XII MEETING
degli utenti italiani GRASS e GFOSS
TRENTO, 9-11 FEBBRAIO 2011

OSGeo

Measuring ecosystem complexity from remotely sensed imagery in an Open Source space

Duccio Rocchini, Luca Delucchi,
Paolo Cavallini, Claudio Porta,
Lucio Davide Spano, Markus Neteler

RS & Biodiversity

Measuring and modelling biodiversity from space

Thomas W. Gillespie,[1]* Giles M. Foody,[2] Duccio Rocchini,[3] Ana Paula Giorgi[1] and Sassan Saatchi[4]

“There can be no question that **spaceborne imagery has made significant contributions to the science of biogeography and biodiversity** over the last seven years.”

Progress report

GIS: biodiversity applications

G.M. Foody*

School of Geography, University of Nottingham, University Park, Nottingham NG7 2RD, UK

“GIS has played a major role in recent biogeographical research. In relation to biodiversity, GIS has provided, especially through remote sensing, a range of data on environmental properties as well as **techniques to explore and use data to further understanding of biodiversity and aid its conservation**.”

“Recent research has based **biodiversity assessment** on **measures of spectral diversity** [...]”

RS & Biodiversity

Folia Geobotanica 42: 209–216, 2007

TO SAMPLE OR NOT TO SAMPLE?
THAT IS THE QUESTION ... FOR THE VEGETATION SCIENTIST

Alessandro Chiarucci

Department of Environmental Science "G. Sarfatti", University of Siena, Via P.A. Mattioli 4, 53100 Siena, Italy; e-mail chiarucci@unisi.it

- Issues to be solved before a sampling design may be prepared
  - (i) number of sampling units
  - (ii) spatial placement of the sampling units
  - (iii) statistical population of concern
  - (iv) operational definition of a species community
  - (v) labor intensiveness and costs
  - (vii a small fraction of a study area may be sampled

RS & Biodiversity

Global Ecology and Biogeography, (Global Ecol. Biogeogr.) (2005) 14, 431–437

RESEARCH PAPER

Maximizing plant species inventory efficiency by means of remotely sensed spectral distances

Duccio Rocchini*, Sergio Andreini Butini and Alessandro Chiarucci

- **Remote sensing** could be the most effective means for predicting species diversity since it can repeatedly allow a **synoptic view of an area** at **regular time intervals**

Aim

- **THE ISSUES**

  1 - Scale

  2 - Metrics

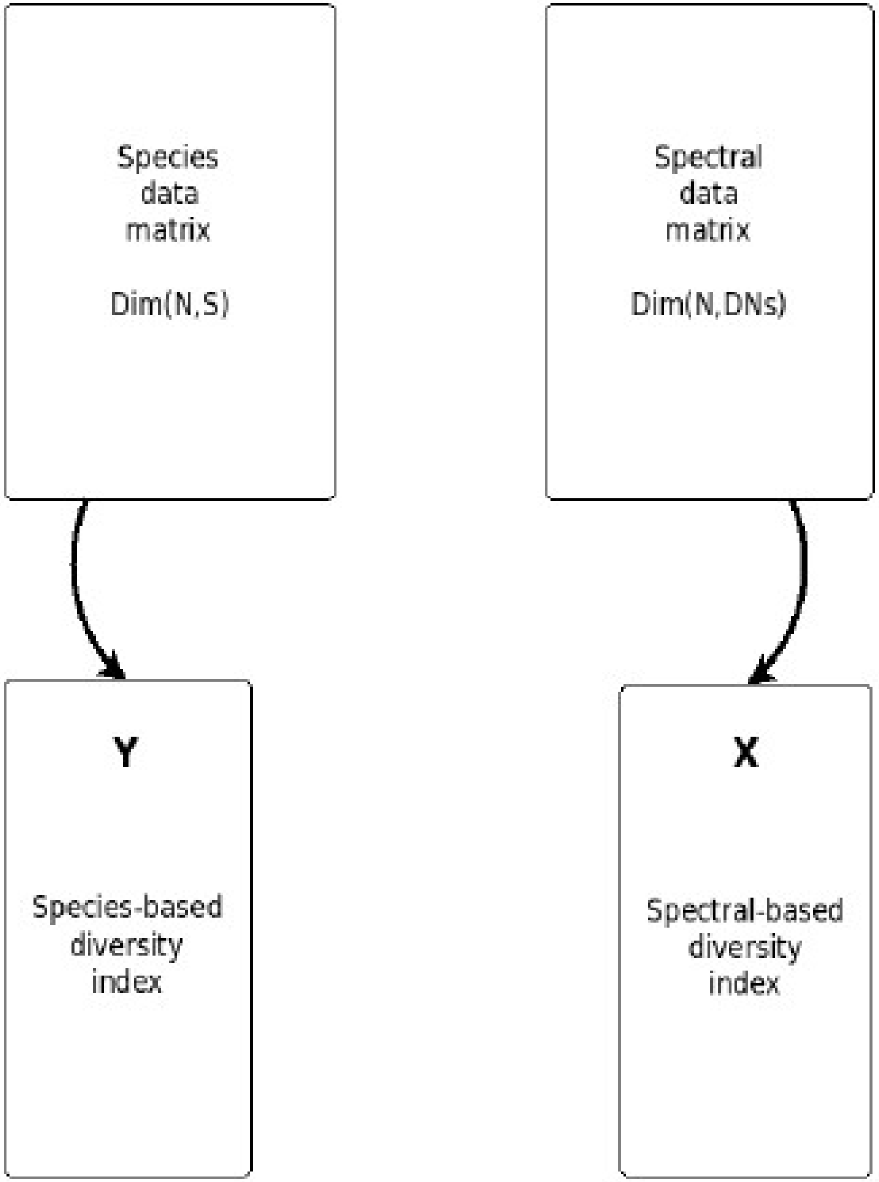
$$H = -\sum p \times \ln(p) \qquad 1 - D = 1 - \sum p^2$$

