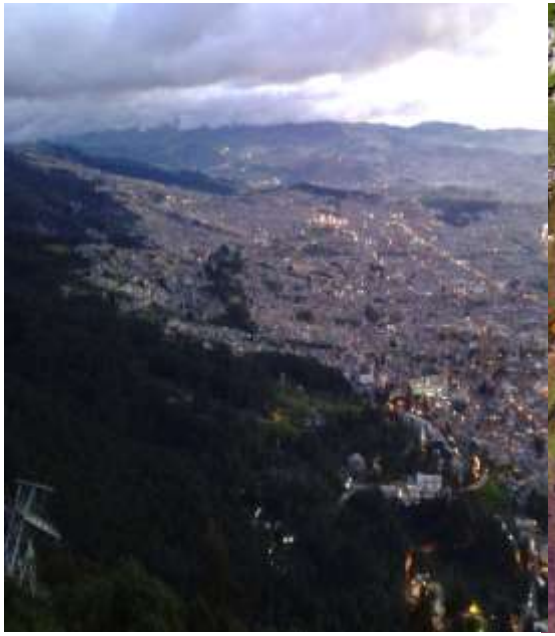
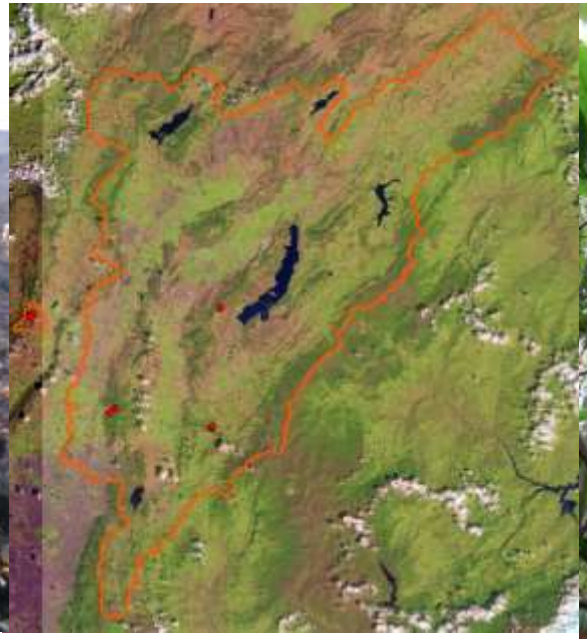
Socio-Ecological Aspects of Climate Change
Impacts: Tropical Forests and Cities


Francisco J Escobedo
Universidad del Rosario
Faculty of Natural Sciences and Mathematics- Biology Program

University of Warwick, 26 June 2019

Objectives

- Applied Natural Sciences at Local Scale
  - Socio-Ecological & Ecosystem Services Framework
- Climate Change Impacts and Policies
  - Hurricanes and forests
  - Forests and CO_2 sequestration
- Climate change impacts and ecosystem services in tropical peri-urban forests
  - Urban and peri-urban Colombia

What do I do?

- PhD Forest and Environmental Policy
- MS Watershed Management
- BS Forestry

- 2016-Present: Professor Socio- Ecological Systems at Universidad del Rosario (Environmental Biology)
- 2006-2015: Assoc. Prof. & Extension Specialist in Urban Community Forestry at University of Florida (Forestry Faculty)

Science of The Total Environment

Available online 19 June 2019

In Press, Accepted Manuscript

Spatio-temporal and cumulative effects of land use-land cover and climate change on two ecosystem services in the Colombian Andes

Nicola Clerici [a], Fabian Cote-Navarro [b], Francisco J. Escobedo [a], Kristian Rubiano [a], Juan Camilo Villegas [c]

Ecosystem Services

Volume 29, Part A, February 2018, Pages 31-39

Consumer demand for urban forest ecosystem services and disservices: Examining trade-offs using choice experiments and best-worst scaling

Forest Policy and Economics

Volume 63, February 2016, Pages 35-42

Landowner attitudes and willingness to accept compensation from forest carbon offsets: Application of best–worst choice modeling in Florida USA

José R. Soto, Damian C. Adams, Francisco J. Escobedo

Show more

https://doi.org/10.1016/j.forpol.2015.12.004

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PNAS

Reforestation as a novel abatement and compliance measure for ground-level ozone

Timm Kroeger, Francisco J. Escobedo, José L. Hernandez, Sebastián Varela, Sonia Delphin, Jonathan R. B. Fisher, and Janice Waldron

Edited by Peter M. Kareiva, Nature Conservancy, Seattle, WA, and approved August 14, 2014 (received for review May 27, 2014)

Environment, Development and Sustainability

April 2016, Volume 18, Issue 2, pp 373–392 | Cite as

The role of urban green infrastructure in mitigating land surface temperature in Bobo-Dioulasso, Burkina Faso

Authors | Authors and affiliations

Ecological Indicators

Volume 96, March 2019, Pages 794-803

Exploring management objectives and ecosystem service trade-offs in a semi-arid rangeland basin in southeast Iran

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Environmental Science & Policy

Volume 13, Issue 5, August 2010, Pages 362-372

Analyzing the efficacy of subtropical urban forests in offsetting carbon emissions from cities

Francisco Escobedo, Sebastian Varela, Min Zhao, John E. Wagner, Wayne Zipperer

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https://doi.org/10.1016/j.envsci.2010.03.009

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Urban Ecosystems (2018) 21:657–671

Socioeconomic and ecological perceptions and barriers to urban tree distribution and reforestation programs

Leaundre C. Dawes · Alison E. Adams · Francisco J. Escobedo · José R. Soto

Published online: 16 April 2018

Universidad del Rosario | Biología

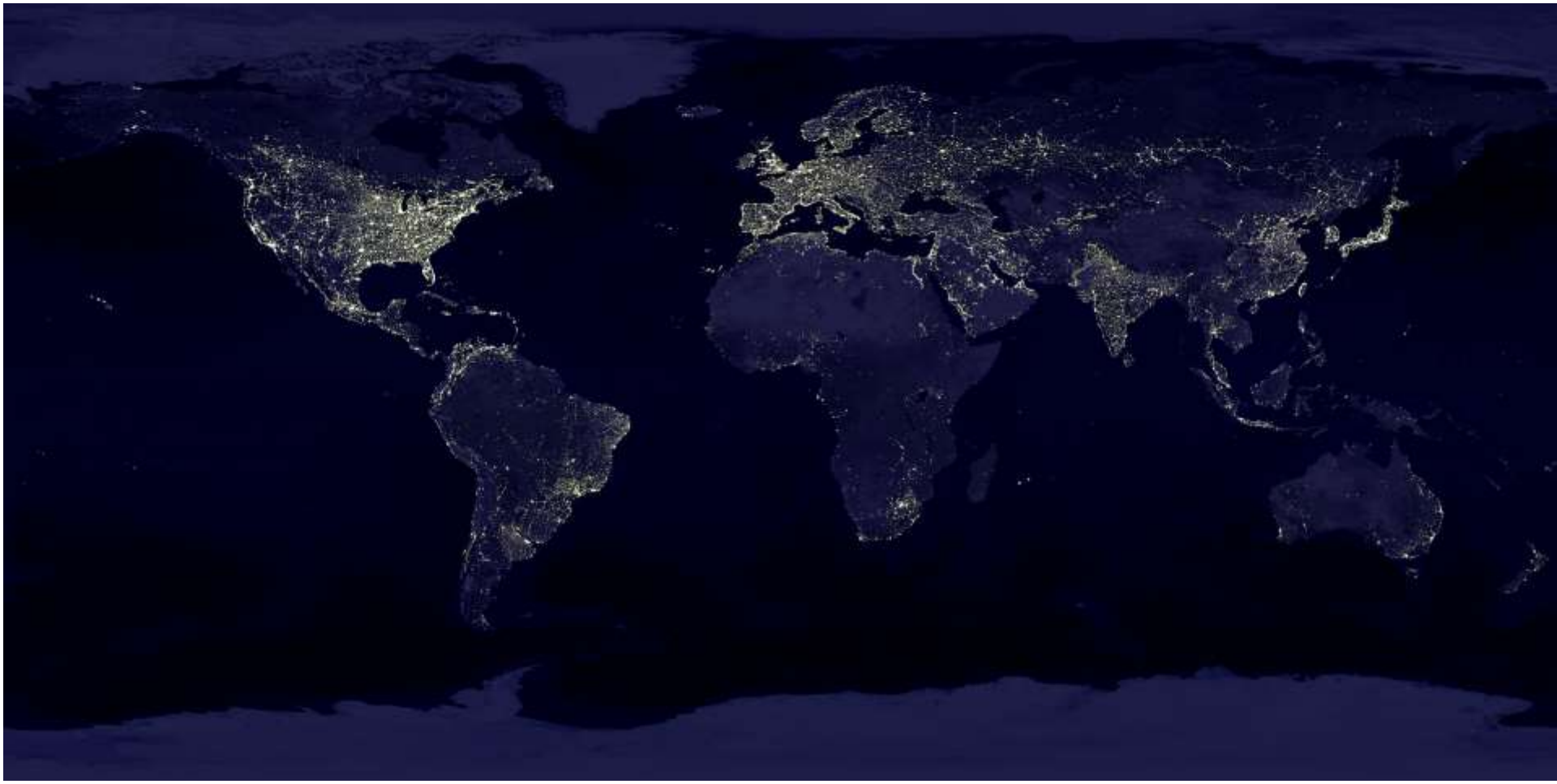
Biophysical Scientists

http://howtopassmatric.co.za/wp-content/uploads/2015/10/ecologist-300x199.jpg

http://www.lincolnecology.org.nz/wp-content/uploads/2015/02/16399392678_6357d9a8f0_z.jpg

http://www.turkanabasin.org/2015/09/ecologists-in-the-field/

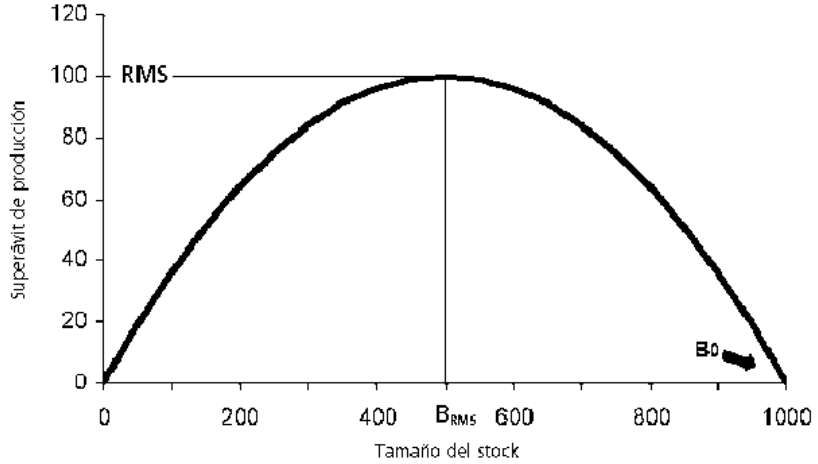
http://www.esa.org/fieldtalk/wp-content/uploads/2011/03/Fulton_080805_2756.jpg

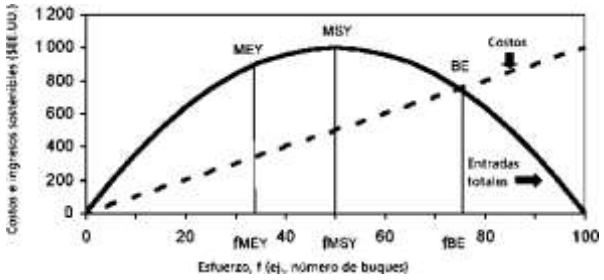


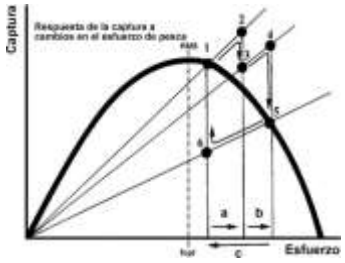
https://eoimages.gsfc.nasa.gov/images/imagerecords/55000/55167/earth_lights_lrg.jpg

Maximum and Sustained Yield of Natural Resources

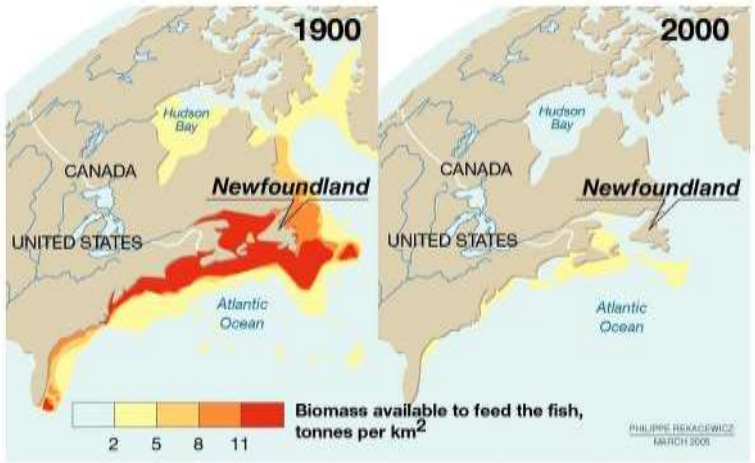
- Economics and engineering
- Fisheries, timber, livestock
- Optimization
- Maximization
- Minimization







Collapse of Cod Fisheries - North Atlantic



Sources: *Ecosystems and Human Well-Being, Synthesis*, Millennium Ecosystem Assessment, Washington DC, 2005; *Global Database on Marine Fisheries and Ecosystems*, Sea Around Us Project, Fisheries Centre, University of British Columbia, Vancouver, Canada (http://www.seaaroundus.org).

