many courses run in institutions fail to achieve their objectives, i.e. students are either unable to practice what they learn, or unable to follow the instructions.

Possible Solutions

1. Open source software provides free solutions to many commercial software. Teaching and coaching in the use of such software will overcome the financial constraints of many agencies.
2. Multiple media and modes of teaching need to be explored, not just classroom based formal courses.
3. The internet in particular needs to be exploited to reach out to a larger audience. Efforts such as the Western Ghats portal[1] need to be extended to include such online-courses and materials.
4. A range of resource persons needs to be identified across various topics and applications to help put together topical and current teaching materials. The same network needs to be accessible by agencies engaged in teaching, research and actual conservation related activities.

Tasks	Relevant Software
General operations	GDAL libraries which have GUIs in a range of software packages.
Vector operations	Various GIS packages including Q-GIS, GRASS, GvSIG, OpenJump, ILWIS, uDIG.
Database functions	SQLite/SpatiaLite, PostgreSQL/PostGIS, MySQL/MySQLspatial
GPS	GPSBABEL and various GUIs, DNRGPS
Spatial analysis	R and various spatial packages, QGIS plugins, SEXTANTE project

Open source software available for operations described in the basic skill-set.

[1] http://www.thewesternghats.org

Course Content

There are two basic and intermediate level courses which may be common to a wide range of ecology researchers, other, more advanced courses would need to change the syllabi based on the specialisation and focus of the students. The skill sets that researchers are expected to possess at the graduate level are listed below:

Basic Skill Sets

- General Operations
  - Projection handling.
  - Geo-referencing.
  - Mosaicking.
  - Warping.
  - Converting formats and sharing data between applications.
  - Metadata management.
- Vector Operations
  - Digitising.
  - Thematic mapping.
  - Map making.
  - Geoprocessing.
- Database Functions
  - Conversions between formats.
  - Joins between spatial and non-spatial tables.
  - SQL for both non-spatial and spatial queries.
- Raster Operations
  - Data handling, including multispectral data, DEM data and ASCII rasters.
  - MASKING.
  - Raster algebra.
  - RGB overlays and composites.
  - Raster colour tables and visualisation.
  - Theoretical aspects of remote sensing including:
    - Resolution.
    - Feature space.
    - Band combinations.
- Global Positioning Systems
  - Collecting way points and tracks.
  - Converting between waypoints - tracks and routes.
  - Using routes to navigate.
  - Data input/output from the GPS and a computer.
- Spatial Analysis
  - Sampling.
  - Spatial correlations.
  - Spatial auto-correlations.
  - Spatial regressions.

Intermediate Skills

- Raster Operations
  - Spectral properties of surfaces.
  - NDVI and EVI - derivation and discussion.
  - Image classification:
    - Unsupervised.
    - Supervised using different algorithms (minimum distance, maximum likelihood).
  - Accuracy assessment:
    - Error matrix.
    - Kappa Statistics.
  - Change detection and analysis:
    - Regression curves (e.g. shoreline change).
- Vector geo-processing
  - Spatial queries and operations.
  - Network analysis.
  - LIDAR tools.
- Analysis
  - Visualisation
  - Landscape tools:
    - GRASS.
    - FRAGSTATS.
  - Image Analysis:
    - Interpolations (bilinear, IDW, regular spline)
    - Geo-statistics (Kriging)
    - Rescaling
    - Tranformation (PCA, CCA, FFT)
  - Terrain analysis
  - Hydrology tools
    - Basic model parametrisation including USLE, TOPMODEL, SWAT, SIMWE.
    - Data visualisation (double mass, co-plots, hydrographs, log plots etc).

Tasks	Relevant Software
Image processing/ analysis	GRASS, SAGA, R (raster package)
Hydrology	GRASS, SAGA, R (hydromat, tsm)
Landscape	FRAGSTATS, GRASS
Terrain analysis	GRASS, SAGA
Vector Geo-processing	SEXTANT, SAGA, GRASS
Data visualisation	R

Open source software available for operations described in the intermediate skill-set.

Road Map

Taking this forward

A number of action points were suggested to take this consultation forward:

1. Identify experts on specific themes, a process already initiated by IFP/FERAL for the WGP.
2. List a range of media options for sharing data, from screen casts, webinars, online tutorials to hands on courses.
3. Formalise the network of institutions and experts so that both formal courses as well as more informal workshop based programmes can be organised to reach the maximum number of researchers.
4. Create a list of existing data, software, materials and tutorials and make it available to researchers so they have access to resources.
5. Start collaborating and putting together specific modules under the themes interface.
6. Raise additional resources to fund this effort.