$$J = \frac{-\sum p \times \ln(p)}{\ln(N)} \qquad H_\alpha = \frac{1}{1-\alpha} \ln \sum p^\alpha$$

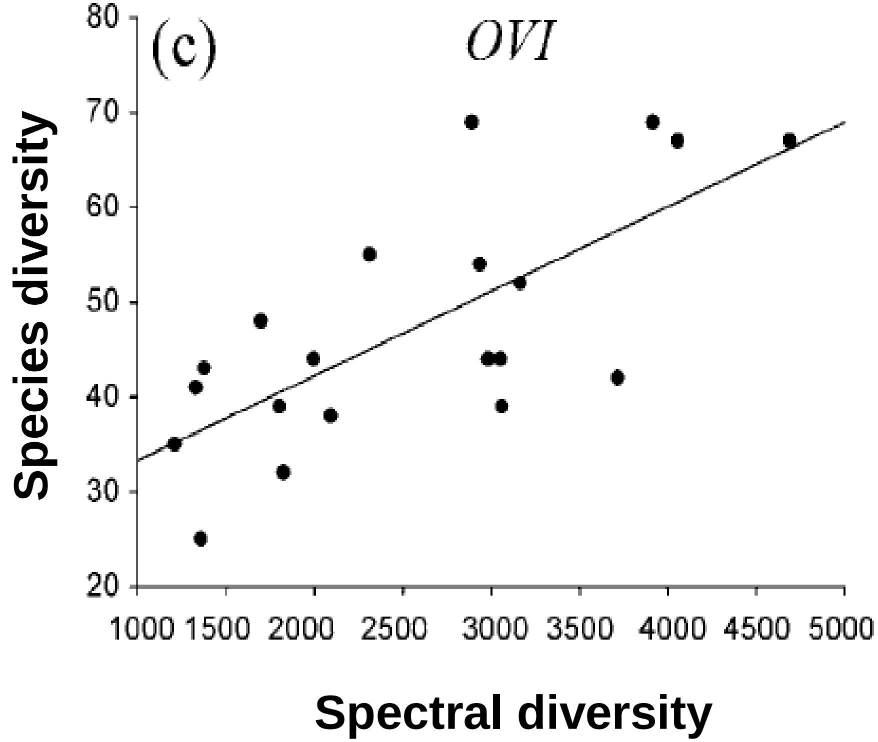
- **THE FOSS SOLUTION**

  - *r.diversity*

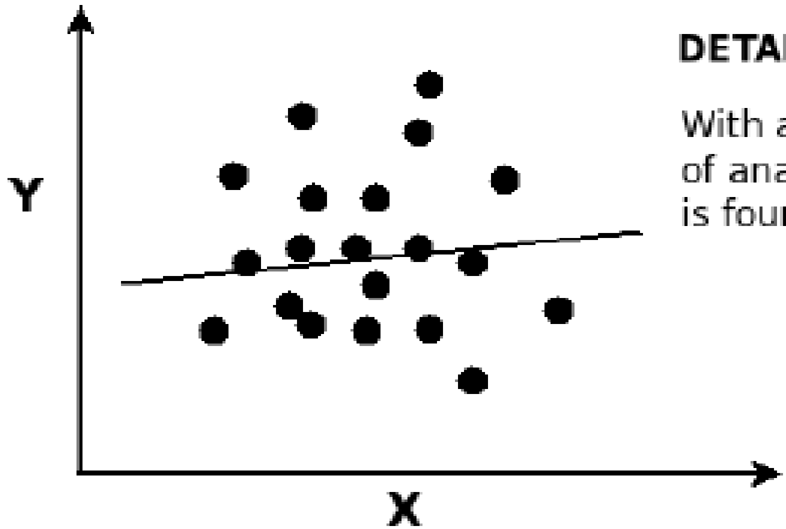
Issue 1: Scale



Oldeland et al. (Ecol. Indic., 2010)