Climate Change and Sustainability

Urban & Climate Change (Google Scholar)

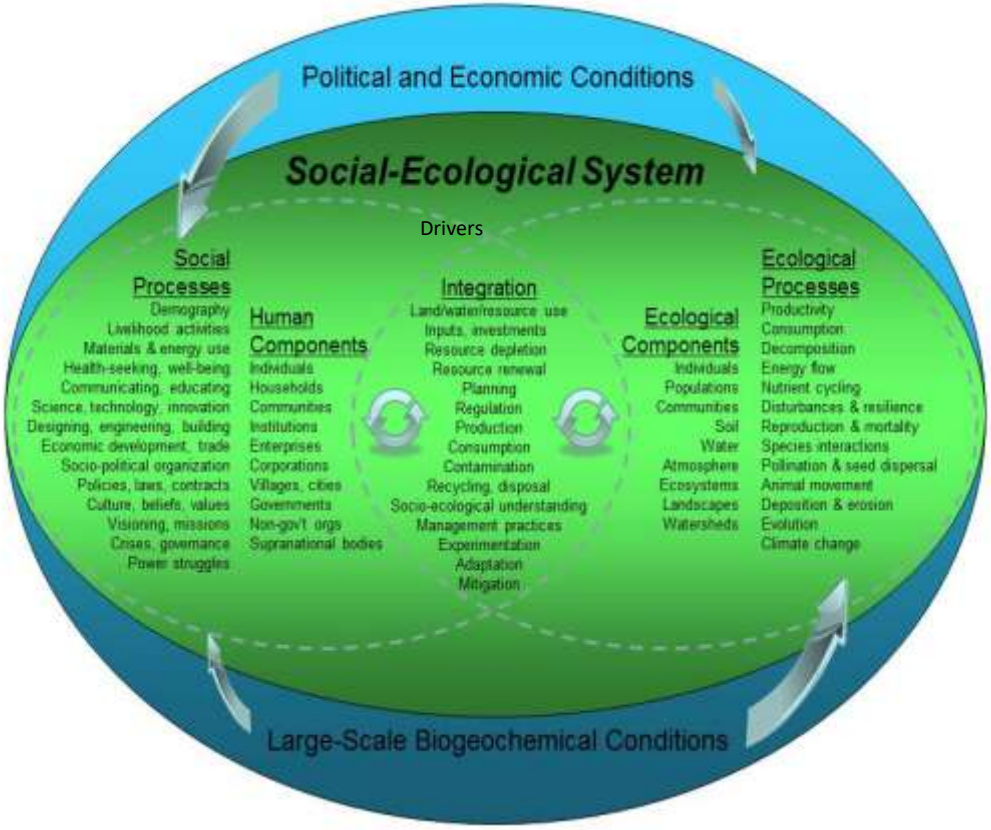
- 1.6 million publications
- Urban & sustainability = 1.4 million

http://cdn.images.express.co.uk/img/dynamic/78/590x/fires-698373.jpg

http://www.aljazeera.com/mritems/imagecache/mbdmegaxxlarge/mritems/Images/2017/4/2/2e2996fbf0074f6ab3bd8ad900a48ac4_9.jpg

Socio-Ecological Systems

- Complex, adaptable, dynamic
- Vary across space an time
- Transdisciplinary approaches
- Understand the biotic-abiotic as well as socio-economic, political and cultural



http://snre.ufl.edu/common/images/graduate/SocialEcologicalSystem.jpg

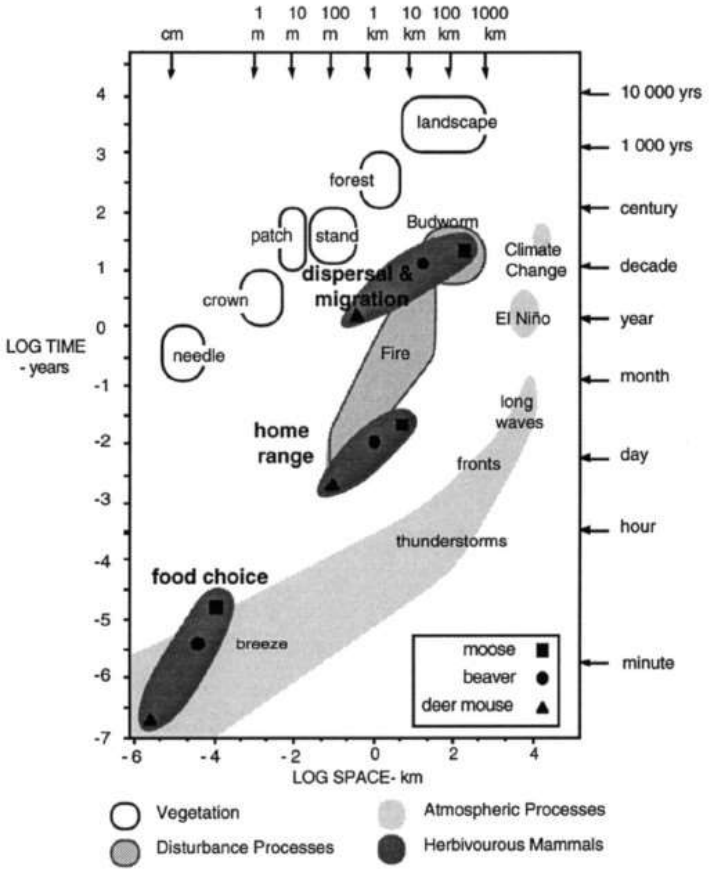
Resilience Alliance

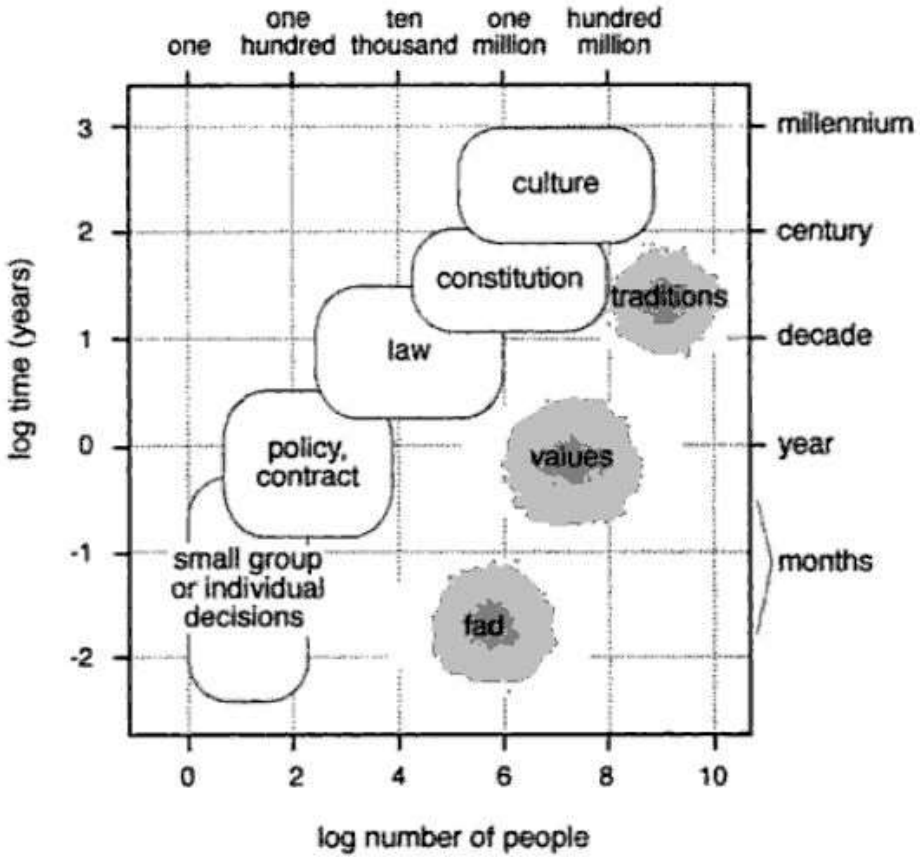
research on resilience in social-ecological systems - a basis for sustainability

Seven principles for building resilience in social-ecological systems:

1) Maintain diversity and redundancy
2) Manage connectivity
3) Manage slow variables and feed backs
4) Foster complex adaptive systems thinking
5) Encourage learning
6) Broaden participation
7) Promote polycentric governance systems

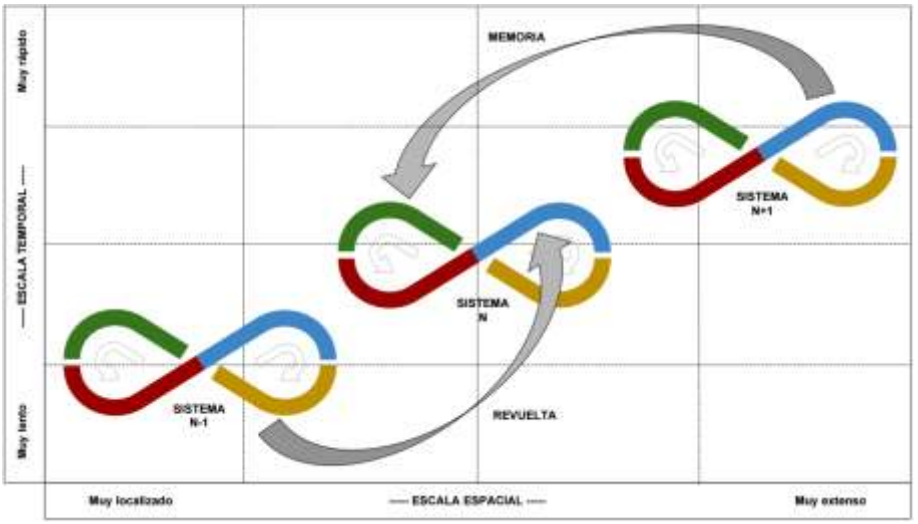
Socio-Ecological Scales

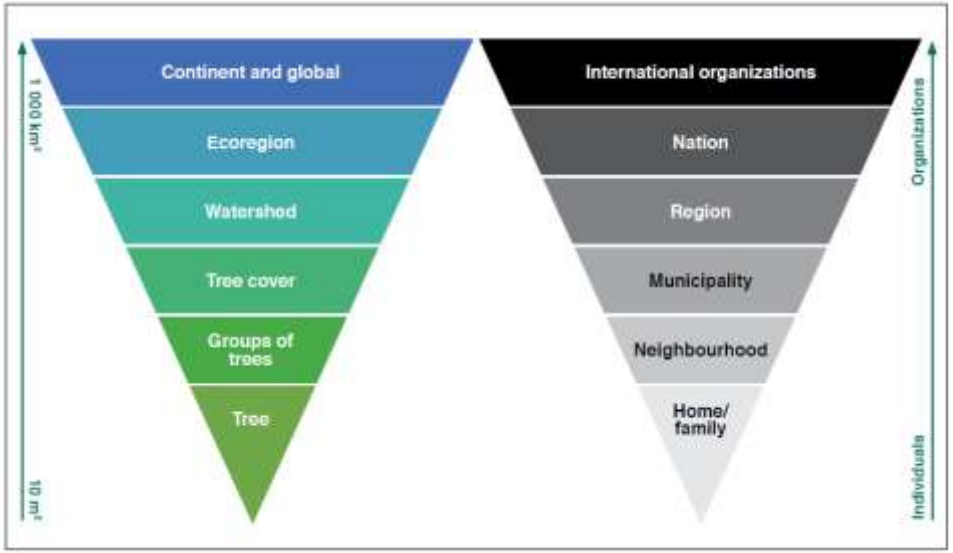




Socio-Ecological Scales

- Panarchys
  - Hierarchichal
  - Nested
  - Feedbacks
- Spatio-temporal
  - Socio-political
  - Biophysical
  - Interactions





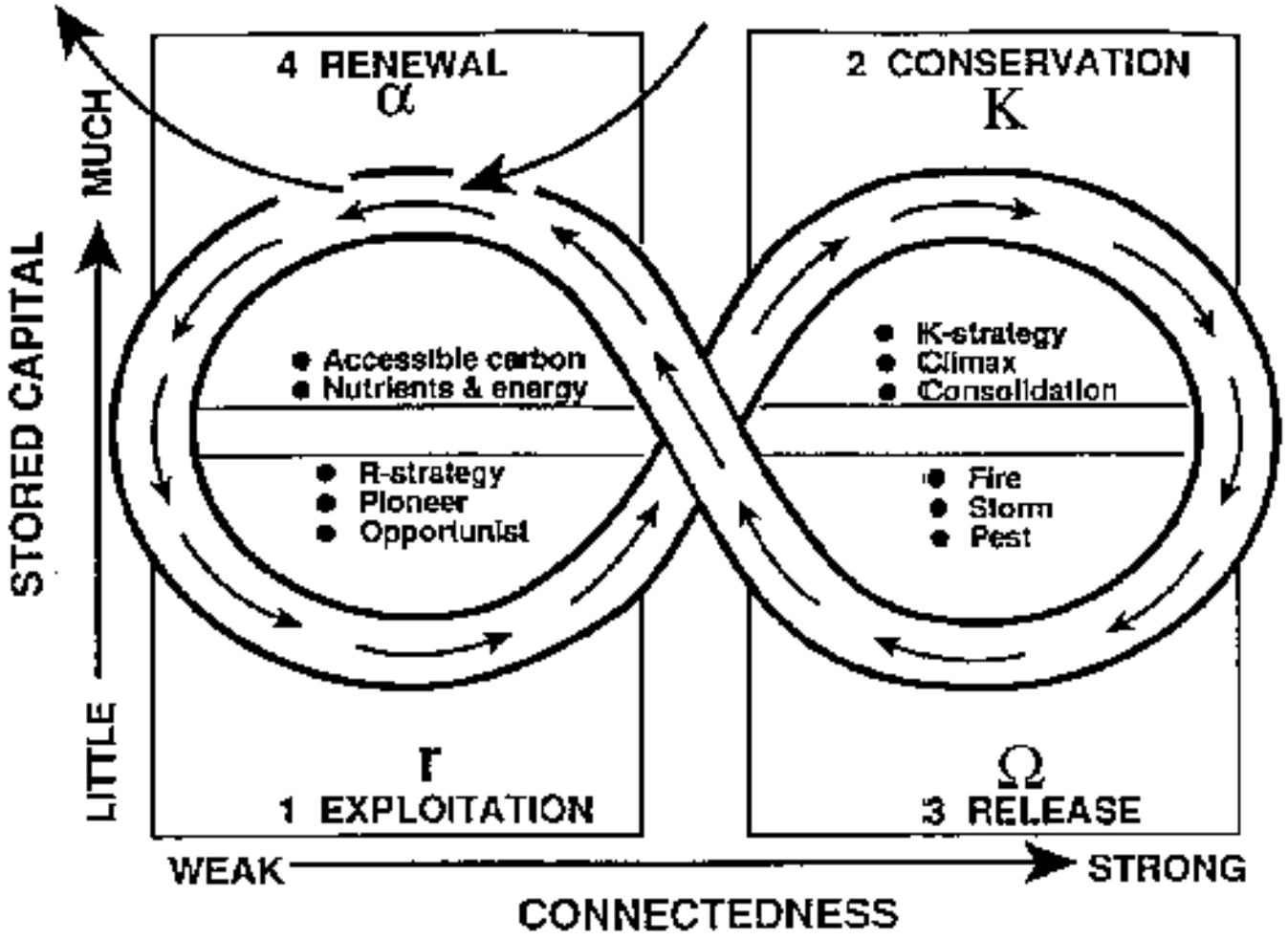
Disturbances

"A relatively discrete event in time that disrupts ecosystem, community or population structure and changes resources, substrate availability, or the physical environment." (White and Pickett 1985)



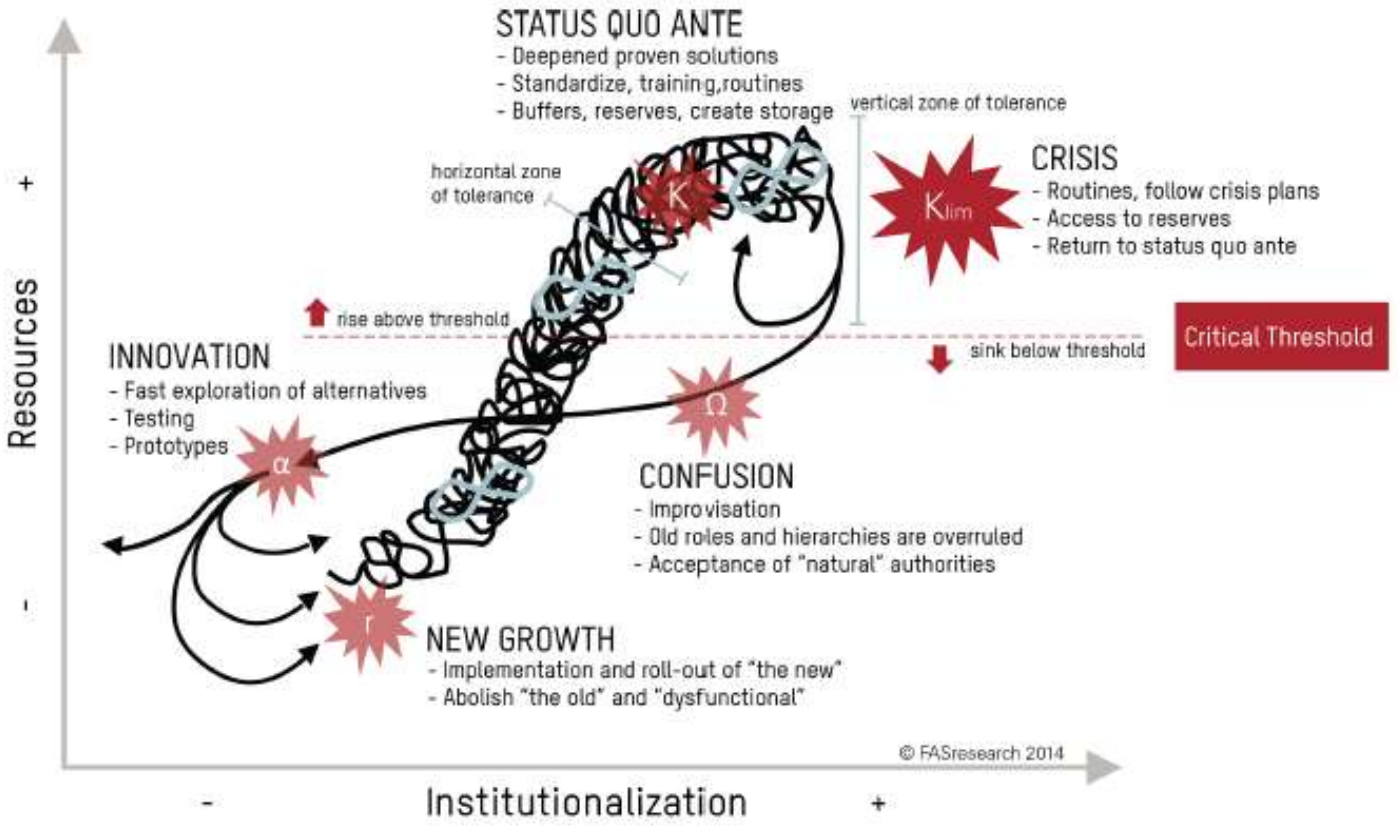



Adaptive Cycle



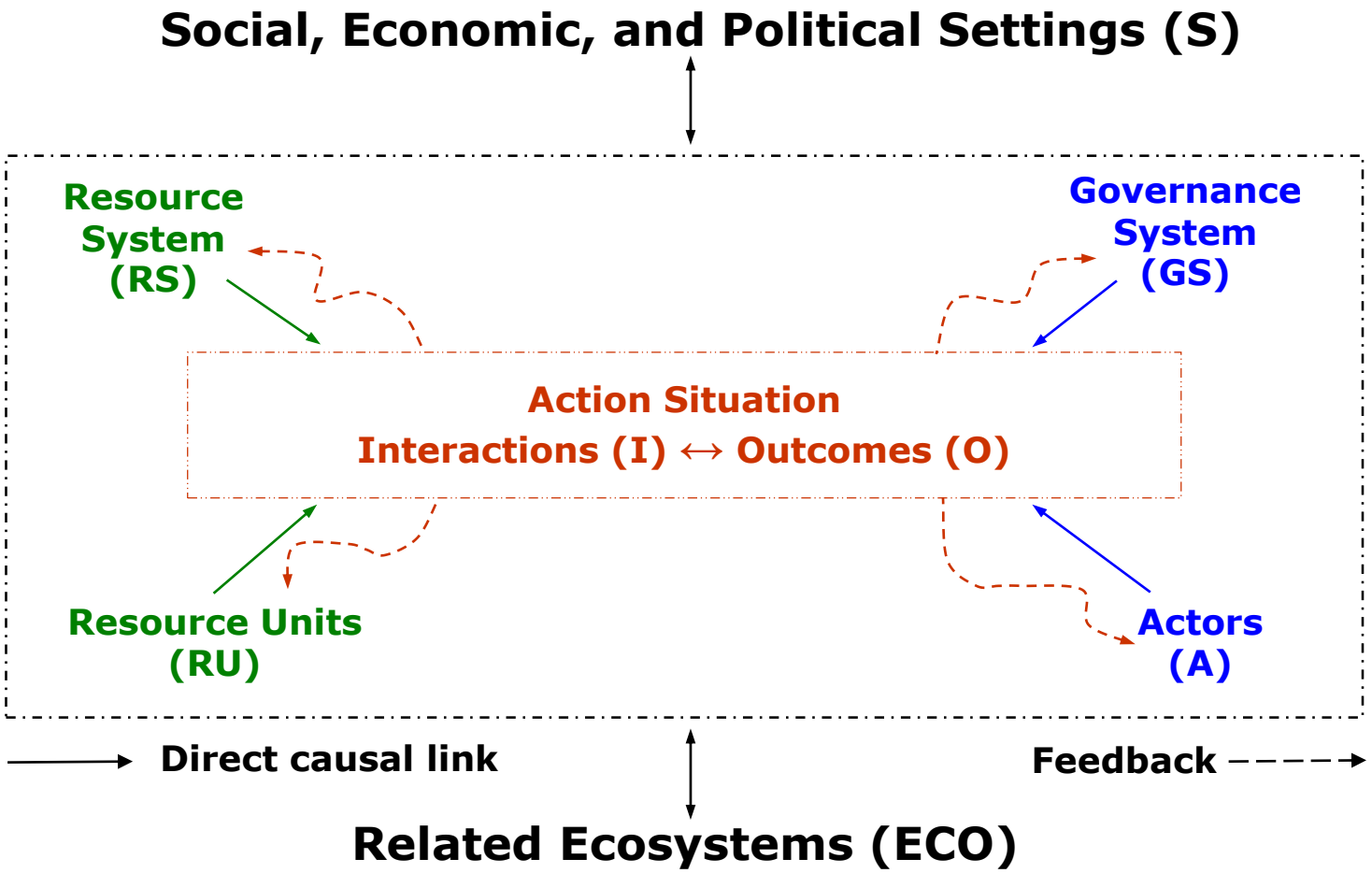
Adaptive Cycle- Social Systems

Fig. 3. Adaptive cycle applied to social systems. Stages in this cycle are similar to ecological stages, from new growth to status quo, to confusion, and innovation. The differentiation between crises that remain within the threshold and those that lead to dissolution are indicated by the vertical range of tolerance.