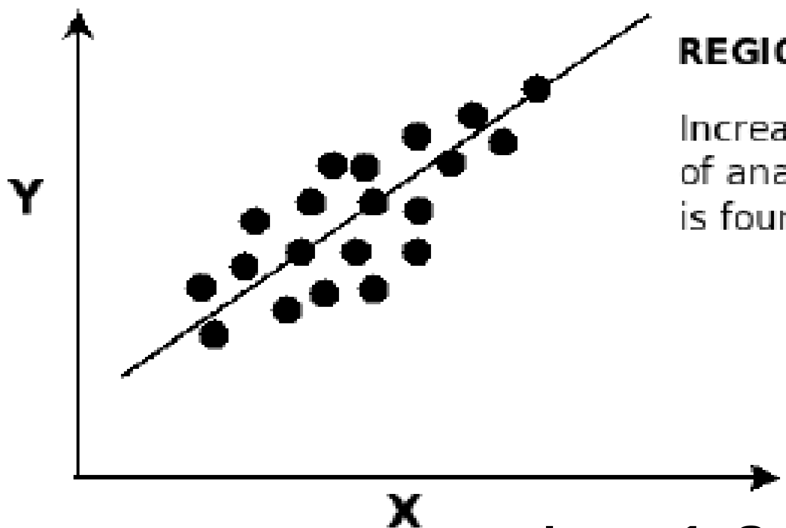


Issue 1: Scale



DETAIL SCALE

With a smaller window of analysis, no relationship is found

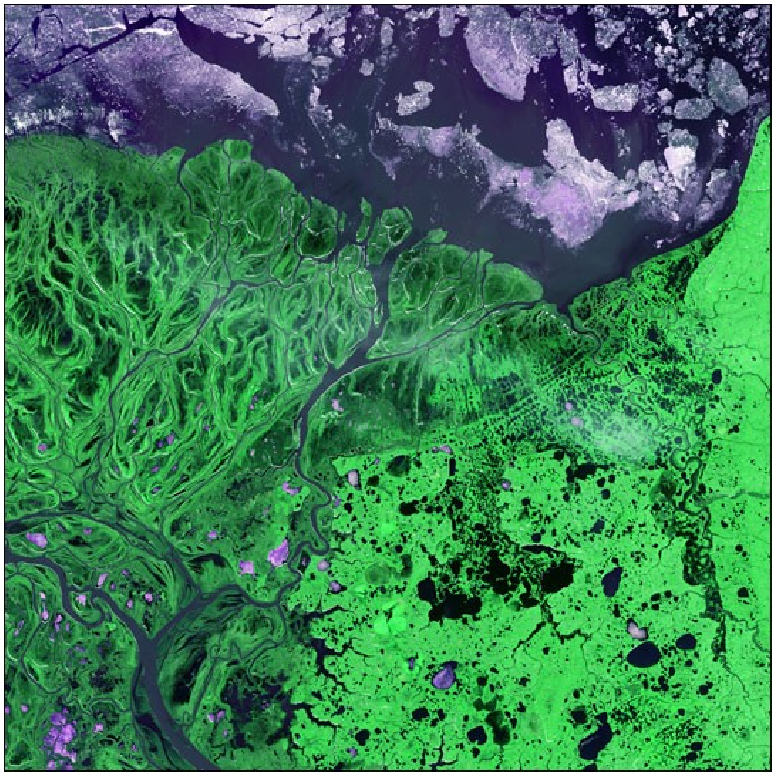


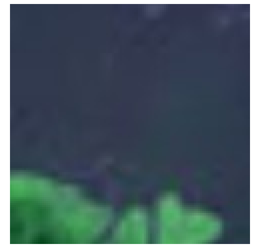
REGIONAL SCALE

Increasing the window of analysis, a positive relationship is found

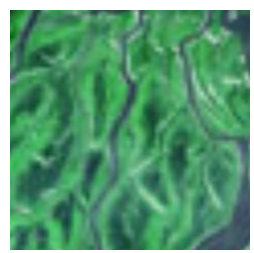
Issue 2: Metrics

- Problems with richness measure





- Richness = 3
- *p=[0.7, 0.2, 0.1]*



- *Richness = 3*
- $p=[0.\overline{3}, 0.\overline{3}, 0.\overline{3}]$

Issue 2: Metrics

- Single diversity metrics
  - Shannon Diversity Index