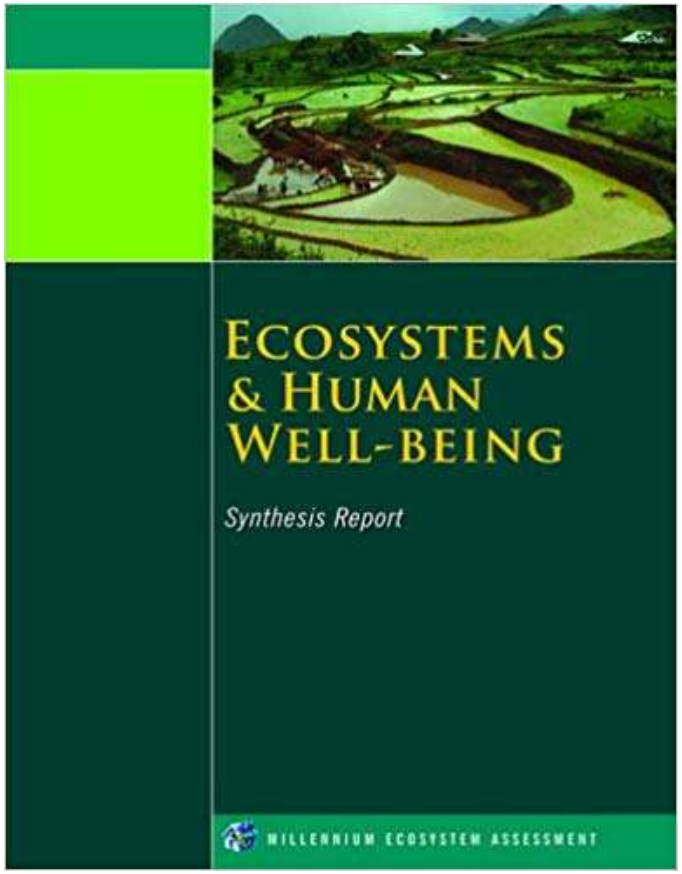
Fath, B. D., C. A. Dean, and H. Katzmair. 2015. Navigating the adaptive cycle: an approach to managing the resilience of social systems. *Ecology and Society* **20**(2): 24. http://dx.doi.org/10.5751/ES-07467-200224

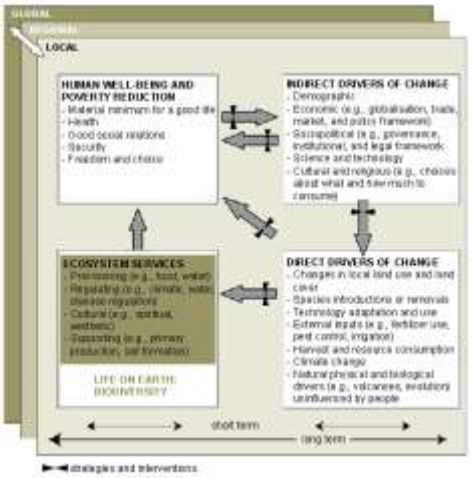
Frameworks

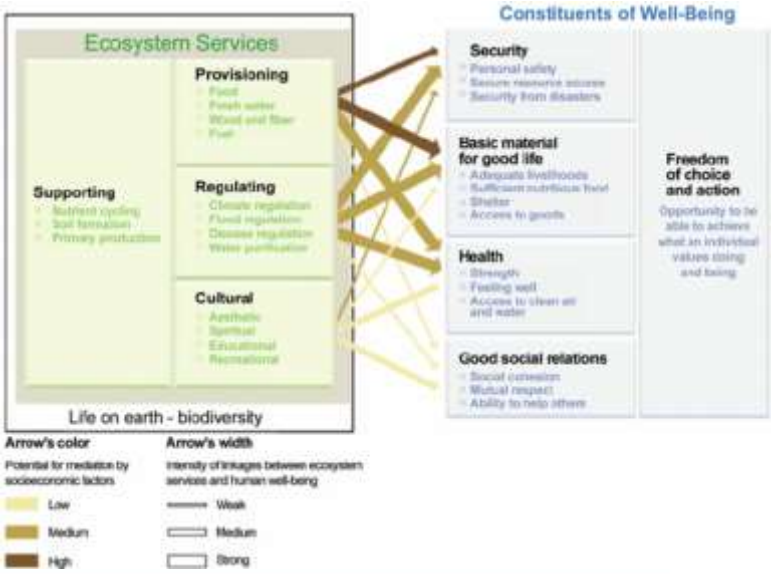


Source: Adapted from E. Ostrom (2007: 15182).

Millenium Ecosystem Assessment 2005

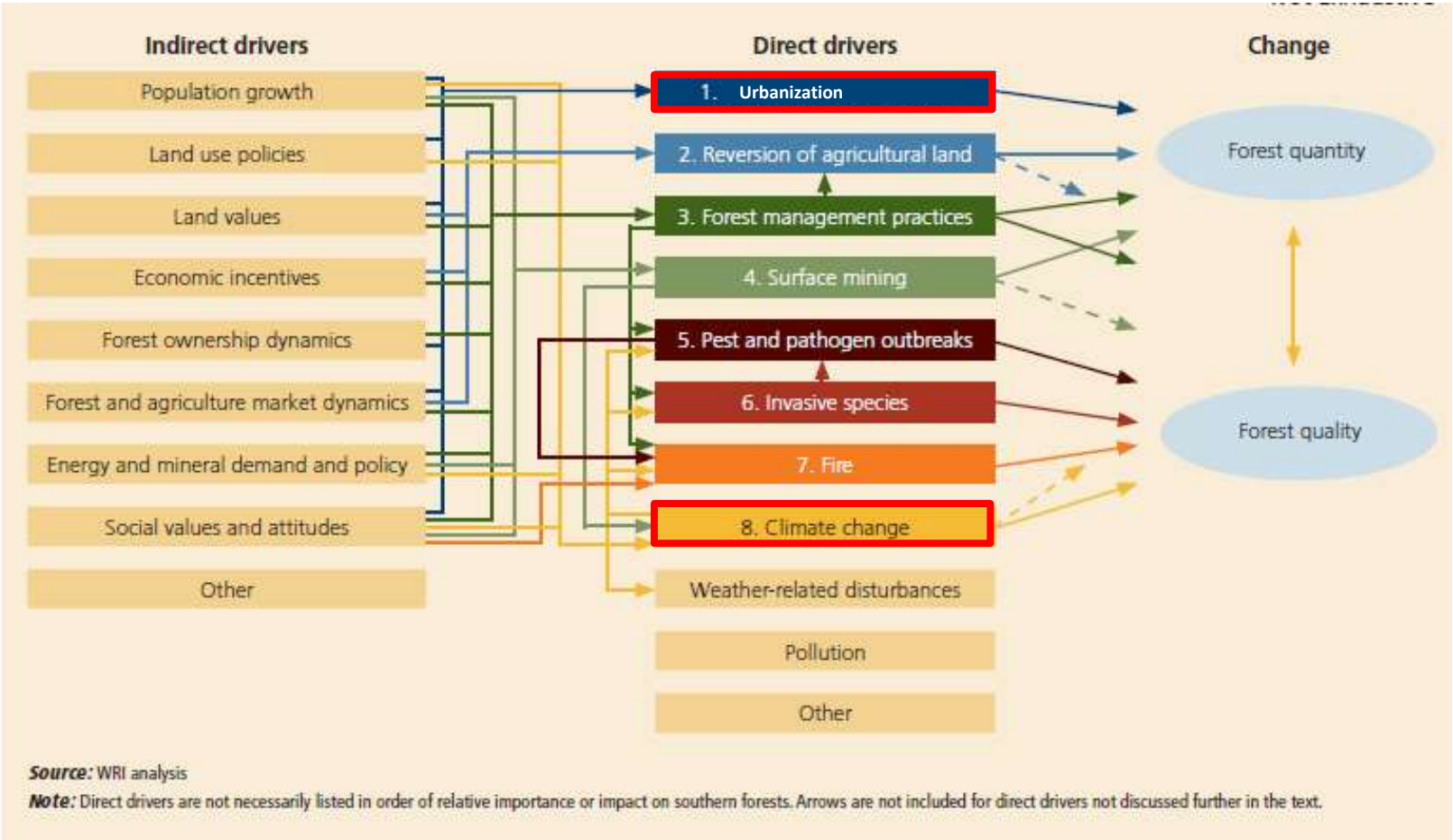






Drivers of change in ecosystems

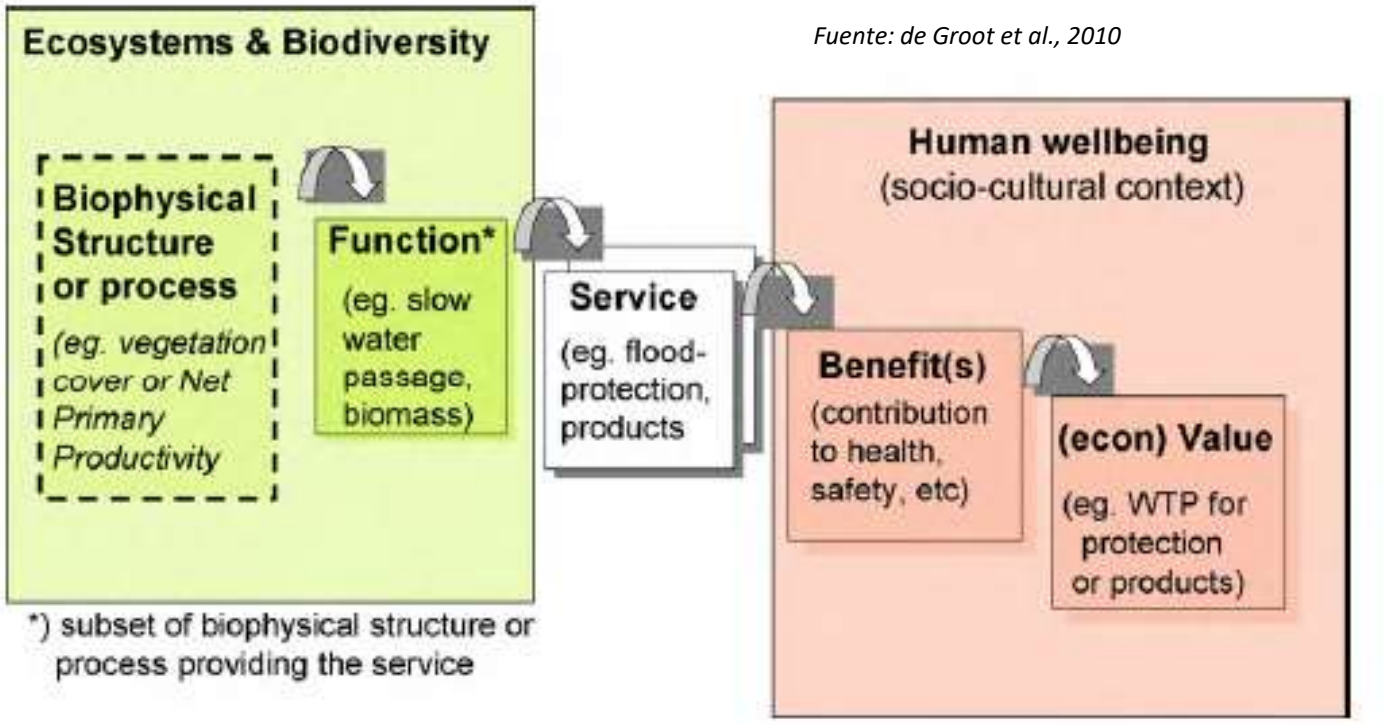
Drivers are ecological or human factors that can affect ecosystem composition and processes (MA, 2005)



Hanson *et al* 2010

Ecosystem Services

"the benefits people receive from ecosystems"



Fuente: de Groot et al., 2010

Fig. 2. Framework for linking ecosystems to human wellbeing (adapted from Haines-Young and Potschin, in press).

“ES AND Urban Forests AND GI AND NBS”