    $$H = -\sum p \times \ln(p)$$

    Simpson Diversity Index

    $$1 - D = 1 - \sum p^2$$

  - Pielou Diversity Index

    $$J = \frac{-\sum p \times \ln(p)}{\ln(N)}$$

- Continuum of diversity measures
  - Rényi Generalized Entropy

    $$H_\alpha = \frac{1}{1-\alpha} \ln \sum p^\alpha$$

Issue 2: Metrics

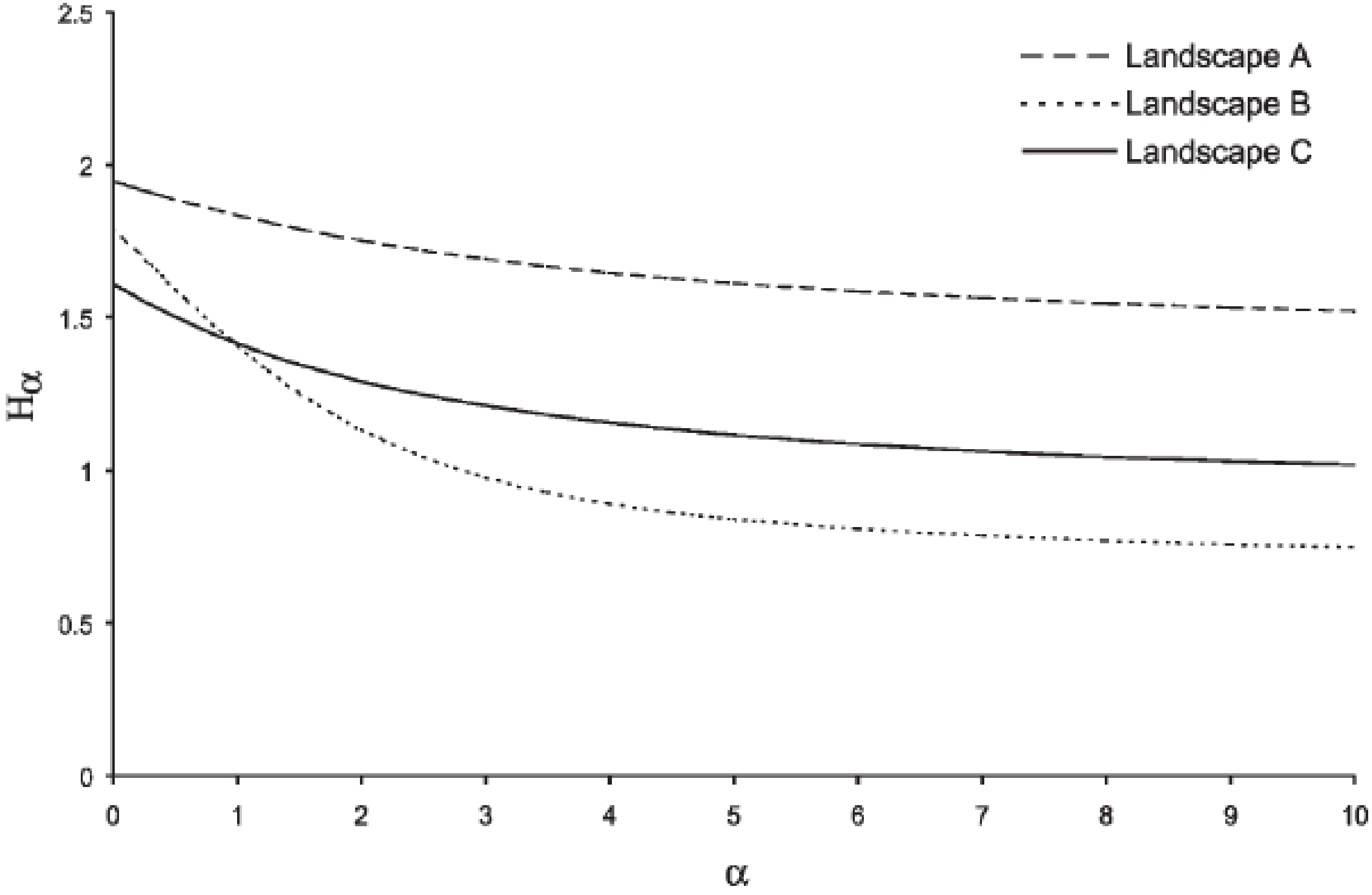
- Continuum of diversity measures
  - Rényi Generalized Entropy

$$H_\alpha = \frac{1}{1-\alpha} \ln \sum p^\alpha$$

$\alpha=0$	Rényi $H_0 = \ln(N)$
$\lim_{\alpha \to 1}$	Rényi $H_1 =$ Shannon H
$\alpha=2$	Rényi $H_2 = \log(1/\text{Simpson Dominance})$

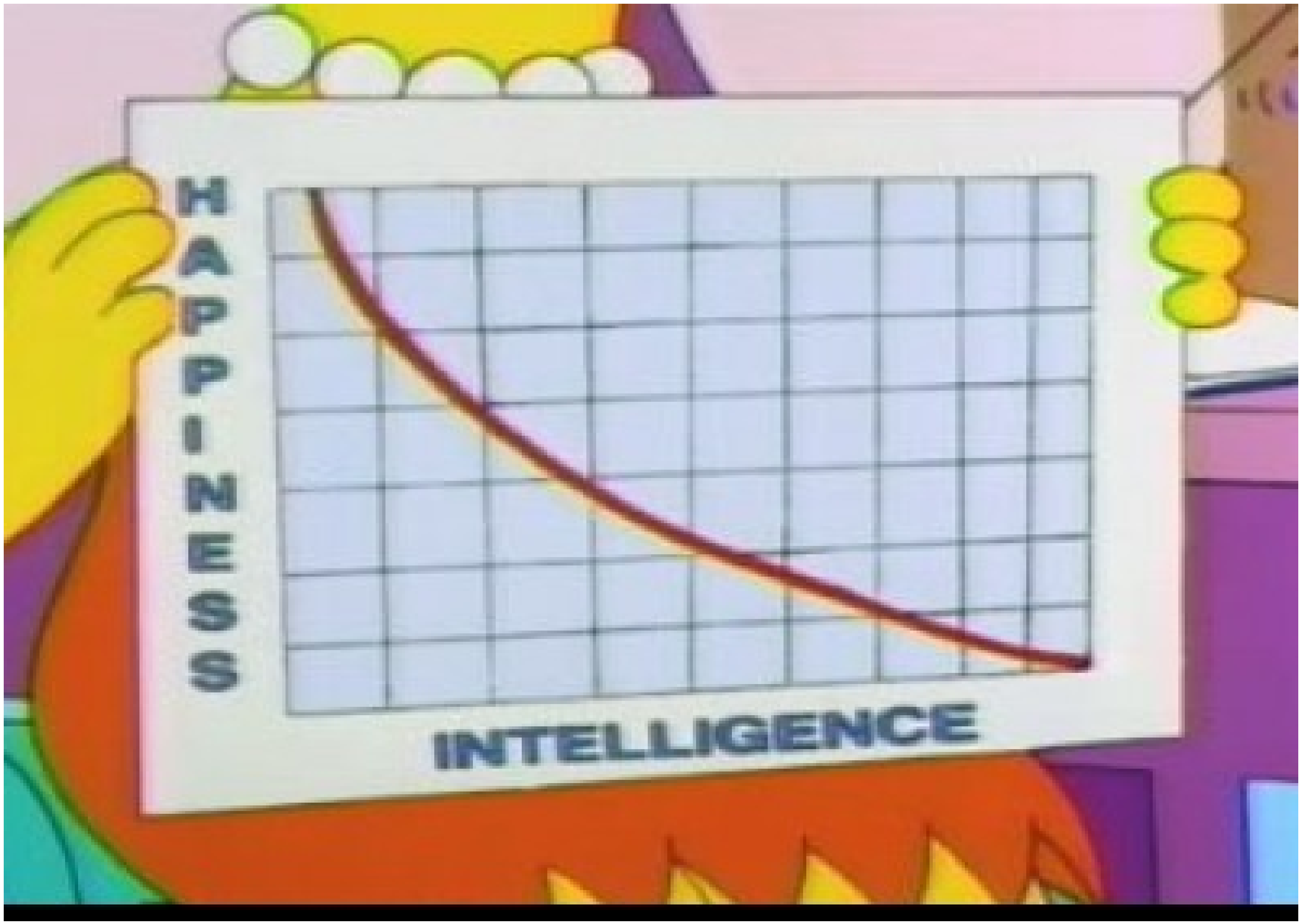
Issue 2: Metrics

Ricotta et al. (Environ. Model. Software, 2003)