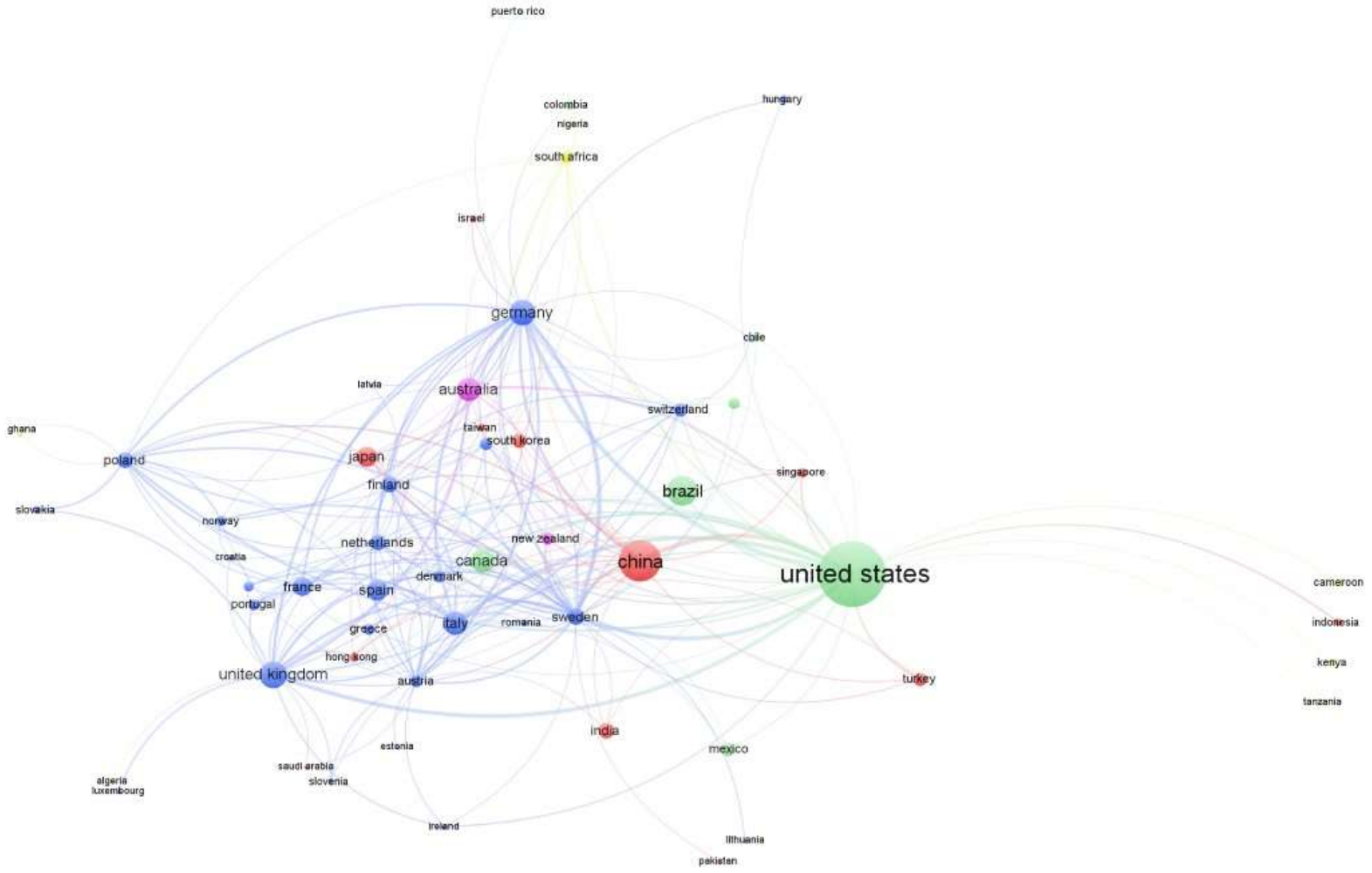


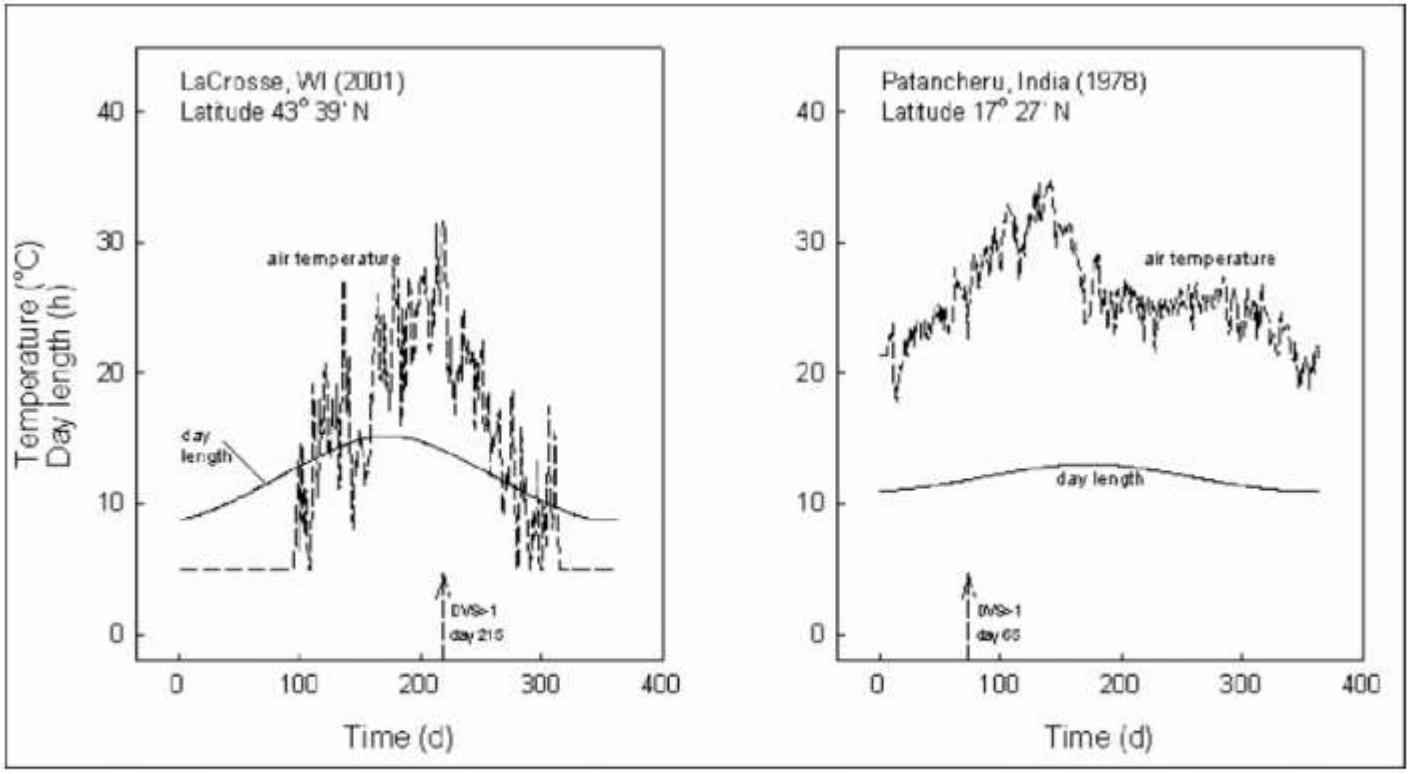
Figure: Vincenzo Guerni

Context and Metaphors

Environmental, social, political, and economic realities (and processes) that define the characteristics of a "socio-ecosystem"

Cultural narrative or frameworks that contextualizes socio-political values and permits the public to better understand complex concepts (Larson 2011)

Difference between Temperate and Tropical Climates



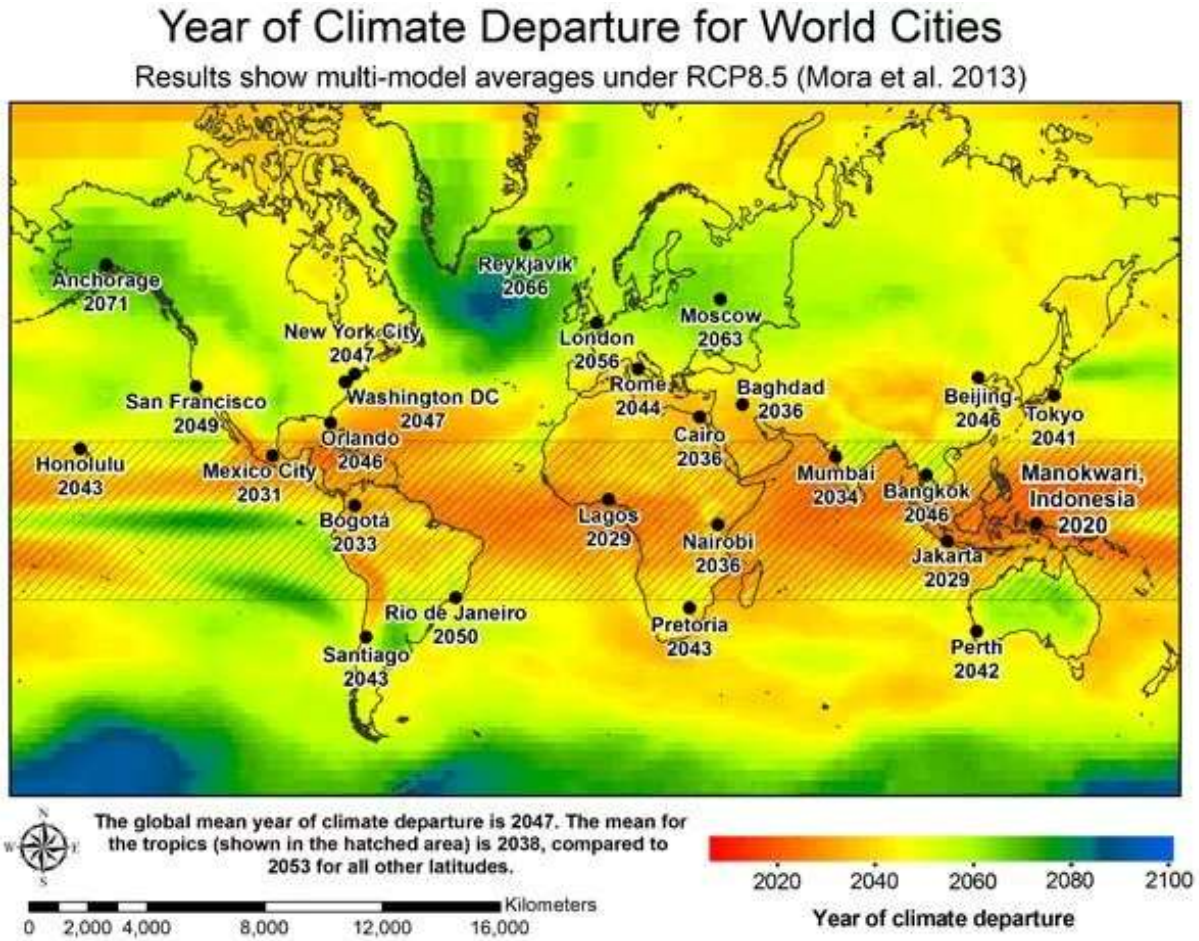
Day length and average temperature in a temperate (left) and tropical (right) climates. Flowering, indicated by DVS=1, occurs later in a temperate than in a tropical climate. Weather conditions: temperate, LaCrosse, WI, USA, 2001; tropical, Patancheru, India, 1978.

Expanded Simulation Models "Version 3.0" for Growth of the Submerged Aquatic Plants American Wildcelery, Sago Pondweed, Hydrilla, and Eurasian Watermilfoil - Scientific Figure on ResearchGate. Available from: https://www.researchgate.net/figure/Day-length-and-average-temperature-in-a-temperate-left-and-tropical-right-climates_fig2_235024095 [accessed 20 Jun, 2019]

Temperate Forests vs. Tropical Forests

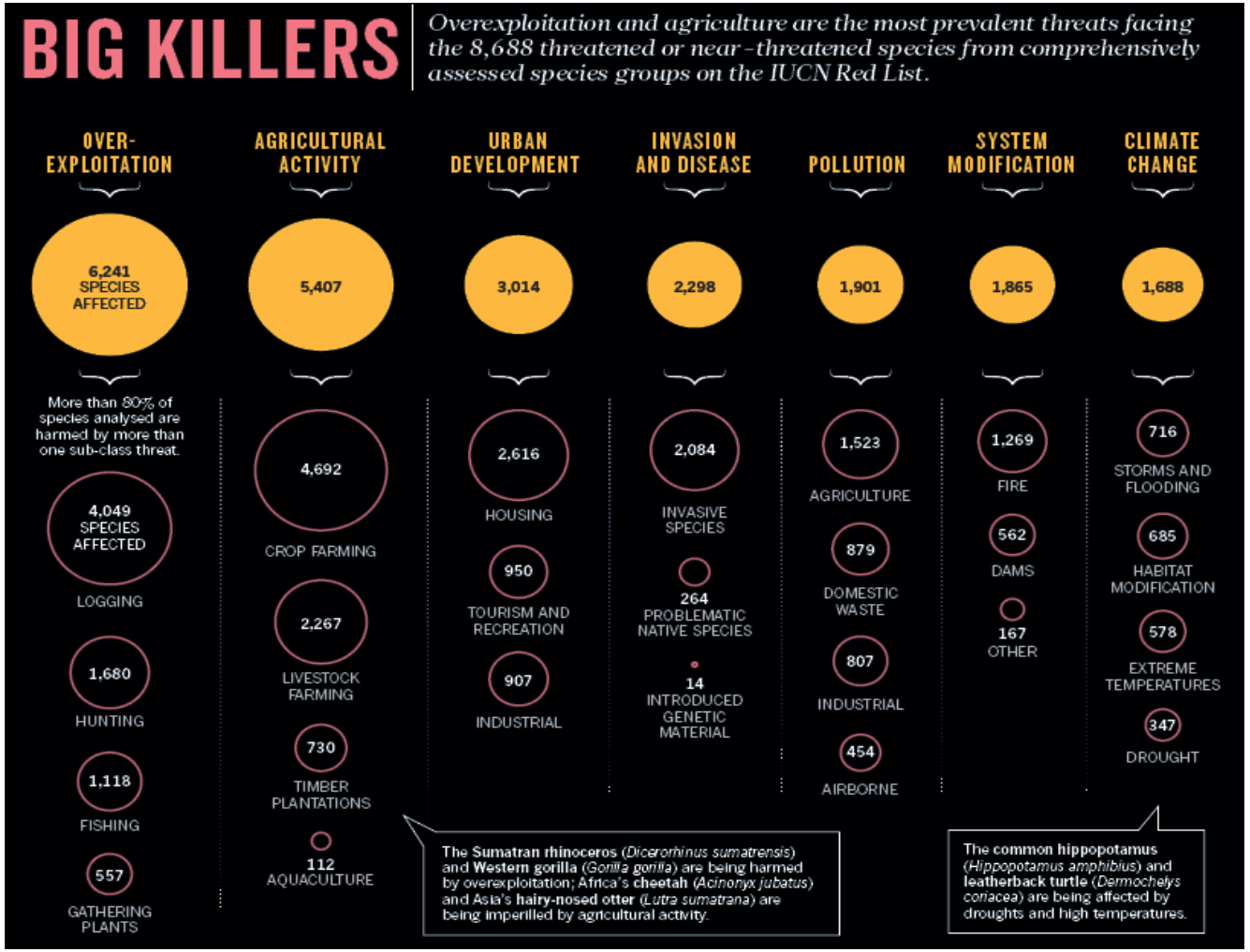
TEMPERATE	TROPICAL
• Slow decomposition	• Rapid decomposition
• One foot leaf litter	• One inch leaf litter
• Seven feet topsoil	• 2-3 inches topsoil
• Temperatures vary widely	• Fairly constant temperatures
• Three layers of vegetation	• Four layers vegetation
• Trees mostly wind pollinated	• Trees pollinated by animals
	• Greater biodiversity