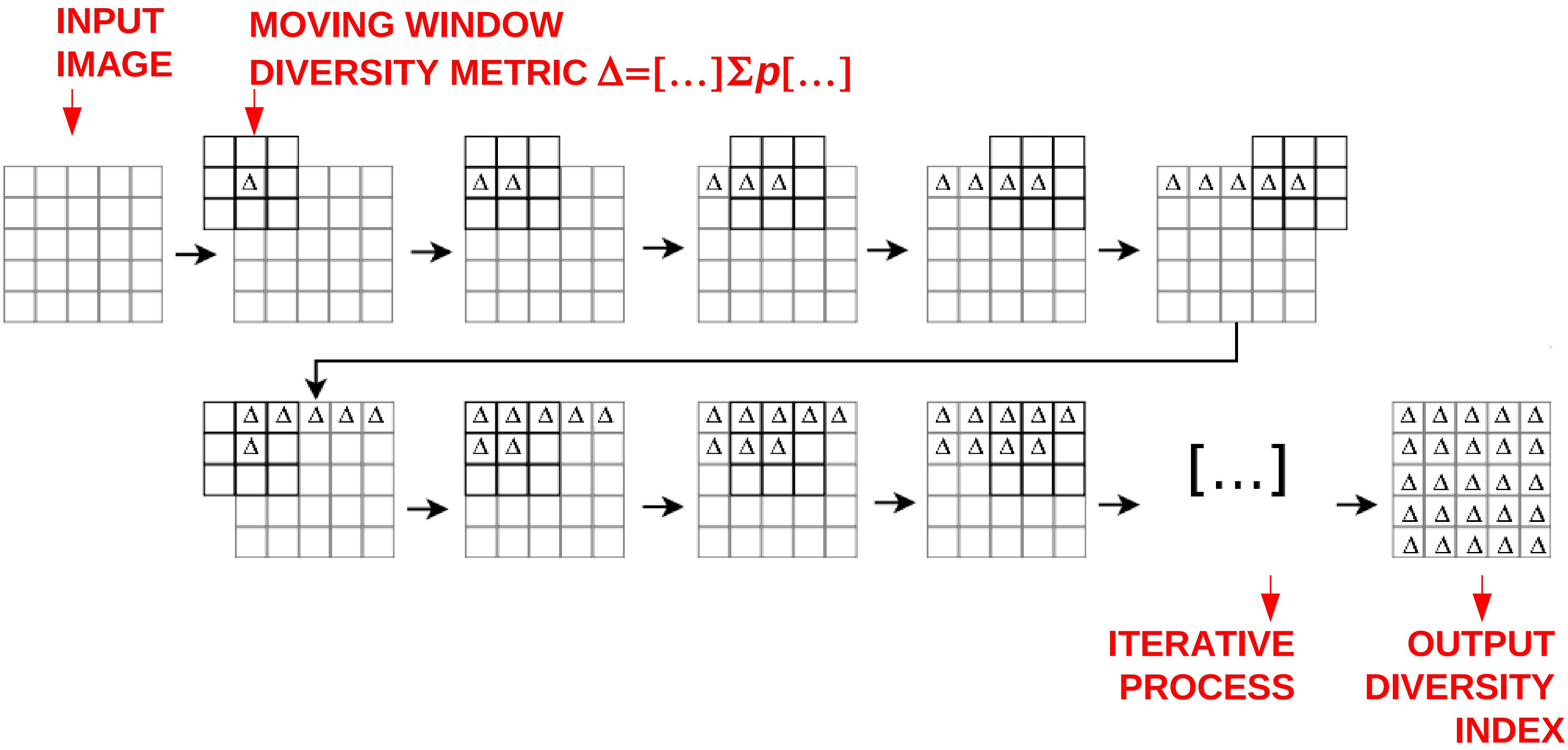
Issue 2: Metrics

Lisa Simpson (Fox, 1990)