Impacts



…..moment when average temperatures…… become so impacted by climate change that the old climate is left behind…

Climate Change Impacts and Biodiversity

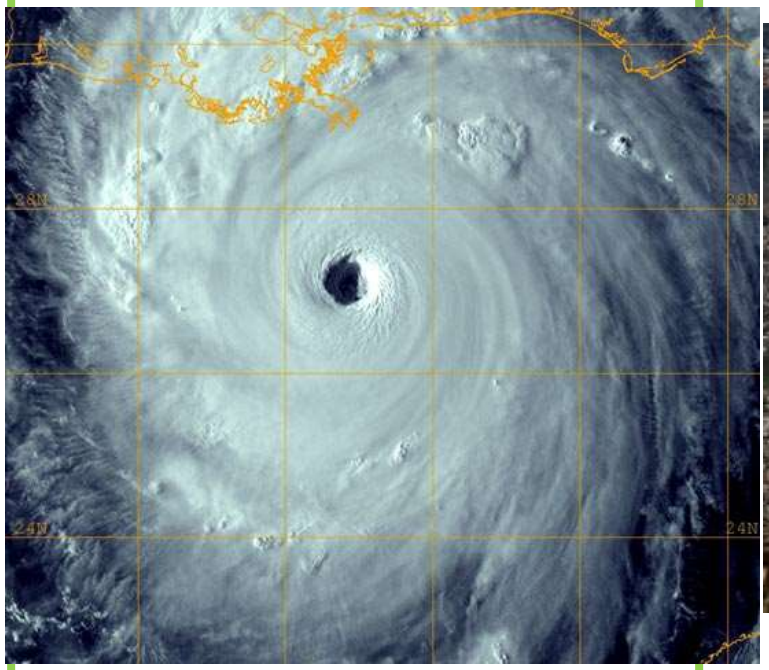


Maxwell, S.L., Fuller, R.A., Brooks, T.M. and Watson, J.E., 2016. Biodiversity: The ravages of guns, nets and bulldozers. *Nature*, *536*(7615), pp.143-145.

Examples urbanization and hurricanes

State of Florida in the United States

URBANIZATION

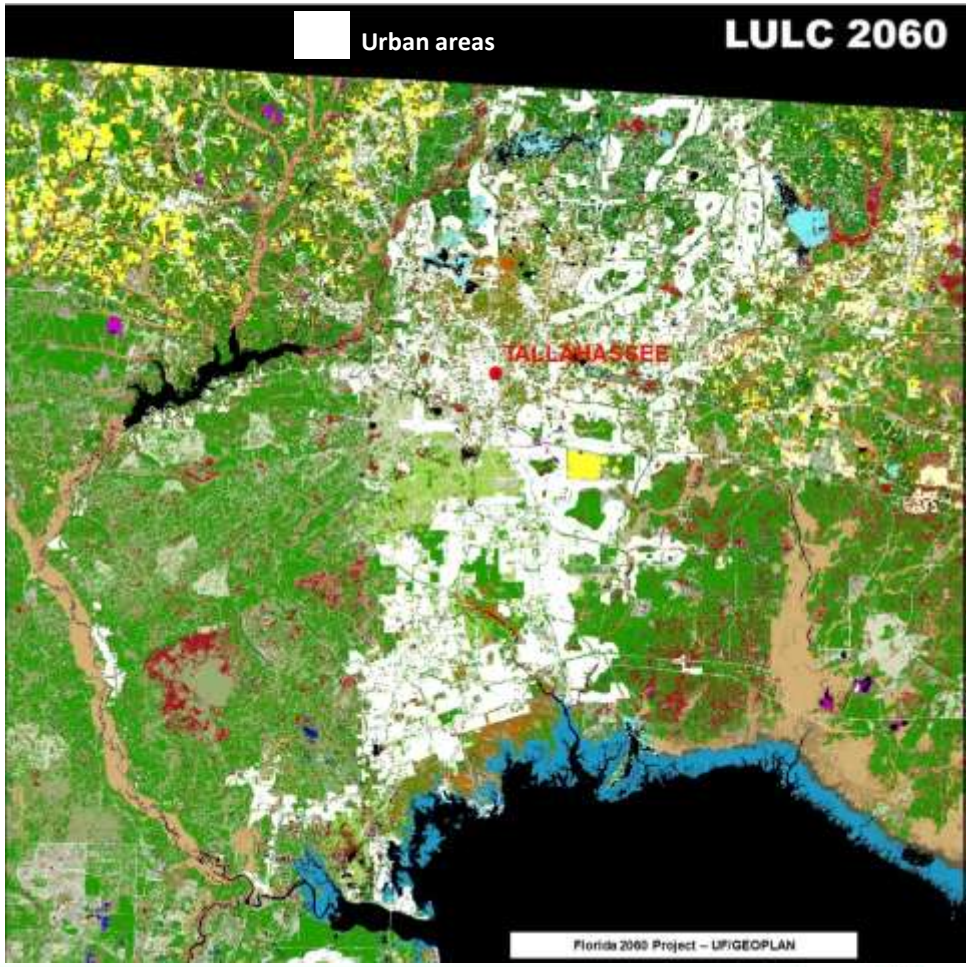


HURRICANES

http://coastal.er.usgs.gov/flash/gallery.html

Urbanization changes ecosystems

- Fragmentation of forests
- Alters climates and air quality
- Changes supply and demand of resources
- Alters water quantity and quality



Disturbance and “change” affects not only humans but fauna as well

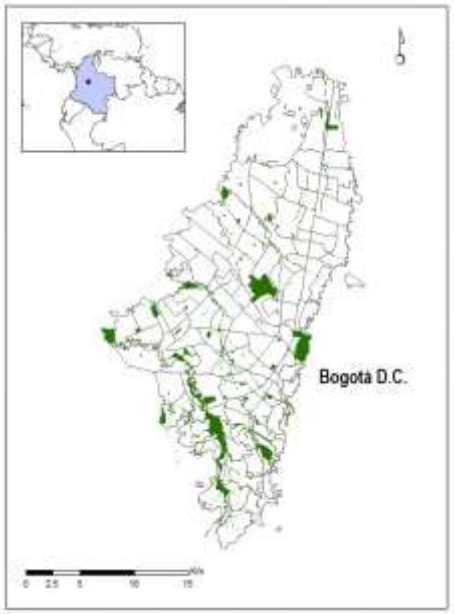
Ditchkoff, S.S., Saalfeld, S.T. and Gibson, C.J., 2006. Animal behavior in urban ecosystems: modifications due to human-induced stress. *Urban ecosystems*, *9*(1), pp.5-12.

Clucas, B., Marzluff, J.M., Mackovjak, D. and Palmquist, I., 2013. Do American Crows Pay Attention to Human Gaze and Facial Expressions?. *Ethology*, *119*(4), pp.296-302.

Longcore, T. and Rich, C., 2004. Ecological light pollution. *Frontiers in Ecology and the Environment*, *2*(4), pp.191-198.

Public forests in and around Bogotá Colombia

- ✓ More tree diversity, density, and “leaf area” in higher income areas
- ✓ More trees = more climate regulation; increased property premiums
- ✓ People in parks in middle income areas perceive greater levels of “well-being”
- ✓ Greater well-being in larger parks

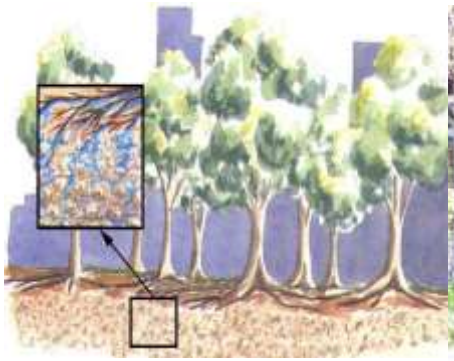


Scopelliti, M., Carrus, G., Adinolfi, C., Suarez, G., Colangelo, G., Lafortezza, R., Panno, A. and Sanesi, G., 2016. Staying in touch with nature and well-being in different income groups: The experience of urban parks in Bogotá. *Landscape and Urban Planning*, *148*, pp.139-148.

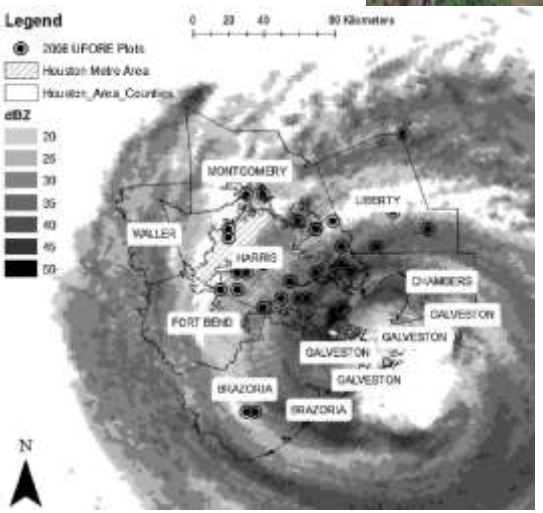
Escobedo, F.J., Clerici, N., Staudhammer, C.L. and Corzo, G.T., 2015. Socio-ecological dynamics and inequality in Bogotá, Colombia's public urban forests and their ecosystem services. *Urban Forestry & Urban Greening*, *14*(4), pp.1040-1053.

Urban and peri-urban areas are socio-ecological systems

- Complex of anthropogenic and “natural” systems
- Ecology *in* cities
  - Biophysical environments, soils, vegetation, fauna y humans
- Ecology *of* cities
  - Systems approach to understand multiple processes (e.g., metabolism)
- Ecology *for* cities = Solutions



Measuring and Monitorig Urban and Peri-Urban Forests



Hurricanes

Escobedo, F., Luley, C., Bond, J., Staudhammer, C., Bartel, C., 2009. A hurricane debris and damage assessment for Florida urban forests. Arboriculture and Urban Forestry, 35(2): 100-106.