The solution

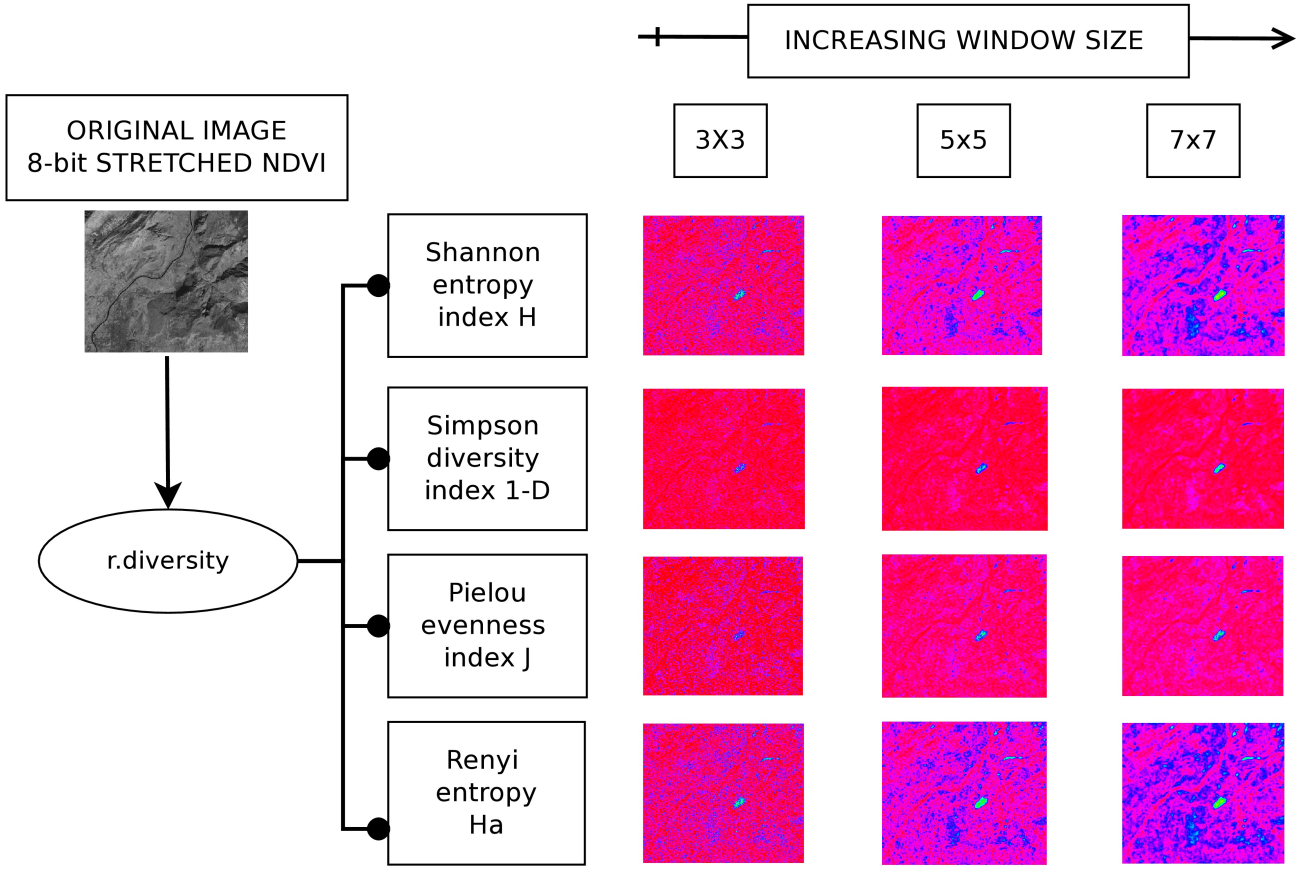
- GRASS add-on *r.diversity*



The solution

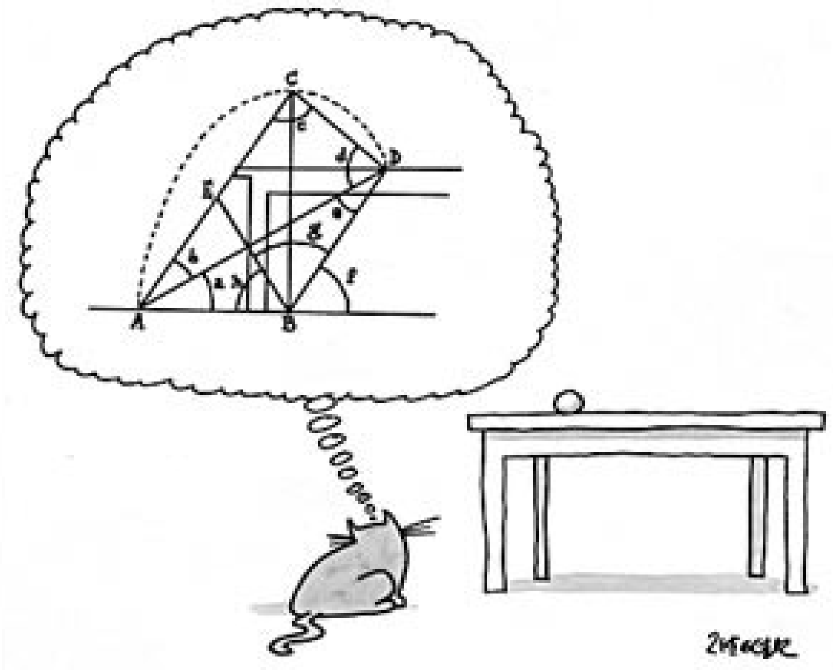
- GRASS add-on *r.diversity*

```
r.diversity input=raster_grass
out=diversity size=3-7 alpha=2
```