Mail survey of community leaders: 578 (22% responded) in Broward (A) & 641 (27% Responded) Hillsborough (B)

- Assess HOA leaders n urban forests
- Asses what influenced their answers

1. What do community leaders think of the benefits and costs of urban forests?

Wyman, M., Escobedo, F., Stein, T., Orfanedes, M., Northrop, R. 2012. Community leader perceptions towards coastal urban forests and hurricanes in Florida. Southern Journal of Applied Forestry,

Perceptions and Realities: Trees and Hurricanes

- ✓ 1,219 community leaders
- ✓ Value: shade, aesthetics, & property price increases
  - ✓ Do not value damage from hurricanes
- ✓ *Air and water quality not important*

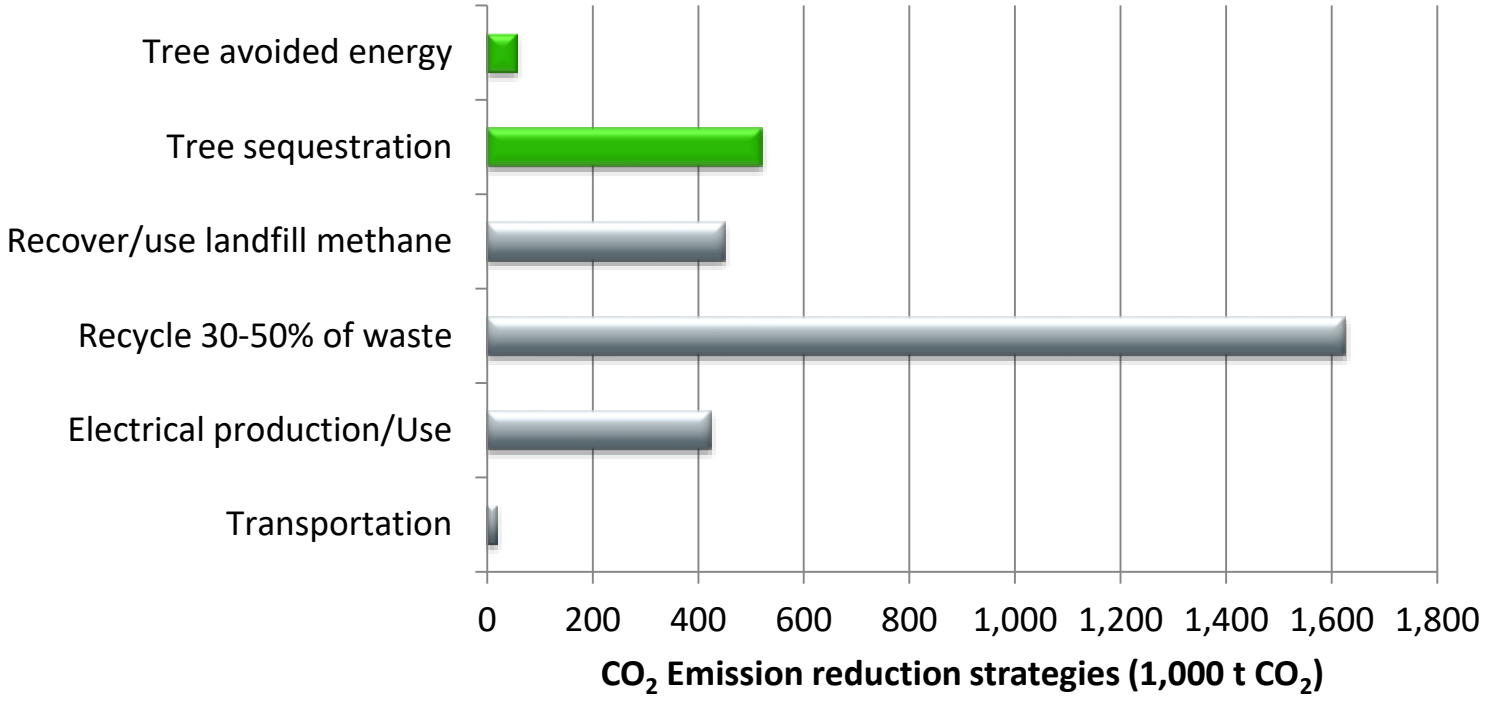
- Cities in Florida USA with greater tree densites = less tree biomass
- Of >1,500 tree samples, following a hurricane, < 5% actually damaged homes

Escobedo, et al., 2009. A hurricane debris and damage assessment for Florida urban forests. Arboriculture and Urban Forestry, 35(2): 100-106

Carbon Offsets by Forests

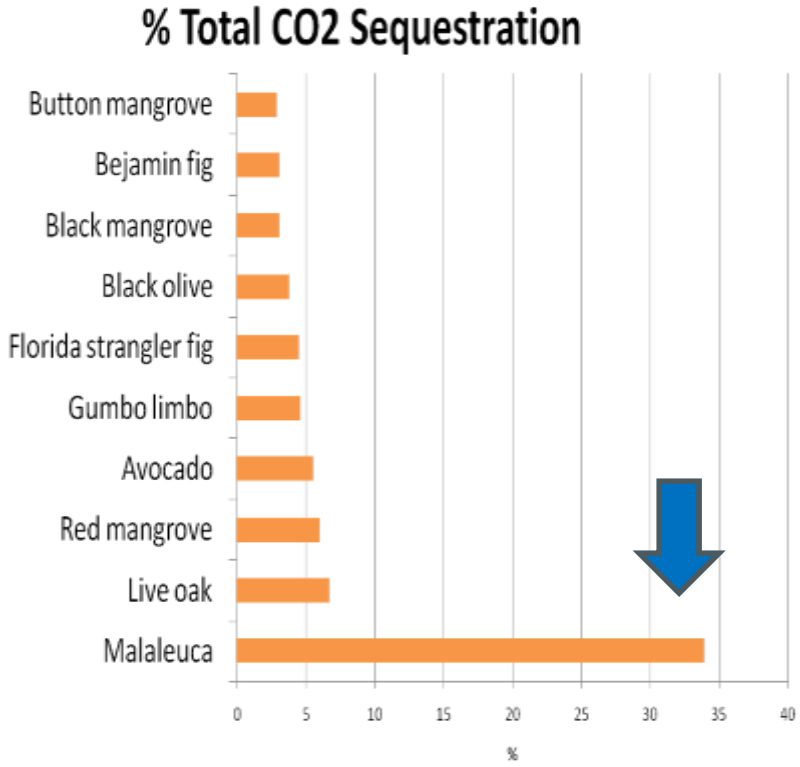
- Hangzhou, China: 14% of industrial emissions
- Gainesville, Florida (US) offset 3% of carbon dioxide emissions

Lesson- Communicate Relevant Results



Trees comparable to other CO_2 reduction strategies in Miami-Dade

Policy Implications: Forests & Carbon offsets in Miami-Dade (US)



Short and long-term tradeoffs among land management, restoration objectives, invasive species and climate change mitigation policies

Szantoi et al 2012. Socioeconomic factors and urban tree cover policies in a subtropical urban forest. GIScience and Remote Sensing, 49:428-449.
Flock, et al. 2011. Environmental justice implications of urban tree cover in Miami-Dade County, Florida. Environmental Justice, 4: 125-134.

Consumer Demand for Urban Forest Services-Disservices: Choice Experiments

Referendum: Florida Neighborhood Urban Forest Program
(Check one option as the most important and one option as the least important)

Most Important		Least Important
☐	High tree shade	☐
☐	Above $4,800 increase in property value (more than 3 trees)	☐
☐	Good condition (no poor condition trees)	☐
☐	$10.00 monthly utility tax	☐

Would you enroll in this program? Yes ☐ No ☐

Florida USA

- People distinguish between private and "community" benefits
  - Will NOT pay for disservices
- Property Value has the highest impact on urban forest preferences, followed by Tree Condition and Tree Shade.
- To increase participation design programs that cost < US$7.00 per month
  - while maintaining good condition trees that provide high shade.

Lesson- Develop Context Relevant Solutions
Example Florida, US & Rosario, Argentina

- *Water quantity and air quality not important in Florida;*
  - *Hurricanes & Temperature are important*
- *Carbon offsets are minimal; need to account for co-benefits and tradeoffs*
- *People recognize scaling effects and non-monetary benefits*
  - *Science difficult to disseminate to public*

- *Given economic crises early 2000s, Urban Agriculture more important than urban forestry*
  - *Department within the Municipality*
- *Modeled and developed guidelines for the temperature effects*
  - *0.2 ha garden = 2.3 ha parks*

Escobedo, F., Luley, C., Bond, J., Staudhammer, C., Bartel, C., 2009. A hurricane debris and damage assessment for Florida urban forests. Arboriculture and Urban Forestry, 35(2): 100-106.

Coronel et al 2015.. Effects of urban green areas on air temperature in a medium-sized Argentinian city. AIMS Environmental Science, 2(3): 803-826.

Colombia










- *Pop. of 50 Million (75% Urban)*
- *4th largest S. American country*
- *OECD country*
- *Recent Peace accord with FARC after 50 year conflict*
  - *Increase in deforestation*
- *GINI coefficient of 50.8*
  - *2nd highest in America*
- *Most biodiverse country / km²*
  - *More bird, amphibian, butterfly, and frog species than anywhere else in the world*
- *Mangroves-forests-glaciers*
- *Bogota 8 million (4,310/km²)*
  - *1,775 km²*

Objectives and Study Areas

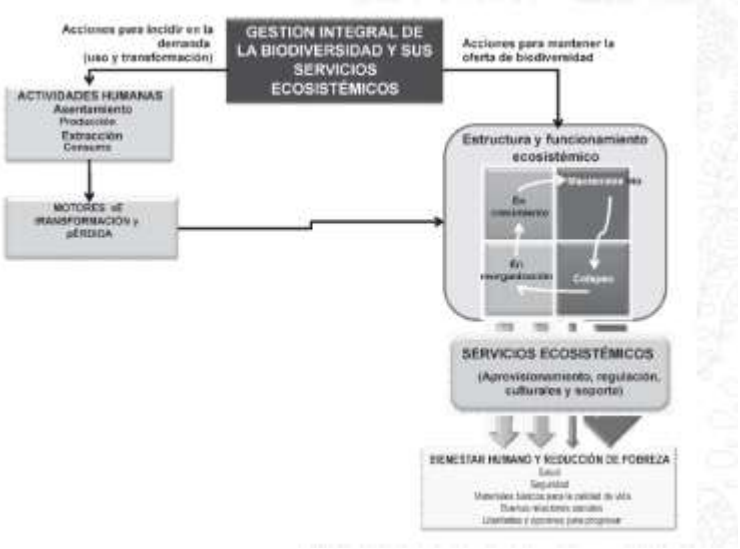
Characterize the socio-ecological dynamics of upper Andean secondary forests adjacent to Bogota and effects of climate change on ecosystem services;

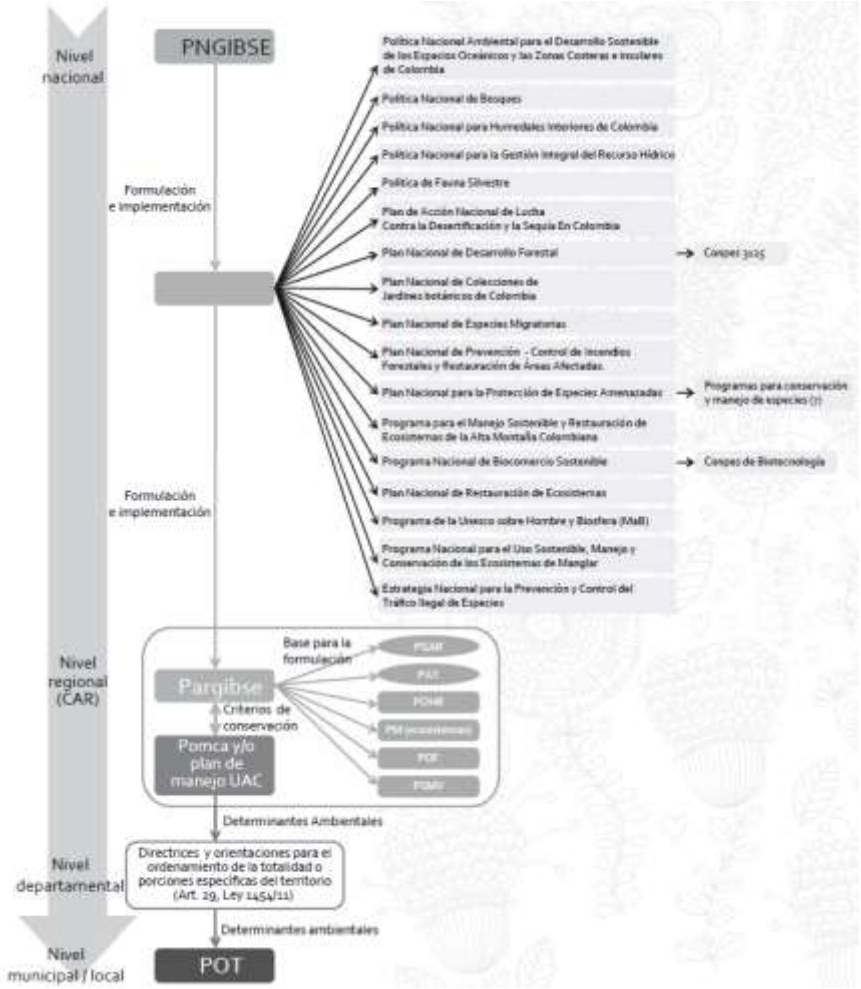
1. How do you “parameterize” climate change effects?
2. How do we provide useful information to decision makers?
3. How do you account for the unique socio-ecological context?
4. How do you parse out climate change from other environmental factors?