The solution

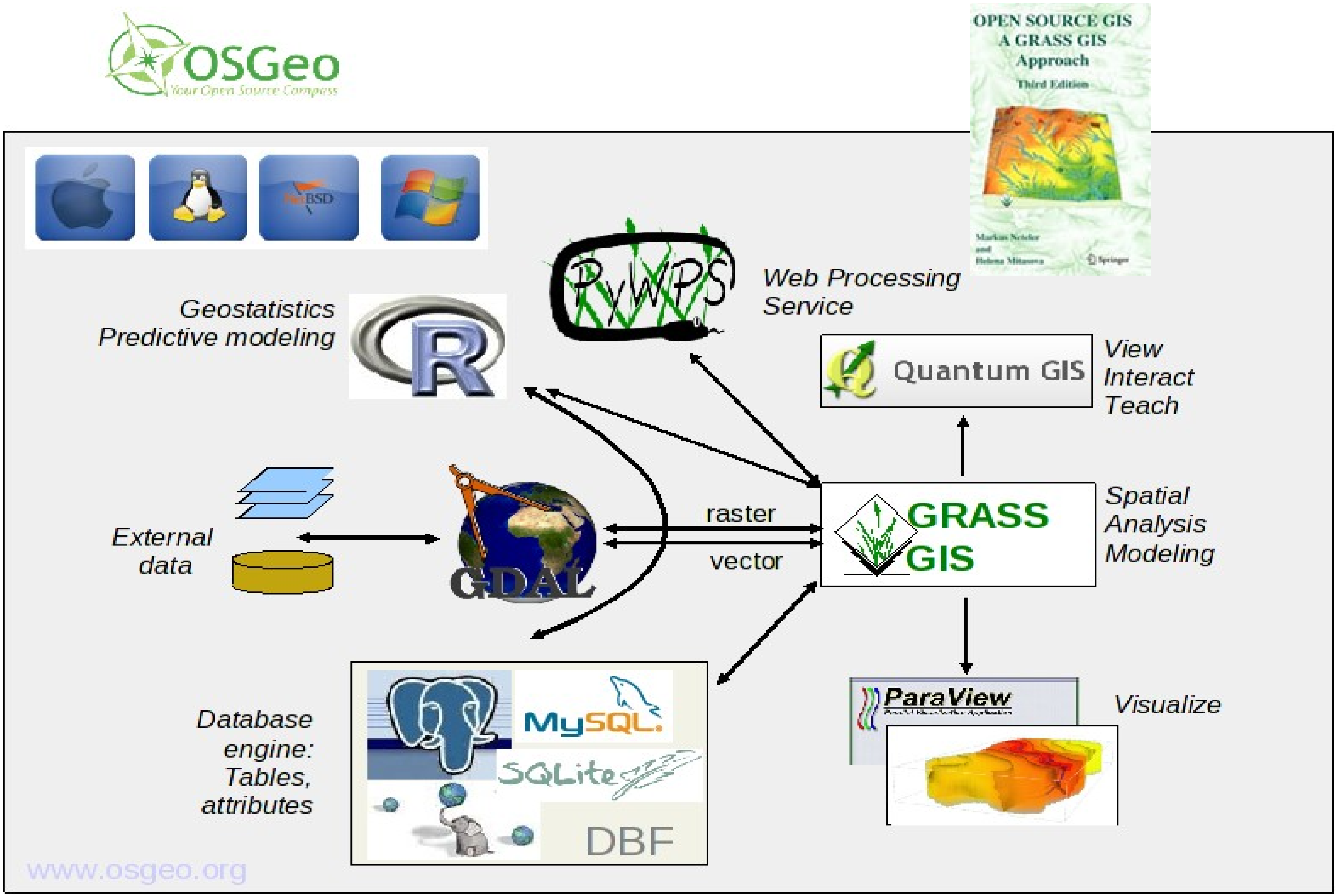
- **Advantages of *r.diversity***
  - Complex diversity calculus available by a ***straightforward command*** into GRASS GIS
  - ***Multiscale*** calculation
  - Multiple metrics available, including a ***Continuum of diversity measures*** (e.g. Rényi Generalized Entropy)
  - ***Code*** available for further improvement



Concluding remarks: where from here?

- Emphasis should NOW be put in finding new ways for robust:
  - **data gathering**: “Future research should focus on incorporating recent and new spaceborne sensors, more extensive integration of available data from **passive and active imagery** that can be used across spatial scales, and the collection and dissemination of high-quality field data.” (Gillespie et al., Progr. Phys. Geogr., 2008)
  - **data analysis**: **Free and robust tools for statistical analysis** of ecological and remotely sensed data are now available in **an Open Source space** to allow applying the celebrated “four freedoms” paradigm (Stallman 1997) to remote sensing

Concluding remarks: where from here?



Thanks!

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ELSEVIER

Remotely sensed spectral heterogeneity as a proxy of species diversity: Recent advances and open challenges

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