Context

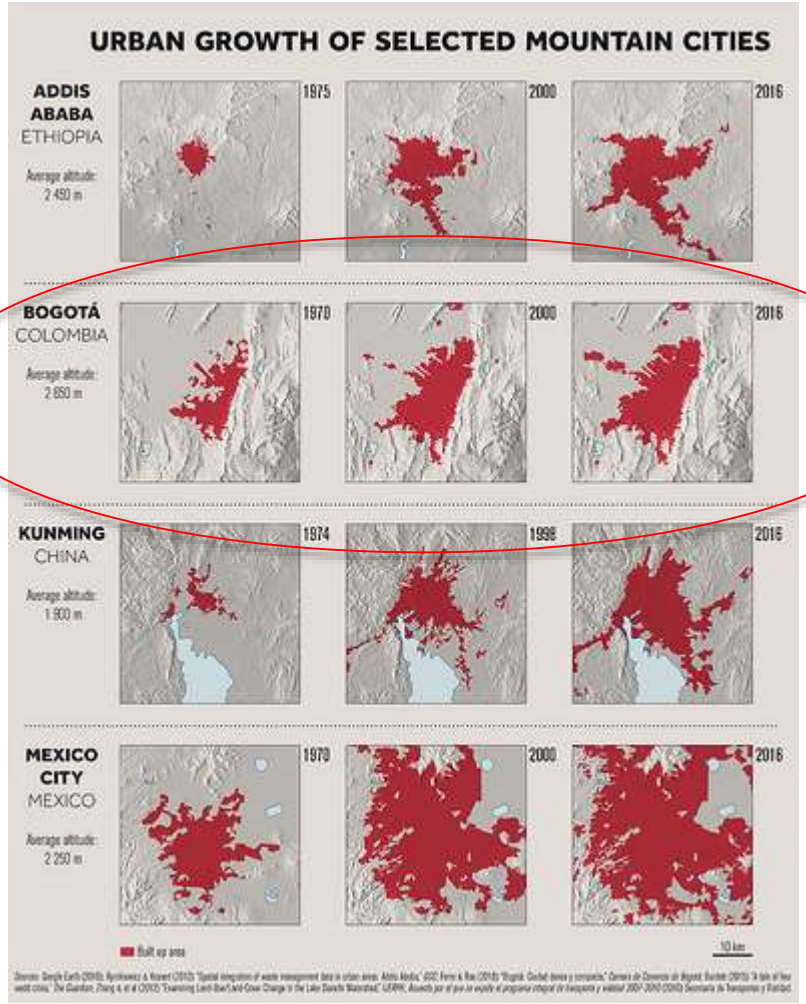
- Lacking geospatial and hydrometeorological data
- Social actors and decision makers difficult to engage
- “Unwillingess to pay” due to perceived corruption
- Value “biodiversity”
- Well formulated policies
- Implications for modelling, valuation, governance

National Policy for the Integrated Managment of Biodiversity and its Ecosystem Serivces (PNGIBSE)





Context

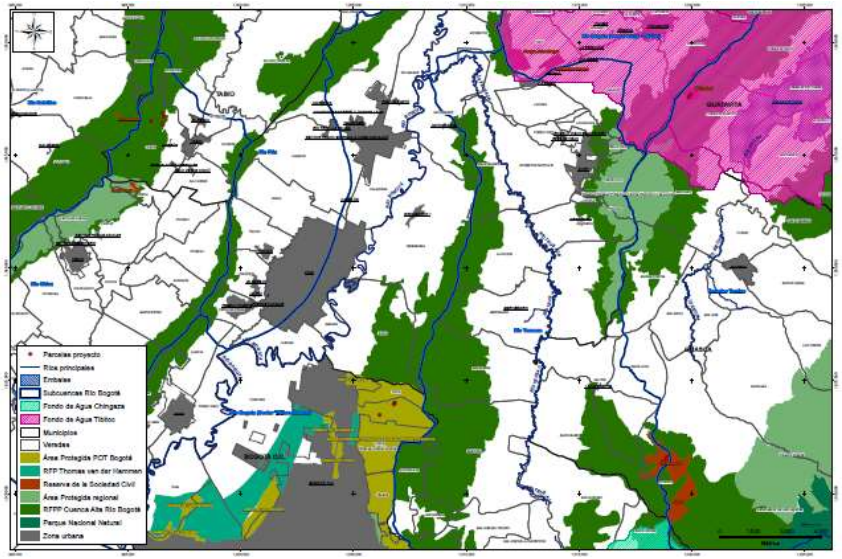


http://www.grida.no/resources/5039

2002-10 changes: ***Forests +42%;*** *Urban +110%; Agriculture -22%*

Complex matrix of actors, governments, landowners

- Modern well structured policy
- Populace that values "biodiversity"
- *Growth rates & Lack of data*
- *Weak governance*
  - *Transparency*
- *Socioeconomic inequities*
- *Survey instruments difficult to implement: safety and literacy*



Typical Quantitative Modeling

Plot and Remote Sensing data

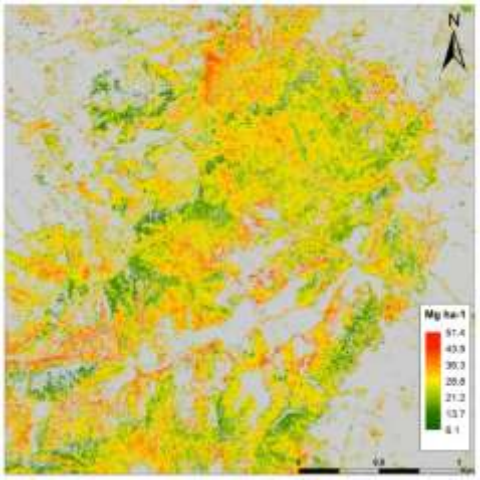
Conversion of Land Use- Effects (Dyna-CLUES) model & Expert elicitation

Hydrologic forecasting (SWAT): *IPCC hydro-meteorological projections*

Spatially explicit maps and trajectories

Spatial Social Valuation

Carbon stocks



SWAT Soil & Water Assessment Tool

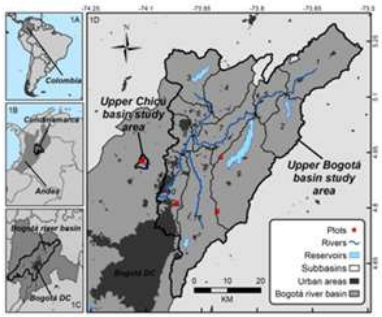
USGS science for a changing world
Social Values for Ecosystem Services (SolVES)

Policy Implications

Climate Change (*IPCC-based data for 2016 & 2046*)

Land Use – Land Cover Change (*Land cover classification, expert elicitation, & DYNA-CLUE model*)

Water Yield and Carbon Sequestration ecosystem services (*InVEST model, land cover classification, IPCC hydro-meteorological data*)



Integrated, multi-decade synergistic assessment of the cumulative effects on ecosystem services in peri-urban areas of the Colombian Andes

Need to incorporate LULC –Climate Change criteria into land management, planning, and policies to maintain ESS particularly in peri-urban agricultural-pasture lands

Urbanization alters forests & agricultural lands

Climate Change overwhelms LULC effects

Socio-ecological drivers affect ecosystem capacity to sequester carbon and regulate water yield

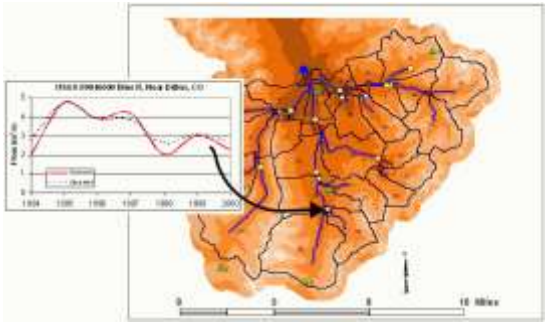

Science of The Total Environment

Spatio-temporal and cumulative effects of land use-land cover and climate change on two ecosystem services in the Colombian Andes

Universidad del Rosario | Biología

Participatory Cartography: Social Valuation

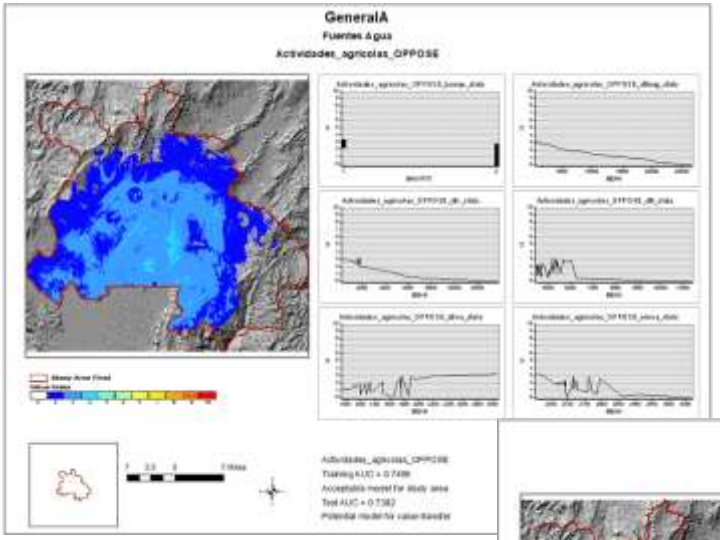
Urban and peri-urban actors*: Structured interviews Using 3-D versus mapped landscapes

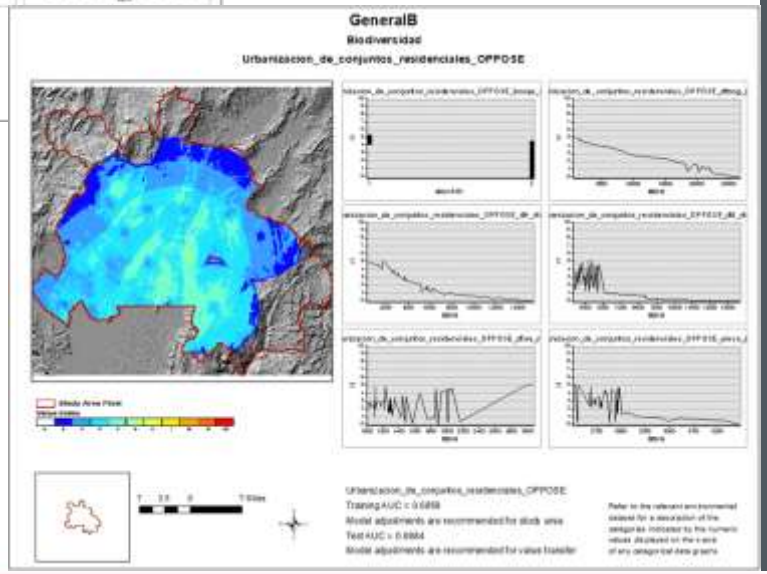


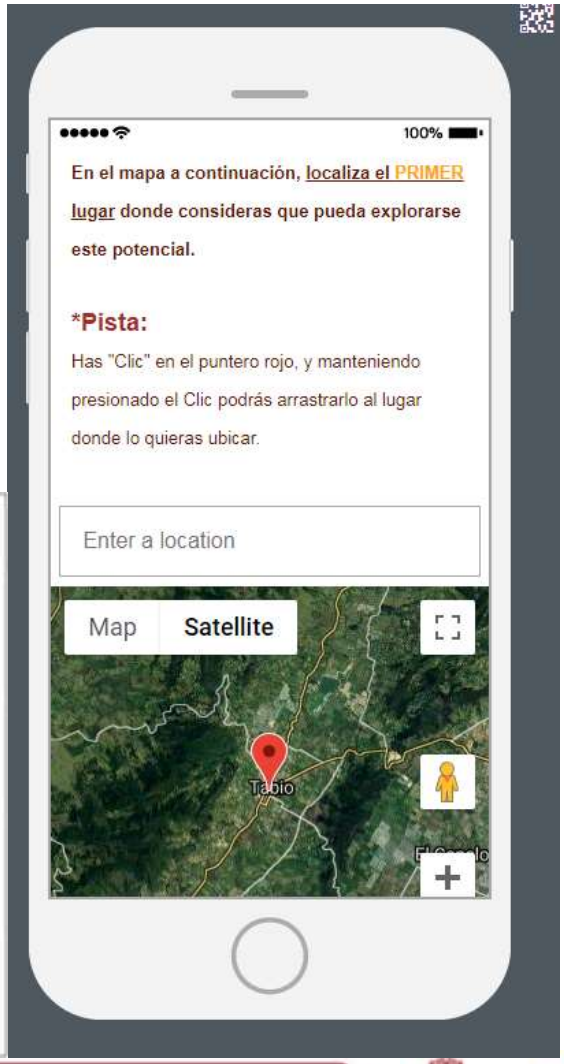
- Urbanites and young adults not able to identify 1 landmark; opposite for more peri-urban interviewees
- Both prioritized water regulation ES; no statistical difference
  - Urbanites heterogeneous responses (air quality)
  - Peri-urban homogenous (invasive)
- Numbers engaged and time spent very different
  - Young and older were more interested

* 30 urban, 30 peri-urban 15 map x15 3-D; **Common International Classification of Ecosystem Services

Spatial Valuation Using On-line Survey







Project Findings

- Land use zoning decisions can increase the severity of climate change
- “Cognitive burden” of understanding complex ecological procesees
- Disparity in how people read “maps”
  - Basic cardboard 3-D maps and Smart Phones have advantages
- “Unwillingness to pay for conservation”
  - Implications for trust and performance of governments

Conclusions

- Science-based information
  - Has to be adjusted for context (region and audience)
- Need to communicate importance of climate change
  - Use most appropriate methods; Benefits need to be direct
- Management needs to address user needs
  - What and how local people value ecosystem services

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